2016

Social Capital And Social Networks: The Importance Of Social Ties For Health Among Residents Of Disadvantaged Communities

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SOCIAL CAPITAL AND SOCIAL NETWORKS: THE IMPORTANCE OF SOCIAL TIES FOR HEALTH AMONG RESIDENTS OF DISADVANTAGED COMMUNITIES

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Philosophy in

Health Promotion, Education, and Behavior

The Norman J. Arnold School of Public Health

University of South Carolina

2016

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DEDICATION

This work is dedicated to my family, friends, and colleagues. Thank you for giving me the time, space, and support to pursue my own dreams, today and always.

Thank you to my family for allowing me to move so far away and forgo many family responsibilities, milestones, and celebrations. So much has changed these past few years, but I am so glad we have not grown apart.

Thank you to my friends, near and far, old and new, who kept me company on this adventure.

Thank you to my colleagues, both academic and otherwise, who engaged with me in thoughtful conversations around research, life, the bigger picture, and everything in between.

None of this would have been possible without you.

ACKNOWLEDGEMENTS

I would like to take this opportunity to acknowledge my tremendously supportive and thoughtful committee members, Dr. Andrew Kaczynski, Dr. Spencer Moore, Dr. Katrina Walsemann, and Dr. Nancy Fleischer who challenged me to think critically and to pursue high-quality, applicable research throughout my years in the doctoral program. Your time, efforts, and enthusiasm are greatly appreciated.

I would also like to thank Dr. Alex McLain for providing statistical expertise and support for the dissertation. This work is indebted to your creativity.

Additionally, this work would not have been possible without generous funding from the Vice President's Office of Research at the University of South Carolina (ASPIRE Award), as well as the BlueCross BlueShield Foundation of South Carolina.

Lastly, I must acknowledge the participants, organizers, and champions of the Greenville Healthy Neighborhoods Project, including Sally Wills, Yvonne Reeder and the neighborhood association presidents. The type of work that we seek to do is not possible without the buy-in and support of the communities we strive to improve. Thank you for trusting me, inviting me into your communities and homes, and for sharing your story with me.

ABSTRACT

Access to social capital via social networks is important for health and may be linked with chronic disease, including obesity and hypertension. Socioeconomic status (SES) may influence access to social capital and social network characteristics, and may also moderate the relationship between social capital, social networks, and health. Yet few studies have explored relationships between social capital, social networks, and chronic disease among resource poor individuals.

Respondent-driven sampling was employed to recruit participants (n=430) from low-income communities in the US South for a household survey as part of the Greenville Healthy Neighborhoods Project. The survey collected information about participants' SES (household income and educational attainment), body mass index and hypertension status, cognitive and network social capital, as well as their core network characteristics (i.e., density, educational attainment, proximity). The data suggest that low SES may be associated with lower access to social network capital as well as social network characteristics. The data also provide some evidence that SES may moderate the associations between social capital, social networks, and chronic disease. Moreover, mixed relationships were observed between social capital, social networks, and chronic disease, suggesting that not all social capital may be associated with improvements in health, as has been widely concluded and promoted in previous literature. Indeed, the relationship between social capital, social networks, and health may be more nuanced

than previously hypothesized, including variations in the directionality of these relationships by socioeconomic positioning.

The contingency of the relationships between social capital, social networks, and chronic disease on SES has important ramifications for public health research, including disparities in chronic disease outcomes, and challenging the framework for social relationships and health among low-income communities. Finally, these studies raise important questions for future research regarding the interplay of social capital, social network characteristics, and SES on health disparities, and in particular for communities most strongly afflicted with chronic disease and poor health.

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LIST OF ABBREVIATIONS

BMI ..... Body Mass Index

GHNP ..... Greenville Healthy Neighborhoods Project

RDS ..... Respondent Driven Sampling

SES ..... Socioeconomic Status

CHAPTER I

INTRODUCTION

Social capital is an increasingly popular construct used to explain health disparities within public health research.[1] Indeed, social capital has been linked with infectious and non-communicable disease,[2–5] mortality,[6–9] health behaviors (such as physical activity and smoking),[10–12] as well as overall self-rated health,[13,14] making it a relevant and important factor to consider among health researchers. Social capital may be particularly important in health disparities research due to its focus on access to resources that may hinder or facilitate health. Apart from traditional measures of socioeconomic positioning of an individual, social capital is a measure of the resources available to an individual through their networks, as well as the ability of an individual to gain access to resources.[15] Examining access to these resources via social capital may provide additional insight into how socioeconomic factors differentially affect health and produce disparities in health outcomes.

Access to resources beyond an individual's capacity occurs through social networks and the ability to leverage those networks.[16] Yet, relatively few studies have examined the role of social networks, and the ability of an individual to access those resources, on health.[17] Instead, public health researchers have tended to use cognitive measures, which conceptualize social capital as a public good (property belonging to a

group) and have frequently been used to assess social capital characteristics at the group level.[15,17,18] For example, these measures have traditionally been comprised of items that measure community levels of trust, reciprocity, and social support.[12,14,19] Thus, communities with high levels of reciprocity are believed to benefit the residents of those communities as a whole.[12] This top-down approach posits that social capital exists at the group level and affects the individuals within those circles equally. Thus, in some instances, aggregate measures of social capital have been applied to broad groups of individuals (such as a neighborhood, a political organization, or work place setting). In more recent studies, an individual's own ranking of their community has been directly (not aggregately) correlated with their self-rated health.[20,21] Such measures tend to focus on individual perceptions of a community's capacity to provide resources and support, rather than an individual's ability to leverage relevant resources.

A second, but lesser known, approach among public health researchers is the network approach, which posits that social capital is generated by individuals who have differential access to the resources afforded by such capital, based on socioeconomic positioning.[15,16] Network approaches place importance on examining the types of actors that individuals may be connected with, and how they are connected. For example, being an acquaintance of (loosely connected with) a highly educated, employed individual may be more beneficial for certain outcomes than being closely connected with someone who has only a high school degree and is unemployed. Additionally, the network approach examines whether network structure, such as the density of ties and homophily – the extent to which group members are similar – facilitates or impedes access to resources (e.g., education and employment opportunities, social support) and information. For

example, having a diverse network may be more beneficial to health than a homogenous network, due to the ability of a diverse network to provide access to varying resources,[15,22,23] rather than resources that one already has available. Thus, the network approach may be best situated to identify potential mechanisms that lead to differences in network social capital (the social capital extended to individuals through others). Furthermore, this approach enables public health researchers to examine how differences in access to social capital via network characteristics may contribute to disparities in health.

Indeed, research indicates that access to resources is not evenly distributed across individuals, and that socioeconomic status may facilitate or hinder the ability to access and leverage resources.[16,23,24] These differences in individual measures of social capital have been linked with health,[25] and may be particularly relevant to health disparities research. Thus, while cognitive measures have previously been associated with health, they do not recognize structural differences in access to capital, such as the capacity of a network to connect individuals with opportunity, nor can they assess how those structural variances (i.e., network diversity) may contribute to disparities in health. Cognitive measures of social capital tend to focus on broader environmental attributes, including shared values among neighbors, but do not assess an individual's ability to access such capital. These limitations may hamper our ability to understand and intervene on the ways in which social capital impacts health disparities, including outcomes such as obesity and hypertension.

The proposed research will examine the relationship between these two distinct approaches to measuring social capital and two chronic disease concerns: obesity and

hypertension. This study will first examine whether these two forms of social capital are associated with body mass index (BMI) and the probability of having high blood pressure (hypertension). Hypertension and obesity are both chronic diseases that are hypothesized to be linked to social capital through numerous mechanisms, yet have shown mixed results within the health disparities literature. Specifically, obesity patterns have not always followed a clear socioeconomic gradient,[26] and an in-depth examination of access to social capital may reveal new relationships. As well, rates of hypertension are disproportionately higher among Black populations as compared to Whites and even other minority groups, despite similarities in socioeconomic positioning.[27,28]

Based on previous hypotheses that suggest socioeconomic status may also influence the relationships between social capital and health,[29] this study will assess whether the relationship between social capital and chronic disease is moderated by household income and educational attainment. The project will then further focus on the network approach by examining social network characteristics of residents living in low-income neighborhoods, and how those characteristics are associated with BMI and hypertension. This may identify potential mechanisms through which social networks and social capital are linked to health. In summary, the overall goal of this project is to identify the mechanisms and measures of social capital associated with chronic disease among residents of low income, historically-disadvantaged communities.

This proposal is part of a broader research agenda to understand how distinct measures of social capital (i.e., cognitive versus network measures are associated with chronic disease, and whether the relationships between social capital and social network characteristics and health differ by individuals' socioeconomic positioning. This broader

agenda proposes that social capital and social networks operate differently based on an individual's socioeconomic positioning and may potentially affect the relationship between social capital and health. Further work will be necessary to examine temporal relationships among these constructs. The purpose of the current study is to examine whether social capital and social network characteristics differ by individual income and educational attainment, and how these differing conceptualizations of social capital are associated with chronic disease.

The current project will contribute to the field of social capital and social network effects on health in numerous ways. First, it will directly compare two distinct forms of social capital. While several studies have employed both forms of social capital to examine health outcomes,[14,30–32] fewer studies have directly compared the utility of both,[25,33] and only one study each has examined this in the context of obesity[34] and hypertension.[33] Second, it will be one of few studies to employ respondent-driven sampling as the main participant recruitment approach. This methodology, while limited by the possibility of biased sample at smaller sizes,[35,36] has the potential to engage members of the eligible study population that may be less likely to participate in research otherwise.[37,38]Finally, this study will answer calls for more research on contextualizing differences in access to social capital through social networks. Specifically, this research will address how individual income and educational attainment may affect the relationship between social capital, social networks, and chronic disease.

1.1. SPECIFIC AIMS AND HYPOTHESES

Aim 1a: To examine differences in cognitive measures (e.g. social cohesion, social support, collective efficacy) and network measures (e.g. network diversity, reach,

and range) of social capital by income level and educational attainment among residents of disadvantaged neighborhoods.

Hypothesis 1a: Low income and less education will be associated with lower levels of both cognitive and network measures of social capital.

Aim 1b: To test the relationship between both forms of social capital (cognitive and network) and both BMI and hypertension, and whether these relationships are moderated by individual socioeconomic status.

Hypothesis 1b: There will be a negative association between both forms of social capital and both BMI and hypertension. As well, these relationships will be moderated by individual socioeconomic status, such that this relationship will be *stronger* among individuals with *lower* income and education (described later as the buffering hypothesis).

Aim 2a: To examine the association between *core network* characteristics (i.e., number of core ties, density, homophily, educational attainment, geographic location) of residents (actors) living in disadvantaged neighborhoods, and income level and educational attainment.

Hypothesis 2a: Low income and low educational attainment will be associated with increased social isolation, lower average network education, and less geographic dispersion of the social network. Density and homophily of networks will not be associated with socioeconomic indicators (income level and educational attainment).

Aim 2b: To examine the relationship between the *core network* characteristics and both BMI and hypertension among residents (actors) of disadvantaged

neighborhoods, and whether these relationships are moderated by individual income level and educational attainment.

Hypothesis 2b: Core network structure and composition will be associated with both BMI and hypertension within this population, such that denser, more homophilous, more proximal, and less educated networks will be associated with increased chronic disease among the actors (denser, more proximal networks are indicative of more homophilous ties and reduced access to resources). Furthermore, these relationships are moderated by individual socioeconomic status, such that the aforementioned associations are stronger among individuals with lower income and less education.

CHAPTER II

BACKGROUND AND SIGNIFICANCE

A vast amount of research on social relationships has suggested that our social networks may be critical to health outcomes.[39–42] In fact, data from several studies have shown that social relationships, specifically social isolation and integration, are more strongly associated with mortality than cigarette smoking, and in some instances the odds ratios for morbidity and mortality outcomes among those who are socially isolated were double the odds of other well established risk factors, such as excessive alcohol consumption, physical activity, and pneumococcal vaccination.[7,40] This suggests that the characteristics of our social connections may be more strongly associated with health outcomes than our health behaviors. The focus on health behaviors related to morbidity and mortality in past research may be due to the proximity of those behaviors with outcomes, as well as the ability to examine potential mechanisms linking behaviors, such as smoking, with outcomes, such as lung cancer. However, recent advances in the conceptualization, measurement, and analysis of social relationships have enhanced scientists' ability to examine mechanisms through which social networks may also influence health outcomes.[43,44]

Social capital may be one such mechanism that links social relationships and networks with health. Interest in the role of social capital on health has increased within the past several years, specifically among public health researchers.[17] Examination of social capital within the public health and health disparities fields has allowed researchers

to examine potential explanations, or mechanisms, for the relationship between income and health, and to consider how other indicators of socioeconomic status, such as educational attainment, occupation, as well as the social capital of others within our social networks, impact health outcomes as well as disparities. For example, a recent study found that the educational attainment of one's spouse was associated with individual self-rated health, and that this relationship was stronger among women than men.[31] Additionally, numerous studies have linked social support with chronic disease outcomes, offering a mechanism through which relationships impact health.[39,45] These studies highlight how our social relationships and the social capital that is extended through those relationships may be important for health outcomes.

In the United States, chronic conditions, including obesity, hypertension, and diabetes, have become an epidemic.[46–48] Among these, obesity is recognized as the most important health problem in the U.S.,[32] given its association with other chronic conditions including diabetes, high blood pressure, heart disease, and some cancers.[49,50] It is currently estimated that 68% of the US population are overweight or obese, and more than 1 in 20 are considered extremely obese.[51]

High blood pressure, or hypertension, is another chronic disease afflicting Americans that can have debilitating effects, including organ damage and cardiovascular complications.[52] Additionally, it contributes to the risk of heart disease, stroke, kidney failure, premature mortality and disability.[46] It has been dubbed a 'silent killer' by the World Health Organization, since many people often go undiagnosed. The estimated prevalence of hypertension among US adults has remained steady in recent years at

nearly 30%, as of 2012.[47] The economic burden of the disease is estimated at nearly $250 billion annually in the United States alone.[46]

Patterns of chronic disease have been shown to follow distinct socioeconomic gradients, such that wealthier and more educated individuals tend to acquire fewer chronic conditions than do individuals with lower income and less education.[53] Several hypothesized mechanisms linking socioeconomic status with health, such as greater access to resources and information, have been proposed.[18] This patterning has been observed with hypertension, such that those with higher incomes and more education have a lower risk of developing high blood pressure.[54–56] However, the association between socioeconomic status and hypertension is not clear cut across racial lines.[27] For example, hypertension rates among Black Americans are among the highest in the world (44%), constituting a disproportionate burden of disease among this population.[28] When comparing Blacks and Hispanics, two minority groups with similar socioeconomic positioning within the U.S., in terms of income and education rates, one might expect that these similarities in risk factors would result in similar rates of hypertension among the two groups. This would be expected if the association between socioeconomic status and health worked the same way for all groups of people, however, data suggests that it does not. Hispanic hypertension rates in the U.S. are comparable to Whites, while Blacks have nearly double the prevalence.[27] Researchers note the differences in the histories and cultures of these two minority groups, and point to social environmental factors, including segregation and increased psychosocial and environmental stressors, as potential sources of increased hypertension among Blacks.[57,58]

Similar patterning of socioeconomic gradients has also been associated with obesity rates, such that lower income and education is associated with higher rates of obesity among African Americans,[59] although results have also been mixed. Mujahid and colleagues found an inverse association between SES and BMI for women, but among men, the relationship was positive, meaning that higher levels of income and education were associated with higher BMI.[60] Similar studies have also found that the relationship between socioeconomic status and BMI differed by gender.[26,61,62] Conversely, another study found that those at highest risk for increases in BMI were Black men and women, regardless of their socioeconomic status.[63] Taken together, these studies suggest that sociodemographic characteristics, including race and gender may also contribute to obesity patterns. Additionally, some research utilizing a life course perspective points out that adult BMI may be linked with earlier exposure and is the result of cumulative effects, or cumulative inequality over time.[60] For example, studies have found an inverse association between parental education and BMI.[61,62] These findings support the notion that the social characteristics of family members, including care givers, are important for individual health, and more broadly that health outcomes are linked to the social circumstances and relationships we occupy.

Social network capital and network characteristics may offer additional insight into the patterning of hypertension and obesity across socioeconomic and demographic patterns. Social networks have the potential to provide individuals with increased access to resources. This is based on the ability of individuals to connect with others through common links, such as mutual friendships, working at the same company, or living in close proximity to one another.[22,64] However, the historical and continued segregation of

Blacks and low-income populations may have important ramifications for the structure of their social networks, and thus their ability to gain access to resources.[65,66] For example, research suggests that disadvantaged populations tend to use close ties, such as family members and close friends, when searching for job opportunities.[67] This may limit the potential of individuals to find new opportunities, since homogenous network members tend to have redundant information. In another study, Kleit examined the effect of housing policies that dispersed low income individuals among more affluent communities and found dispersed residents had greater access to diverse sources of information than those clustered into low income public housing.[68] This work suggests that living in low-income neighborhoods may limit access to social capital among residents, and furthermore, that low-income populations tend to rely on nearby others for information. Yet, few studies have examined social network capital and network characteristics of residents living in historically disadvantaged communities and whether differences in network characteristics exist across socioeconomic status (SES). The current study will address this significant gap in the literature.

Two mechanisms by which socioeconomic circumstances are thought to impact access to social capital has been speculated and put forth by Lin.[16] First, he argues that the inequality in access to social capital occurs due to structural differences in the socioeconomic positioning of certain social groups. Specifically, certain social groups have been historically disadvantaged based on their race, gender, and class, while others have benefitted. Second, he highlights how social groups tend to form clusters, and associate with similar others, which is known as homophily.[22] Thus, while all groups tend to share resources and information, the availability of resources among clusters of

privileged groups is potentially much greater than the resources and information available among disadvantaged groups. As such, aspects of social capital, such as density of networks and homophily, may operate differently on health outcomes among disadvantaged populations than among privileged populations. This underscores the need to understand how network characteristics are associated with health outcomes among disadvantaged populations.

Despite these potential differences in the relationship between social capital and health by SES or race, many of the studies examining social capital and health have examined predominantly White populations. Few studies have examined social capital characteristics among Black communities,[9,69,70] and none have examined the role of social capital on chronic disease among this population. Given that Black populations are more likely to experience higher rates of hypertension and obesity than Whites,[28,51] the relationship between social capital, socioeconomic status, and health among Blacks has been mixed within the literature for this population,[16,71] and the principles of social capital may operate differently according to individual socioeconomic positioning,[16] more studies are warranted that examine how these factors operate simultaneously to contribute to chronic disease within this specific population. Examining the relationship between social capital and chronic disease across socioeconomic indicators among a predominantly Black population will thus address another glaring and significant gap in the literature.

Social capital, social networks, and chronic disease

The majority of past research on the association between social capital and chronic disease has utilized cognitive and structural measures. Additionally, these studies

have often aggregated cognitive measures at the community level. Multiple studies have examined how community-level social capital and rates of social participation affect obesity and hypertension rates.[5,12,72] For example, studies have assessed cognitive and structural social capital through measures of group memberships (affiliation), generalized trust, and volunteer activities in association with obesity.[12,73] One study found no evidence of an association between social participation and obesity.[73] Yet, another study found evidence to suggest state-level social capital was moderately associated with obesity, and that informal socialization was more strongly associated with obesity than formal civic and political participation.[12] Less work has examined the association of civic engagement and social participation on hypertension rates, although similar patterns have been found. One study found significant associations between participation in informal social clubs (e.g., Rotary, lunch groups) and high blood pressure among men, but no associations for more formal types of participation, including political and civic groups.[74] Additionally, one study found that low social participation was associated with a higher risk for cardiovascular disease.[75] These findings provide preliminary evidence to suggest less formal relationships, such as those that comprise core ties within social networks (i.e., close friends, family), may be more strongly associated with chronic disease than loose ties (i.e., acquaintances). As opposed to cognitive measures, the network approach allows for the examination of access to capital through core ties, such as family, friends, and other informal ties that provide sources of support

As well, social cohesion and social control, two constructs that represent cognitive measures of social capital due to their assessment of trust and reciprocity among neighbors, have also been examined in relation to chronic disease. For example,

some studies have found a negative relationship between social capital and obesity, such that higher levels of social cohesion and control are associated with lower levels of BMI,[32,76] while other studies have found no relationship between indicators of social capital and BMI after adjusting for socioeconomic and demographic covariates.[77] As well, one study found that while aggregated levels of reciprocity were associated with hypertension, aggregated levels of community trust, a similar construct, were not associated with hypertension.[2] These mixed results about the relationship between cognitive social capital measures and chronic disease warrant further study, especially that which compares the utility of such measures with network approaches to social capital.

Previous studies highlight several potential mechanisms that link social capital with chronic disease, such as social control, social support, and the ability to be active (in safe neighborhoods).[39,76,78] As well, Cohen et al. suggested that stress may be an additional mechanism through which social capital affects disease outcomes.[32] Specifically, they hypothesized that low community capital is associated with greater stress among residents due to a lack of social support from neighbors. Yet, cognitive measures, such as social cohesion and social control, do not directly measure sources of support (such as network capital), and thus, only speculate that these constructs are associated with disease through such mechanisms. Thus, while this previous study and several others have suggested several plausible mechanisms through which social capital and chronic disease are associated, they also highlight a weakness in the ability of cognitive approaches to directly measure and test potential mechanisms liking social capital with health.

Additionally, other studies have hypothesized that cognitive measures of social capital moderate the association between socioeconomic status and chronic disease. For example, Evans and Kutcher hypothesized that youth who are poor, but who live in communities with greater social capital will have BMI scores similar to their more affluent peers.[79] The results from their study indicated that social capital moderates the relationship between socioeconomic status and BMI. While the difference in having high or low capital did not appear to affect BMI among affluent youth, for those who were poor, having greater social capital attenuated the negative relationship between income and BMI. These results suggest that the relationship between social capital and health operates differently depending upon the socioeconomic positioning of the individual, such that social capital may matter more for health outcomes among poorer populations. This is particularly upsetting given that low income populations may have lower levels of social capital.[80,81] Examining the social networks of such individuals may provide further insight on ways to increase levels of social capital among these groups to improve health

An early study utilizing a network approach to health and mortality found that the number of social ties an individual had was directly associated with the risk of obesity.[8] Since then, however, few studies have examined the relationship between social networks and BMI,[34,82] and only one study has examined the relationship between network social capital and hypertension.[33] No research has examined these constructs among low-income and predominantly Black communities. However, these studies have consistently indicated that network diversity is associated with lower rates of both obesity and hypertension. The consistent link between social networks and chronic disease in these

initial studies warrants further research that utilizes the network approach to explore potential relationships between social capital and health.

Additionally, the disproportionate use of cognitive and structural measures of social capital over a network approach has met with some criticism among health researchers. For example, researchers point out that the public health field has been quick to adopt a fairly narrow definition of social capital, stemming from the work of Robert Putnam, as opposed to or in addition to other ideations of capital from Pierre Bourdieu, Nan Lin, and others (a more thorough discussion follows in the next sections).[17,71,83] Additionally, Muntaner and Lynch [19]) point out that the use of social cohesion to explain differences in health outcomes ignores class relations, and in doing so, prevents an examination of how health inequalities are generated. Furthermore, they go on to state that "an emphasis on social cohesion can be used to render communities responsible for their mortality and morbidity rates, a community-level version of 'blaming the victim'." (p. 59)[19] These criticisms of the cognitive approach in particular provide further justification for the use of a network approach to explore the relationships between social capital and health.

The current study will simultaneously examine both cognitive and network approaches as they relate to chronic disease in an attempt to address these critiques about the approach to social capital research within the public health field. Further discussion on these two approaches is provided below.

Cognitive versus Network Measures of Social Capital

A recent study that examined the adoption and use of social capital into the public health field found that many scholars have utilized only one form, or definition, of social

capital to examine its relationship with health.[17] Moore called this the 'privileging' of communitarian social capital over other approaches through citation practices within the literature.[17] Specifically, an early and widely cited study published in the *American Journal of Public Health* defined social capital as "civic engagement and levels of mutual trust among community members" (p. 1492).[6] This relatively narrow definition of social capital has promoted the use of Robert Putnam's ideas on social capital research within public health.[84,85] Moore argued that the widespread adoption of this definition and singular approach has perhaps limited our ability to think about the ways in which social capital affects health outcomes.[85] Instead, health researchers should comprehensively examine the "complexity and depth [of] the concept of social capital and social networks" (p. 1336) by utilizing, and even comparing, multiple measures.[17]

Within other realms of social research, there is a debate as to whether social capital is an individual- or community-level construct.[23] The cognitive approach conceptualizes resources as a public good, and thus social capital exists at the community level.[6] Within public health, this has been conceptualized as the social capital of a neighborhood or other community setting (i.e., the workplace).[86–88] For example, social cohesion measures ask about perceptions of shared values among neighbors. In contrast, the work of Pierre Bourdieu and James Coleman has largely conceptualized social capital and its resources as a property or function of an individual's social network.[89] As such, those with better networks have better access to resources. This orientation allows researchers to focus on the structure of social relationships, while reducing the emphasis of spatially-bound communities. Indeed, as previously discussed, many of the important social relationships an individual may utilize in order to gain access to resources are not a

neighbor or co-worker, but rather a close friend or family member.[67] Thus, our social relationships and the subsequent capital resulting from them are not bound by geography. The cognitive approach is limited by this false sense of spatially defined communities. Additionally, the network perspective emphasizes the importance of social ties and the ability to access resources through those relationships. The examination of social networks may thus provide insight on the characteristics of social relationships of marginalized groups within society and subsequent issues related to poorer health among those populations.

In summary, the cognitive approach lacks a focus on the inequality that exists in access to social capital, which may occur through social network characteristics. Thus, the network approach may be more appropriate for studying structural inequalities in social capital that are associated with health outcomes.

2.1 THEORETICAL FRAMEWORK

Social Networks

The role of social relationships and networks on health was established through the work of several scholars, including Emile Durkheim, a 19th century French sociologist; John Bowlby, a 20th century British psychiatrist; British anthropologists, Barnes and Bott; and American sociologists, such as Mark Granovetter and Barry Wellman, to name a few.[23,41,67] Although their theories are broad and diverse, they overlap in one central view which posits that social institutions, including social capital, are responsible for the resources made available to the individual, and thus their behavior.[23] Additionally, Wellman and Berkowitz argue that communities are defined by their social rather than spatial structure.[90] Thus, the structure of social communities

(networks) may not align with how we conceive of physical communities, such as neighborhoods. The use of network analysis allows us to test whether the resources that flow through social networks are bound by geographic location, such as within neighborhoods, or some other structure, such as kinships or other affiliation. In 1988, Wellman and Berkowitz wrote,

> "The network approach has enabled us to see which attributes of ties and networks best foster sociable relations, interpersonal support, informal sense of control, and a sense of personal identity –the traditional output of variables of community studies. For, if neighborhood and kinship ties make up only a portion of communities ties, then studies restricted to neighborhood and kinship groups give a distorted picture of community." (p. 134)

As such, the focus on social relationships and networks within the context of low income communities will help illuminate potential sources of health disparities that stem from the structure of social, rather than spatial, communities.

Berkman and Glass (2000) argued that a major strength of the network approach for examining health is the focus on the characteristics of the social network, rather than individual factors, as explanatory variables. Their conceptual models, shown in Figure 2.1, depict how social networks are involved in the pathways connecting socioeconomic factors with downstream mechanisms leading toward health behaviors and outcomes.[41] Like Lin, Berkman and Glass also hypothesize that upstream factors, such as social inequality and poverty, lead to potential differences in social network structure that may give rise to disparities in health outcomes.

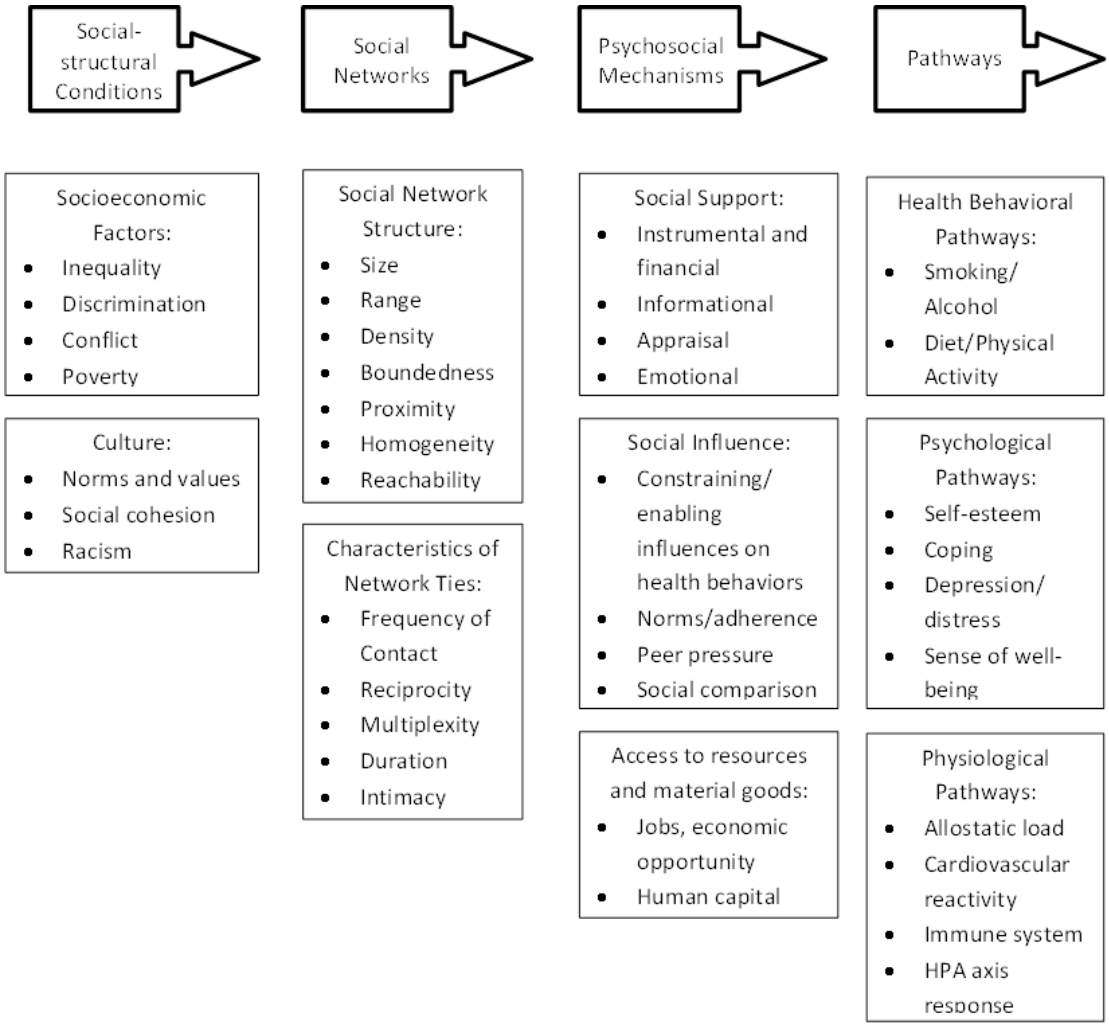

Figure 2.1 Conceptual models of how social networks impact health (adapted from Berkman and Glass, 2000)

Additionally, they offer multiple downstream mechanisms potentially involved in the pathway between social networks and health outcomes, including social support, social influence, and access to resources. The current study will examine multiple relationships within these models, including both the relationship between social-structural conditions (namely individual socioeconomic status) and social network characteristics, as well as the relationship between social networks and downstream health outcomes (BMI and hypertension).

Social Capital

A discussion around both social resource and social capital theory may help to further elucidate the theoretical underpinnings of this study. First, social resources are resources made available to an individual through his or her relationships with others.[91] These are distinct from personal resources, which are possessed by the individual. Social resources have been proposed to account for status achievement beyond that which can be attained through personal resources, leading researchers to hypothesize that social resources may be influential for social mobility and health.[91,92]

Social resource theory attempts to explain how the structure of social positioning influences one's ability to access resources. Three propositions have been formulated: (1) social resources exert effects on the outcome of an instrumental action (i.e., referral for a job), (2) social resources are affected by the original position of the individual (i.e., personal resources, such as family socioeconomic status, educational attainment), and (3)social resources are affected by the use of weaker (vertical) rather than strong ties (horizontal).[15]

Of particular importance for the current project is the second proposition, illustrated with a pyramid shape, which demonstrates how an individual's social network capital is directly influenced by their personal socioeconomic positioning. Those with lower original status may have fewer opportunities to obtain social resources than those with higher original status. Further, the third proposition highlights how the use of weak ties and in particular, upward reaching ties, may be more beneficial for status attainment and health than the use of strong ties, which are likely to be more similar in socioeconomic positioning to the individual and may not offer any additional resources.

These propositions are illustrated in Figure 2.2. Here, ego one's social positioning is lower than ego two. This original position affects the social resources attainable to him or her. Thus, even though they are both utilizing an upward reaching (weak) tie, the position of the accessed resource (the alter) is much higher for ego two than for ego one, based on the original positioning. Thus, while both ego one and two have the same network range (illustrated by the vertical blue line), ego two is able to access a higher positioned individual based on their own relative positioning.

Social capital theory emerged in the late 1970s and early 1980s as a parallel to, but independent of, social resources theory. While scholars have previously referred to a variety of features represented by social capital (e.g., community norms, trust, social participation), it has more recently been defined, and theorized, as the access to resources through one's social network. This theory supposes three features of social capital: (1) resources are embedded within a social structure, (2) individuals have opportunity to access those resources through their network, and (3) ability of individuals to mobilize those resources through purposive action. [15]

Taken together,

> "the convergence of the social resources and social capital theories complements and strengthens the development of a society theory focusing on the instrumental utility of accessed and mobilized resources embedded in social networks…. At the empirical and research levels, social resources are used, whereas at the general theoretical level, social capital is employed." [91]

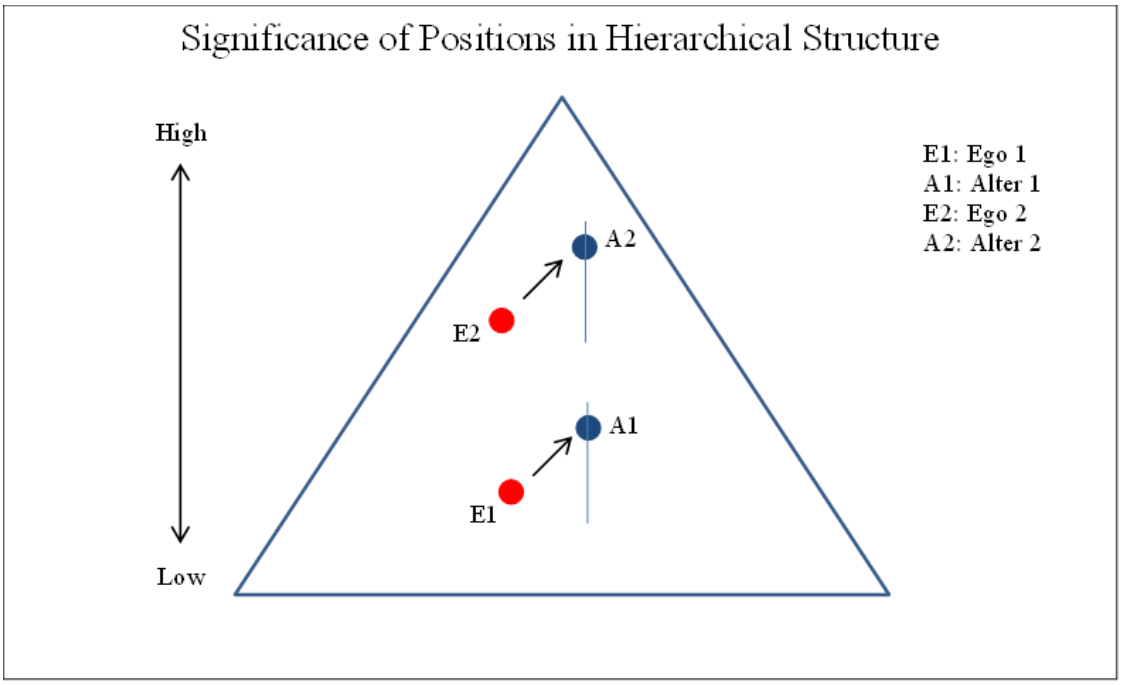

Figure 2.2 Relative advantages of structural positions for accessing social capital (adapted from Lin, 2001)

Within the literature, there has been a call for more research regarding *differential access* to social capital.[16,91] It is hypothesized that certain populations have different access to social capital based upon their structural position and the characteristics of their social networks (see Figure 2. These outcomes may affect the relationship between social capital and health. For example, for wealthier individuals, having a homophilous network comprised of individuals similar to oneself in race, gender, and educational attainment may be beneficial for health. For example, one study found that White males were more likely to encounter information about job opportunities in their casual conversations with similar others than were females or individuals of differing race and ethnicity.[93] Furthermore, while the number of job leads decreased among Black males in supervisory positions, this number increased among Whites. As this study demonstrated, social

capital and network characteristics were advantageous for some (White males), but not all (Black men and women, and White women). This may be due to differences in network social capital between disadvantaged and privileged groups, specifically because the networks of disadvantaged groups do not possess as much social capital as can be leveraged among more privileged networks. Subsequently, network characteristics, such as network homophily, serve as an advantage to privileged groups and may disadvantage groups with lower social capital. For individuals who are socio-demographically or -economically disadvantaged, purposive actions, such as accessing resources beyond their usual social ties through linking ties, may be necessary to gain higher social status. Thus, having less dense and less homophilous networks may be associated with better health, specifically among low-income and disadvantaged populations.

Neighborhoods, Social Environments, and Health

While the current study does not focus on neighborhood characteristics, per se, a certain level of understanding about the relationships between neighborhoods, social capital, and health is implied, and is reviewed here briefly. Extensive research has examined the role of neighborhood factors on both health behaviors and outcomes.[94–96] Similar to social networks, neighborhoods are thought to provide access to resources that may influence health. These include both physical and social features, such as sidewalks and green space,[97,98] affordable and healthy food outlets,[99,100] as well as opportunities for socialization and collective efficacy.[101–103]

Measures of cognitive social capital are often indicators of the neighborhood social environment. For example, collective efficacy, which encompasses elements of social control, trust, and solidarity, is a construct that measures the capacity of a

community to achieve common goals.[101] Similarly, social cohesion, which measures trust and shared values among neighbors,[104] is also considered an indicator of cognitive social capital. Both measures are frequently used to assess neighborhood quality,[101,105] and have also been associated with health.[32,104] Given that neighborhoods are often viewed as a source of social capital,[66,102] it illuminates the possibility that disadvantaged neighborhoods may be associated with poorer health due to a lack of social capital among residents.

Stemming from the hypothesis that disadvantaged neighborhoods perpetuate cycles of black poverty,[66] a national experiment took place in 1994 in an attempt to study the impact of housing mobility on financial stability and well-being among adults with children. The Moving to Opportunity (MTO) study, which aimed to test whether relocating residents of public housing projects to more affluent areas would improve their well-being,[106] met with mixed results. Participants of the experimental group, who were required to relocate to low poverty neighborhoods for at least one year, saw some initial improvements including lower BMI and improved mental health over time compared to those in the control group.[107] However, there were no improvements in financial stability.[106,108] Furthermore, many residents in the experimental conditions ultimately moved back to their old communities.[109] It is hypothesized that the social relationships these participants lost when they moved to new communities hampered their ability to integrate.[110] It is also probable that without the support of these networks, many residents were unable to take advantage of the increased opportunities in their new surroundings. Similarly, a more recent study that examined a relocation process among slum-dwelling adults in India found that participants who moved reported no improvements in income

or capital, and moreover, experienced increased isolation from kin networks and reduced access to insurance.[111] In short, this literature highlights the importance of neighborhood social environments for health, including the proximal social relationships between neighbors of low-income communities.

While it is not the aim of the current project to examine how neighborhood factors influence social relationships or access to social capital, it should be noted that we sought to examine the social capital and social networks of residents among low-income and disadvantaged communities based on prior findings indicating the importance of these relationships for such individuals. Future studies seeking to explore disparities in related health outcomes should consider evaluating the relationship between neighborhood characteristics and both social capital and social network characteristics, and whether the previously observed associations between neighborhood characteristics and health are mediated by social capital.

Social Capital among Disadvantaged Populations

Access to social resources is determined largely by the structural properties of one's social network. For example, individuals with larger networks theoretically have greater access to resources due to the odds of having someone in their network with the information or support they need. As well, larger networks are more likely to include individuals who serve as bridges, or links to other networks, which can, for example, speed the diffusion of new information or a behavior within a network.[112] Network structure, such as density, may facilitate some opportunities, while limiting others. Dense networks, composed of similar others, and characterized by high levels of trust may foster the sharing of available resources.[113] However, these networks are also limited by

their ability to access new information and by the lack of bridging ties to resources outside of the network. Dense networks among the poor may be particularly detrimental since the redundant information and low levels of personal resources within such networks leads to the perpetuation rather than improvement of their circumstances.[66,114]

While research on the network characteristics and social capital of disadvantaged populations is limited, there is some research to suggest that those who are poor (and arguably in greatest need of resources generated by social ties) tend to have smaller and more homogenous networks. Granovetter (1983) argues that the perpetual reliance of poor individuals on kin networks and relationships with similar others "has the impact of fragmenting communities of the poor into encapsulated networks" (p. 213) that are further disconnected from other networks which may be beneficial. Indeed, prior notions about the benefits of kin networks and strong core ties are contradicted by research suggesting these networks may actually contribute to the cyclical nature of poverty and poor health.[66,116,117] According to Wilson, much of the disadvantage faced by poor African Americans, in particular, stems from the lack of social structure in high-poverty neighborhoods.[66] Residents of these neighborhoods are less likely to be employed, and thus may have limited access to information or other sources of support beyond their neighborhood.[66,114,116]

Tigges, Browne, and Green examined the effect of race, class, and neighborhood poverty on social networks.[116] They compared household data from poor and non-poor African Americans to non-poor Whites living in Atlanta, Georgia. They found significant class differences among Blacks in the likelihood of living with another adult, being socially isolated (i.e., not having a discussion partner to talk with about personal matters),

and whether or not that discussion partner had a college education. For both Blacks and Whites, high levels of neighborhood poverty were associated with lower probabilities of living with another adult. They also found class differences in the odds of having at least one close tie outside the household. Additionally, they found strong evidence to suggest that Blacks living in high poverty neighborhoods were more likely to experience social isolation, measured by the presence or absence of a discussion partner, and decreased access to social resources than those in low poverty neighborhoods. Taken together, their results suggest that race, class, and neighborhood characteristics play a role in social network composition, and that disadvantaged groups may have less access to social network resources.[116] This research supports the conceptual model put forth by Berkman and Glass about socioeconomic positioning, network characteristics, and health, and further substantiates the need for more research utilizing a network approach to understand disparities in health outcomes among similar populations.

Social Capital and Health: Is The Relationship Contingent Upon SES?

In addition to research that indicates SES is associated with access to social capital and social network characteristics, there is also mounting evidence to suggest that SES moderates the relationship between social capital or social networks, and health. Numerous studies have found that household income, educational attainment, and neighborhood disadvantage moderate the relationship between social capital and well-being.[118–120] Additionally, one study reported a three-way interaction between social capital, income, and race, indicating that low-income Blacks were less likely to benefit from auxiliary friendships (e.g., proximal relationships that can provide support) than high-income Blacks, or both low- or high-income Whites.[121] These studies demonstrate

that multiple dimensions of socioeconomic positioning, and even sociodemographic characteristics, may influence the relationship between social capital and health.

Uphoff and colleagues (2013) conducted a literature review around the interplay between socioeconomic inequalities and social capital on health outcomes, and proposed two hypotheses by which the association between capital and health is moderated by SES. First, the buffer hypothesis maintains that among individuals with low SES, increasing levels of social capital are associated with improvements in health. This may occur due to the ability of social capital to counteract the effects of stress or improve the ability to cope by providing emotional or monetary support.[122] In the buffer hypothesis, individuals with high SES do not accrue additional health benefits from increases in social capital. In this way, social capital serves to 'even the playing field' by allowing low SES populations to catch up to their more advantaged counterparts. This effect is illustrated in Figure 2.3.

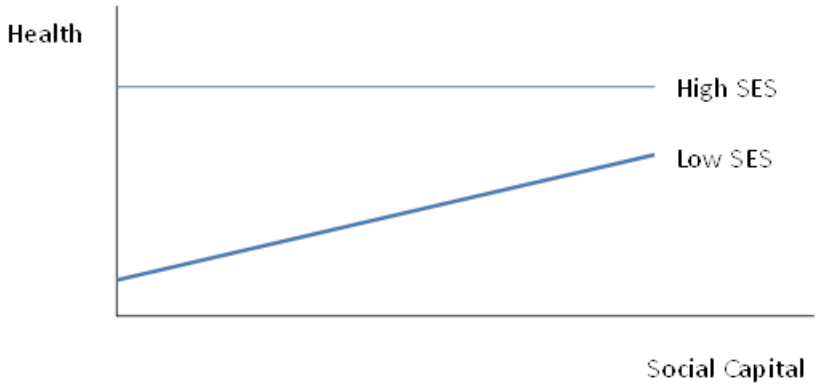

Figure 2.3 Buffer effect of social capital on socioeconomic inequalities in health (adapted from Uphoff et al., 2013)

Several studies have provided evidence for the buffer effect across multiple populations and settings.[123–125] For example, Pearson and Geronimus (2011), found

access to co-ethnic social ties was associated with better self-rated health among Jewish Americans, and that this relationship was strongest among those with low SES. Their data suggest that those with low SES benefited most from having access to co-ethnic social ties.

The second way in which SES is thought to impact the relationship between social capital and health is the dependency hypothesis, which postulates that individuals with high SES see improvements in health outcomes. This hypothesis proposes that high SES populations may be better positioned to utilize the resources made available through social capital. This is based on Bourdieu's model of social capital,[127] which infers that economic and cultural capital is required in order to accumulate social capital. Based on this hypothesis, increasing levels of social capital do not offer any additional health benefits among low SES populations, as seen in Figure 2.4.

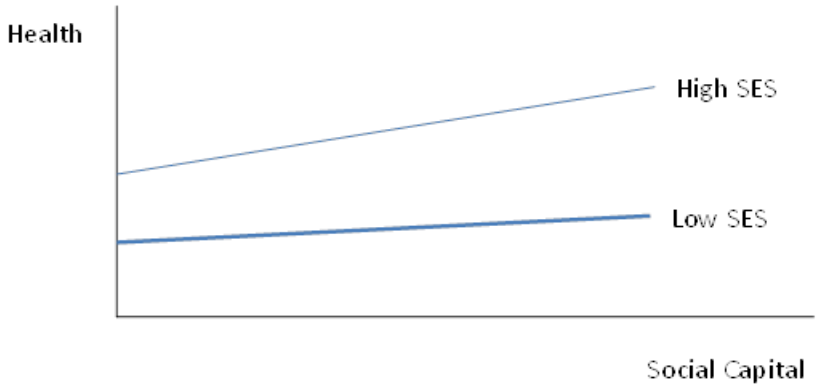

Figure 2.4 Dependency of social capital and socioeconomic status influencing health (adapted from Uphoff, et. al., 2013)

There is limited evidence to support this hypothesis.[120,121] However, one study (described previously) found an interaction between income, race, and auxiliary friendships on self-rated health.[121] Thus, the dependency hypothesis may be specific to

certain demographic groups, including Black Americans. However, the lack of research on social capital and social networks among Black populations limits the ability to determine whether there is substantial evidence to support this hypothesis.

Furthermore, no studies have examined whether socioeconomic status moderates the associations between social capital and social networks, and chronic disease. Yet, a clearer understanding of these relationships has the potential to yield policies and interventions that are best suited to address disparities in chronic disease outcomes. Specifically, the buffer hypothesis suggests that improvements in social capital would suffice to improve health among low-educated and low-income populations, whereas the dependency hypothesis posits that low income and low education are root causes of low social capital and therefore must be addressed first. While there is more substantial evidence for the buffer hypothesis,[29] more studies are warranted before pursuing social capital and social networks as viable intervention strategies for improving disparities in population health outcomes.

Mechanisms Linking Social Capital and Social Networks with Chronic Disease

Social capital and network characteristics are hypothesized to be associated with chronic disease through various mechanisms. While these mechanisms will not be assessed in the current study, a review of the literature on these potential pathways will help formulate hypotheses about the relationship between social networks and chronic disease. Berkman and Glass proposed several mechanisms by which social networks are thought to affect health.[41] First, they distinguished between individual-level mechanisms, such as behaviors and physiological responses, and more upstream, intrapersonal mechanisms, including social influence, social support, and access to resources (Figure

2.1). A focus on the literature of the latter of these mechanisms may best inform the current study.

Social support

Social support has been divided into distinct subtypes, which further elucidate its ability to impact health.[128] Emotional support consists of the sympathy, love, and confidence provided by a typically intimate relationship. Instrumental (tangible) support refers to help, aid, or assistance provided by another, typically in the form of providing transportation, money, or labor (i.e., cleaning, carrying groceries). Informational support consists of the provision of advice or information, for instance about potential job openings, or where to access low cost health care.

A study that examined the effects of social support on hypertension and cardiovascular disease distinguished between family support and belongingness.[129] Belongingness assessed whether participants socialized with friends, spoke with friends on a daily basis, or participated in organized groups. Their results indicated that both types of support were associated with hypertension in the predicted direction, such that higher-rated support from both sources was associated with lower odds of hypertension. Another study examined three types of social support - marital status, emotional, and financial support - in relation to race and hypertension.[130] Bell, Thorpe, and LaVeist found that social support moderated the relationship between race and hypertension, such that black-white disparities were greater among those with less social support than those who had more social support.[130] The results from this study suggest that increasing social support among Blacks may reduce racial disparities seen in hypertension. However, there is little consensus on how to increase social support among social networks.[131] While it

may be that individuals with larger social networks or whose networks have greater capital receive more support, there is limited research about the network characteristics associated with hypertension. This lack of research further strengthens the rationale for the current study, which will examine the social network characteristics and their association with hypertensive outcomes among a predominantly Black population

Social integration and isolation

Social networks are thought to impact health through the promotion of social engagement and attachment of individuals to their friends, family, and more broadly, their community.[120] Social integration is closely linked with other mechanisms linking networks with health since those who are more socially integrated often have increased social support and access to resources. However, social isolation and integration should be distinguished from social support, as it includes other features, including feelings of belonging and social obligation. As Berkman and Glass argue, "this pathway is distinct from the level of support that is either received or even perceived, standing apart from cognitive and behavioral aspects of support." (p. 147)[41]

Previous studies have suggested a link between integration and hypertension, although results have been mixed.[120,132,133] A recent study by Gorman and Sivaganesan examined the role of social integration as a mediator between socioeconomic status and hypertension. For this study, a social integration index was calculated using indicators of whether or not participants frequently spoke to or visited with family and friends, and whether they were active in religious and community organizations. Results indicated that the odds of hypertension decreased as social integration increased.[120] Although they did not find that social integration mediated the relationship between SES and

hypertension, they noted some quizzical socioeconomic interactions in the relationship. Specifically, they found the opposite relationship between social integration and hypertension among those with less education, such that higher rates of integration were associated with higher odds of hypertension among the less educated, but not those with more education. These results suggest that the role of social networks on health may operate differently for various socioeconomic positions and provides additional support for the current study's rationale to test whether the association between social networks and chronic disease is moderated by SES.

Fewer studies have examined the role of social isolation and integration on obesity outcomes. A study conducted with mice indicated that randomization to social isolation resulted in obesity and the development of diabetes.[134] Much of the work around social isolation among human health has examined older adults who live alone.[42] This body of work suggests that social isolation is associated with increased mortality. Emerging studies indicate that rather than actual isolation, feelings of loneliness are most strongly correlated with poor health.[135] In the current study, the number of close social ties identified by each participant will serve as a proxy for the number of social contacts they have, which approximates their level of social integration and access to resources.

Social influence

The role of social influence on health can best be summarized as the control that social networks may have on the attitudes, beliefs, and ultimately, the behavior of individuals within those networks. For example, a study examining the impact of marriage on health found evidence to support the hypothesis that social relationships, such as those with a spouse, influence an individuals' control exerted on their own health

behaviors.[136] As well, a recent review of the literature examining social influence and obesity has found that both social network structure and social influence are significant factors associated with the obesity epidemic.[78] The report highlights the role of social norms, including norms around eating and body image, as a major source of influence on obesity. Additionally, a study that examined the role of social influence in a team-based weight loss intervention found that weight loss tended to cluster within teams and that those who reported higher levels of social influence experienced a greater percentage of weight loss.[137] This study demonstrates that health outcomes tend to occur within social groups and suggests that social influence may be a driving factor of this phenomenon.

This discussion on social influence would be incomplete without mentioning the competing hypothesis of homophily.[22] There has been significant debate and little research that addresses whether social networks affect individuals (social influence) or whether individuals seek out similar others, a selection effect known as homophily.[138,139] For example, among those who smoke, it remains unknown whether current smokers seek out networks of individuals who also smoke, or if over time they became smokers based on their network composition. In a study conducted by Christakis and Fowler, which followed social networks over time, the data showed that adults become heavier (more obese) over time, and that obesity tends to cluster within social networks.[82] These longitudinal findings suggest that social networks can influence individuals over time, ultimately contributing to their weight status. However, because of the cross-sectional nature of most of the studies examining social networks and health, including the current project, researchers have yet to conclude which process is occurring if not, in fact, both. A longitudinal study examining social networks and alcohol use among adolescents

found that selection effects and influence are largely separate processes, in that they operate differently when acquiring new versus continuing existing relationships.[140] More research is needed to determine if similar processes occur among adults.

Much of the research on social networks and chronic disease, including potential mechanisms linking social network characteristics to health, has not yet examined the associations between social capital, social networks, and chronic disease within the context of disadvantaged populations, including Blacks living in low-income neighborhoods. The current study seeks to address the previously discussed gaps within the literature, including utilizing a network approach, among a population that may benefit from this work, but which has largely been ignored within this research.

2.2 STUDY SIGNIFICANCE

Adverse consequences of hypertension and obesity

Hypertension has been referred to as "the silent killer" due to its under-diagnosis and ability to cause damage and distress to the cardiovascular system.[46] High blood pressure can lead to left ventricular and cardiac failure, contributing to death and disability among individuals with the disease.[141] Even among youth with pre-hypertensive symptoms, target organ damage can already begin to occur.[142] Beyond the negative consequences incurred by individuals, the disease also carries a tremendous cost to society. The median state-specific cost of hypertension in the United States exceeded $1.6 billion dollars in 2010, representing a significant economic burden.[143]

Similarly, obesity has been referred to as the biggest public health challenge of the 21st century.[144] Obesity is associated with several other chronic diseases, including hypertension, diabetes, and cancer.[145–148] The disability, premature mortality, and

absenteeism associated with the complications of obesity are reported to exceed an annual cost of $147 billion dollars at the national level.[149]

Prevalence of hypertension and obesity

Black Americans have the highest rate of hypertension in the world.[47,150] They are also at an increased risk of overweight and obesity. In 2012, Black women between the ages of 40-59 had the highest overall prevalence of overweight and obesity, at 85.2% among all race and age groups.[151] This pattern was similar for Black women over the age of 60. The high prevalence of obesity and hypertension among African Americans has led to intervention efforts specifically directed at this population.[152] Most of these intervention efforts include behavior modification, including increasing physical activity, decreasing sodium intake, and other dietary modifications.[153–155] One of these intervention studies indicated that African Americans were least likely to adhere to dietary guidelines associated with the prevention of hypertension.[156] Additionally, a literature review on African American women and weight loss has indicated that this population is least likely to benefit from such behavioral interventions.[157] This may be because these efforts largely undermine the root causes of the racial inequities seen in these outcomes and ignore potential upstream mechanisms that lead to such disparities. Indeed, this review has called for more studies that expand the research on social environmental factors associated with obesity among African Americans.[157]

Promising avenues for disparities research

An overwhelming amount of research suggests that social capital is important for health.[1,14] And yet, while social capital research has become increasingly widespread within the public health field over the past decade, few studies have examined social capital and social networks among low-income and Black populations. Lin's work around

inequities in access to social capital and the subsequent ramifications for health outcomes provide a promising approach for examining health disparities within the context of social capital and social networks that has yet to applied to chronic disease outcomes.[16]

Furthermore, the importance of social ties among disadvantaged populations demonstrates that the social relationships and support received by Black Americans plays a role in chronic disease outcomes. Understanding the characteristics of these social relationships, including sources of network social capital and support, may illuminate possible causes of health disparities among this population. These studies suggest that factors such as social network composition and network social capital may offer key intervention targets for strategies aimed at decreasing and eliminating the disparities in chronic disease outcomes seen among this population.

In summary, there is an absence of research on how social capital and social networks affect health, specifically among disadvantaged populations, including Black communities. Paradoxically, it is these populations that may benefit the most from a deeper understanding of how social capital and social networks interact with socioeconomic status to impact chronic disease rates and contribute to disparities in health outcomes.

Study Innovation

The current research is innovative in several ways. First, it utilized a respondent-driven sampling approach. Respondent driven sampling is a network sampling technique used in hard-to-reach populations.[37] It involves the identification of seeds who serve to identify eligible members of the specified population or community and uses previous participants to engage other potential participants in a multiple wave process. Specific to RDS is the use of unique identifiers which link respondents to their recruiters. The

formation of these recruitment chains allows the researcher to identify how participants enter the study and to analyze these networks. While this sampling methodology has been widely used to generate population prevalence rates of outcomes such as HIV and injection drug use,[36,38,158] it has not been previously used as an engagement method among neighborhood residents. The current study employed a respondent-driven sampling methodology in an attempt to engage members of the study population who may be less likely to participate in research. This approach had several advantages over a conventional convenience sample approach for the current study, including a potential increase in sample size and the ability to reach individuals who are less socially involved. The overall aims of this study are to examine links between social relationships and health. Yet, many traditional recruitment methods tend to sample individuals that may already be more socially involved or connected. The use of RDS allowed the current study to recruit participants that may not have heard about the study otherwise, and therefore may sample individuals who are less likely to be connected to their community. Examining data from individuals who are less likely to be involved will increase the variability of the sample and allow comparisons within the study between those who are more socially connected and those who are not. Future studies will explore differences in the study population by recruitment wave to examine the utility of this approach in engaging low income and socially isolated individuals in scientific research. To our knowledge, this approach has not been used previously to recruit eligible participants from a neighborhood-based sample.

Second, the use of respondent driven sampling required a unique analytic approach. Most studies that employ respondent driven sampling use the data to generate

population estimates, such as, for example, the prevalence of HIV among individuals who inject drugs.[38] Very little research has used regression techniques to examine relationships among variables using this sampling approach. The primary reason for this is the inherent non-independence of the sample due to the use of recruitment chains, which violates a major assumption of regression analysis. However, the advancement of statistical analyses, including gains in the popularity of multilevel modeling especially among public health researchers, may provide a solution for the characteristic clustering of data within the sample design. To our knowledge, there is currently only one study that employed regression analysis utilizing data collected via RDS. In their study, Rhodes and McCoy compared several different approaches to modeling the RDS data in order to examine the relationship between various psychosocial predictors of condom use among Latino men.[159] Although they do not provide specific recommendations as to the best approach for future studies seeking to model RDS, their results suggest that the use of multilevel modeling and the use of a robust sandwich estimator may account for the clustering of the data. However, there is also some documentation to suggest that the use of both multilevel modeling and a robust estimator may over account for the clustering of the data, and may be overly conservative. This approach paired with a lower sample size may result in a type-II inflation of error. The absence of prior studies utilizing regression based modeling with RDS data represents a challenge and new frontier within this field. Despite the current limitations to analyzing data collected via RDS, there are several promising approaches that may resolve these concerns. The subsequent analysis plan for the current study will thus require an innovative and thoughtful approach, and represents

a unique opportunity to apply advanced statistical methodologies to a previously limited sampling strategy.

Third, there is limited research that examines the association between social capital, social networks, and chronic disease outcomes among a predominantly Black and historically-disadvantaged population. Furthermore, there is no research that examines the social network characteristics of this population. This key information could inform future research and policy about the role of social relationships and network characteristics on disparities in chronic disease among this important population.

Finally, this study was one of the first to examine how the relationship between social capital and chronic disease is moderated by individual-level socioeconomic status. The examination of residents living in historically Black and low-income communities offers an opportunity to assess individual- as well as community-level factors that may affect social networks, and subsequently, health. Patillo's work on the Black middle class in one of Chicago's South Side neighborhoods illustrates that middle-income Black families still often live in low-income neighborhoods due to other factors, including discrimination in housing policies and the presence of historical and family ties within those neighborhoods.[160] Similarly, the current sample includes middle and upper income households who currently reside in each of the eight historically disadvantaged neighborhoods selected for this project. This offers a unique opportunity to examine the impact of individual-level socioeconomic status among individuals living in low-income neighborhoods. The examination of SES as a moderator of the relationship between social capital, social networks, and chronic disease will assess whether individual socioeconomic positioning contributes to the strength and direction of these relationships.

Specifically, this project proposes that social capital operates differently on health outcomes based on individual socioeconomic positioning, and will be one of the first studies to examine how income and educational attainment moderate the relationship between social capital and chronic disease.

CHAPTER III

METHODS

The Greenville Healthy Neighborhoods Project (GHNP) is part of a broader research agenda to examine the characteristics of low-income communities and how these contexts may contribute to health. Accomplishment of the aims in this proposal represents an important next step in ongoing research about the role of social environments on health outcomes among residents of low-income and historically-disadvantaged communities and how social capital and social networks may contribute to health disparities in the United States.

Conceptual Model

This study will be guided by a social determinants framework, including Berkman and Glass' model of social networks and health (Figure 2.1), and other social network theories of health.[16,41,161] Figure 3.1 encompasses a conceptual model for both Aims 1 and 2. Aim 1 examined the traditional focal relationship between social capital and health that has utilized a cognitive approach in the measurement of social capital. Thus, the primary independent variable is cognitive social capital which is operationalized as social cohesion, social support from neighbors, and collective efficacy. The second independent variable, which is hypothesized as a rival independent variable, is network social capital which is operationalized as network reach, range, and diversity. The dependent variables are hypertension and BMI. Socioeconomic status (educational attainment and household income) were hypothesized as predictors of social capital, as well as moderators of the

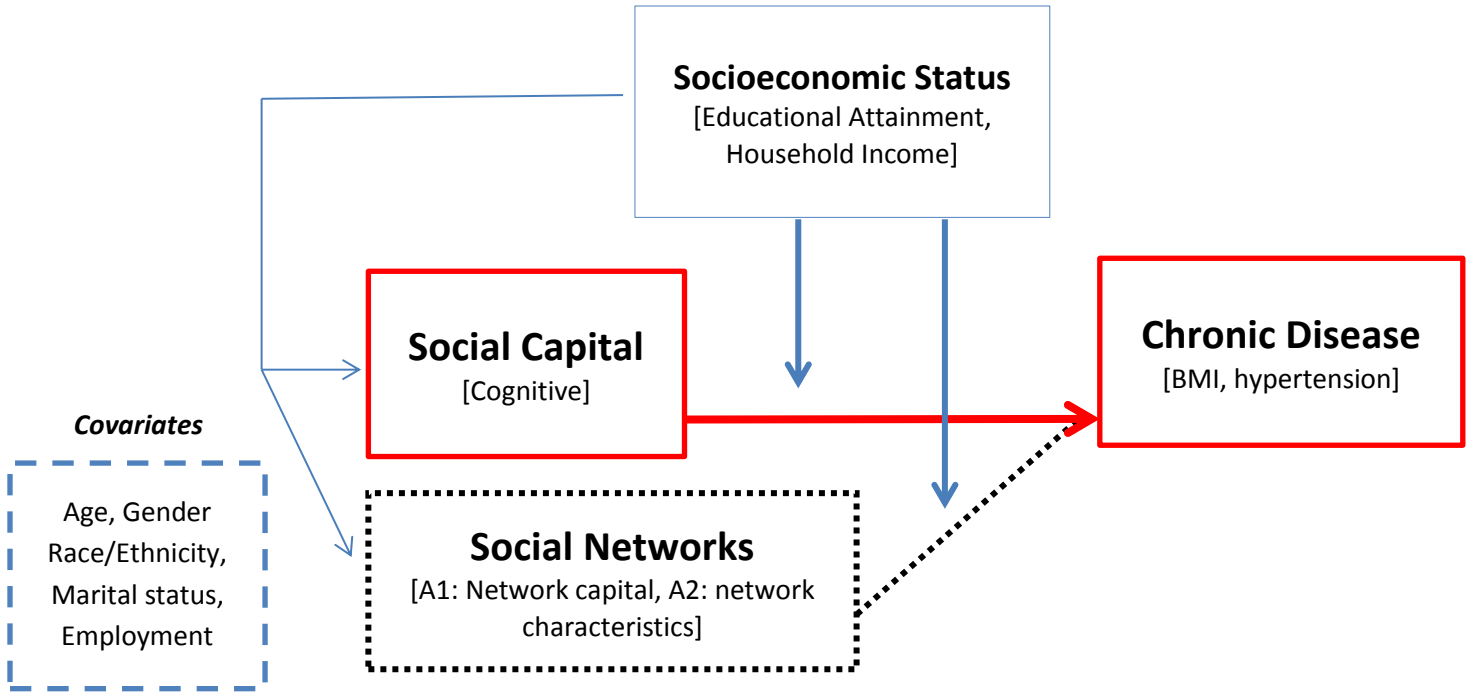

Figure 3.1 Conceptual model of the role of social capital and social networks on disparities in chronic disease outcomes

relationships between social capital and chronic disease. Covariates within the model included age, gender, race/ethnicity, marital status, and employment status.

For Aim 2, the focus will narrow to examine the association of specific social network characteristics and composition (density, average educational attainment, geographic location) with chronic disease outcomes. The dependent variables will still be hypertension and obesity, and socioeconomic status will still be hypothesized to moderate these relationships. Covariates within the model will include age, gender, race/ethnicity, marital status, and employment status.

3.1 STUDY SETTING AND OVERVIEW

The Greenville Healthy Neighborhoods Project (GHNP) occurred in 2014 in eight 'Special Emphasis' neighborhoods located within the City of Greenville, South Carolina as part of a collaborative effort between researchers at the University of South Carolina and community partners at LiveWell Greenville and Greenville Dreams. LiveWell Greenville is a network of organizations who have partnered together to create and maintain a community that supports healthy lifestyles. Greenville Dreams is a United Way initiative that brings together neighborhoods and community leaders to empower residents and improve neighborhood conditions through leadership and leveraging available resources. As of 2014, 13 neighborhoods within the City of Greenville had been designated as 'special emphasis' neighborhoods. This designation represented a heightened effort on behalf of the City of Greenville to partner with disadvantaged communities in order to leverage existing resources and promote well-being among residents of those communities.

The City of Greenville, South Carolina is an important population for this study due to the drastic health disparities that exist among Blacks and Whites living in the Southern United

States. South Carolina consistently ranks high for chronic disease, and these rates are substantially higher among the state's Black population. In 2014, South Carolina had the seventh highest rate of diabetes in the nation, with the highest rates among low-income (1 in 5) and Black (1 in 6) adults.[162] Within Greenville County, the age-adjusted morbidity rates (per 100,000) were drastically higher among Blacks than Whites for almost all major chronic diseases (e.g. 20.5 vs. 3.0 for hypertension, 196.5 vs. 142.3 for heart disease, 41.9 vs. 14.1 for diabetes), and were higher among Blacks living in Greenville County than state averages across all races (e.g. 20.5 vs. 7.9 for hypertension, 196.5 vs. 179.2 for heart disease, 41.9 vs. 22.5 for diabetes).[163] These disparities justify the examination of potential causes of poor health and chronic disease among this population.

Additionally, the City of Greenville and the 'special emphasis' neighborhoods provided an ideal location for the study for the following reasons: 1) it leveraged existing partnerships among health-oriented coalitions and organizations within the area, 2) it benefitted from a community liaison that helped establish trust and rapport within a historically hard-to-engage population, and 3) it was supported by a well-established infrastructure of community networks and resources that made data collection feasible. A total of eight neighborhoods were selected for this project from the 13 designated 'special emphasis' neighborhoods to represent a diverse mix of socioeconomic and demographic resident characteristics (i.e., race/ethnicity), population size, household income, and availability of community resources (i.e., public parks, recreational fields, community centers, etc.). Table 1 shows selected characteristics of the eight GHNP neighborhoods compiled by the City of Greenville.

Most of the neighborhoods are historically and predominantly Black communities, ranging in size and population. All are located within the City of Greenville, which is a semi-urban city center. In all of the neighborhoods, more than 30% of the residents live at or below the Federal Poverty Line and annual household incomes

average less than $20,000. The neighborhoods range from zero to six in the number of community resources available (i.e. publicly available parks, recreational fields, and community centers).

Table 3.1 Study Neighborhood Characteristics

Neighborhood	Population	Black (%)	Median Household Income ($)	Poverty Level (%)	Community Resources†
Green Avenue	360	71.2	15,569	46.7	0
Greenline-Spartanburg	688	52.0	19,032	33.6	2
Haynie-Sirrine	544	34.0*	18,509	41.9	1
Nicholtown	3183	80.4	19,316	33.6	3
Pleasant Valley	841	79.3	17,478	36.7	1
Southernside	1328	70.4	18,319	31.4	6
West End	589	66.7	18,649	46.1	0
West Greenville	1167	82.6	15,550	56.4	2

Source: ESRI Business Analyst Online (Census 2010, ACS 2005-2009)
† Indicates the number of publicly available parks, recreational fields, and community centers
*Haynie-Sirrine is a historically Black community that is currently experiencing gentrification and an influx of White residents. It is still currently considered a 'Special Emphasis' neighborhood.

Data Collection

Data collection for the GHNP occurred in two phases. Focus groups were conducted in each of the eight neighborhoods between the months of February and May

2014. Each focus group was hosted at a local community center or church and lasted approximately 90 minutes. Focus group participants were recruited by the neighborhood association President, had to be at least 18 years of age, able to speak and comprehend English, and a resident of the corresponding neighborhood to be eligible to participate in the focus group. Participants were asked to define and describe their neighborhood, as well as discuss the ways in which their neighborhood affected their health. Healthy snacks and water were provided at each focus group and residents received a $20 gift card for their participation. Future studies will analyze these data to explore neighborhood factors associated with health behaviors, such as physical activity and diet, within this context.

The second phase of the project, and the collection of data that will be employed for the current study, involved the use of a household survey (see Appendix). Beginning in September 2014, the study team employed a respondent-driven sampling (RDS) technique to engage residents from each of the eight neighborhoods to participate in the survey portion of the GHNP. RDS was developed as a technique to estimate population proportions among groups that are traditionally hard to monitor, such as the homeless.[37] Limitations associated with this method, including non-probability sampling, have previously hindered the use of RDS among researchers. However, recent work by Heckathorn (2002), which addresses these biases, and provides recommendations for generating valid statistical inference has resulted in increased use of the approach. More recently, studies have highlighted the ability of RDS to engage hard to reach populations.[37] Although it is similar to snowball sampling, RDS has two unique features that may enhance its ability to engage hidden populations. First, it includes a double

incentive system, which not only provides compensation to participants for completing the survey, but also for successful recruitment of other participants. Second, new participants are invited to participate via community members, rather than study personnel. These features allow a community to take ownership of the referral process and may make participation more inviting to those who are less likely to engage otherwise.

In the current study, the neighborhood association president served as the initial seed (recruiter) in each neighborhood. The presidents were asked to select ten residents who would serve as the initial (first) wave of the sampling chain. These ten people were given a coupon from the president that served as their invitation to enter the study and which also tracked how they entered the study (i.e., who recruited them). After participants of the first wave completed the survey, they were asked to recruit three more individuals (a second wave) who lived in their neighborhood to complete the survey. This second wave was also given coupons to track how they entered the study. All participants were given a $10 gift card for completing the survey, and were incentivized to recruit other residents with the use of a raffle. Specifically, for each of the three coupons that were returned by a subsequent participant, the recruiter was entered to win a $50 gift card to a local grocery store. Participants of the second wave were also asked to recruit three others, and so forth, for a total of four waves of participants. Specific to RDS methodology, the coupons contained identification numbers that linked participants with their recruiters, giving detailed information about how each participant entered the study. These identification numbers were used to create sampling chains which informed the cluster variable for multilevel analysis.

Participants completed the survey at a local community center or church located within their neighborhood. Eligibility for the survey included the ability to speak and comprehend English, being at least 18 years of age or older, non-institutionalized, and residing in one of the eight study neighborhoods. While most participants were invited to participate in the survey through RDS and the use of coupons, eligible residents who did not have coupons, but had been informed of the study through a community member were also eligible to complete the survey.

Data Management

Survey and focus group data were completely anonymous at the individual level. Survey data were collected and entered into SPSS by trained research staff. Focus groups were facilitated by the project coordinator, and were audio recorded and transcribed verbatim. Data collected by USC's Arnold School of Public Health is highly secure with limited access. The dataset was only shared with the investigative team through a password protected server on a secure computer network. The dataset was backed up on an external hard drive maintained within the BEACH Laboratory. Hard copies of the survey data are stored in a locked cabinet in a locked office when not in use.

Sample

The final sample included 430 completed surveys. Table 2 provides the socio-demographic characteristics of the sample. Participants ranged in age from 18 to 90 years old, with a mean age of 55 years. More than two thirds of the sample was female (71.25%). The majority of participants self-identified as Black. The 'Other' category includes individuals who identified as either Asian or American Indian. There were five participants who indicated they were Hispanic, but who also identified as Black. Those

participants have been categorized as Black. Participants reported their annual household income by selecting one of six range options, which have been further grouped into low, middle, and high income categories. More than a third (37.7%) of the sample reported very low income (less than $15,000 annually). Less than a fifth the sample (15.3%) reported high income (more than $60,000).

Table 3.2 Sample Characteristics

Age (Mean, SD)	55.4 (15.1)
Female (%)	71.3
Race (%)	
Black	89.1
White	10.2
Other	0.7
Household Income (%)	
Less than $15,000 (Very Low)	37.7
$15,000-$29,999 (Low)	20.5
$30,000-$59,999 (Middle)	26.5
$60,000 + (High)	15.3
Educational Attainment (%)	
Less than High School	17.1
High School/GED	40.2
Some college/AA	24.8
College/Advanced Degree	17.9
Employment Status (%)	
Employed (full/part-time)	34.2
Unemployed/Disability	27.9
Retired	29.7
Other (homemaker/student)	8.3
Marital Status (%)	
Single	37.1
Married/cohabitating	25.1
Separated/divorced/widowed	37.8
Hypertension (%)	60.2
BMI (Mean, SD)	29.8 (7.3)

More than half of the sample had a high school education or less (57.3%). Another quarter of the sample (24.8%) had some college experience or an Associate's degree.

Less than a fifth of the sample (17.9%) had a college or advanced degree. In line with the relative age of the sample, nearly a third of participants (29.7%) reported that they were retired. Another third were employed (34.2%), and a quarter of the sample (27.9%) were either unemployed or on disability. A quarter of the sample (25.1%) was married or cohabitating, and the remaining participants were evenly divided among those who were single (never married; 37.1%) and those who were divorced, separated, or widowed (37.8%). More than half of the sample (60.2%) reported they had been told by a medical professional that they had hypertension. The mean BMI of participants was 29. 3 kg/m^2 (SD 7.3), indicating that the average participant bordered between being classified as overweight or obese.

Previous literature around RDS samples has suggested that a doubling of the sample size needed to achieve power under a convenience sampling design is necessary.[35] These calculations are based on the prevalence of the outcome, as well as the design effect, which can range from ten to less than one.[35] Given the estimated prevalence of hypertension and obesity among this population (more than 40%) and a conservative design effect of two, and within the limitations of resources available for the current study, an initial goal of 800 respondents was established, with approximately 100 respondents coming from each of the eight neighborhoods. Following data collection, a final sample of 430 completed household surveys was collected. Thus, an absence of statistically significant findings in the current study may be due to low sample size. Within the available resource limits, every effort, including the addition of a fourth sampling wave, was made in order to increase the final sample size before data collection concluded in December of 2014.

3.2 MEASURES

The two main outcomes of interest in the current project are hypertension and BMI. For Aim 1, two distinct forms of social capital were examined in association with hypertension and BMI. First, cognitive forms of social capital were assessed using a social cohesion scale, a collective efficacy scale, and perceived support from neighbors. A network approach to individual capital was also assessed using a position generator, which was used to produce three distinct measures of individual level capital (see below). For Aim 2, the characteristics (i.e., density) of participants' social networks will be examined in association with hypertension and BMI. Network characteristics will include the number of social ties, as well as information obtained through the use of a name interpreter. In both of these aims, individual level socioeconomic status, represented by household income and educational attainment, will be examined as potential moderators of the relationships between social capital and network characteristics, and chronic disease.

Hypertension status was self-reported by asking participants if they had ever been told by a doctor, nurse, or other health professional that they had high blood pressure. For women who had ever been pregnant, there was an option to specify whether this was during pregnancy only. Hypertensive status was assigned to males who indicated yes, and to women who indicated they had high blood pressure outside of pregnancy. Individuals who were 'not sure' about their blood pressure status were not included in the analysis (n=4). Hypertension status was coded 1 (yes) or 0 (no). Self-reported hypertension has previously shown relatively high validity among both Black and White South Carolina residents.[165]

Body Mass Index was calculated using self-reported height and weight. Participants reported their height in feet and inches, and their weight in pounds. This was converted to a BMI score using the following standard equation: BMI = [weight (lbs.) / height (in.)^2] x 703 (in^2/lbs)(kg/m^2). This value was kept as a continuous variable (raw BMI score) for analysis. In a previous cohort study, self-reported height and weight data that were used to calculate BMI scores were shown to be valid measures for examining relationships in epidemiological studies.[166]

Communitarian Measures of Social Capital (Aim 1)

Social cohesion was measured using a 5-item scale that assesses perceived trust and shared values (see Appendix A, items 10a-e).[101] The scale includes items such as "People in this neighborhood can be trusted", which were assessed on a 5-point scale (1=Strongly Disagree, 5=Strongly Agree). Two items were reverse coded and a mean score was calculated across the five items such that higher scores represented greater social cohesion. The scale has shown good reliability and validity in previous studies among similar populations.[167]

Collective efficacy was also measured using a 5-item scale that assesses a participants' perceptions about the willingness of their neighbors to intervene on behalf of the common good (see Appendix A, items 11a-e).[101] The scale includes items such as "Children were hanging out in the neighborhood or around a school at night". Participants were asked to rate how likely a neighbor could be counted on to intervene in each of the scenarios using a 5-point likeliness scale (1= Very Unlikely, 5= Very Likely). A mean score was calculated across the five items where higher scores represent greater collective efficacy.

Social support from neighbors served as an additional measure of cognitive social capital. Four items assessed perceived support received from neighbors across various forms of social support (instrumental, informational, emotional; see Appendix A, items 10f-i). Participants were asked to rate their level of agreement using a 5-point Likert scale about the different types of support they receive from their neighbors, including information and advice about job opportunities, for example. These items were assessed for internal consistency and mean score was calculated across the four items.

Network Measures of Social Capital (Aim 1)

Network social capital was assessed using a position generator. Position generators are a common survey tool used to measure individual-level social capital and to specifically capture access to social resources useful in instrumental actions.[168] The position generator asks respondents to identify whether they are on a 'first name basis' with people holding a range of occupations in society, such as an accountant, physician, or high school teacher. The twelve occupations in the position generator instrument have previously been assigned a prestige value,[169] which serve as indicators of accessible social capital.[168] For example, a janitor has a prestige score of 22.33, a musician a score of 46.56, and a nurse a score of 66.48. The lowest prestige score was 20.83 (plant machine operator) and the highest score was 86.05 (physician). Key measures of network capital that were calculated using the position generator were *reach* (i.e., highest occupation accessed), *range* (i.e., difference between highest and lowest occupation accessed), and *diversity* or extensity (i.e., number of unique occupations accessed; range 0-12). Network diversity was positively skewed and was treated as a continuous variable (with Poisson regression). Network reach and range were collapsed into uniformly-

distributed quartiles and treated as ordinal variables. Specifically, network reach values were categorized as follows: None (reach=0; i.e., no known occupations), Low (reach=1-59), Middle (reach=60-79) and High (reach>80). Network range values were categorized as follows: None (range=0), Low (range=1-39), Middle (range=40-59) and High (range>60). Of the three measures, network diversity has been most often associated with health outcomes.[33,34] However, it is cautioned that use of a single indicator can lead to the loss of potentially interesting and important information.[168] As such, the current study included all three measures as indicators of individual-level network capital.

Social Network Characteristics (Aim 2)

Participants' social network characteristics were assessed using a variety of measures. First, the number of *core ties* was assessed using a name generator.[170] This asked participants to name up to three people (alters) with whom they had discussed important personal matters over the last six months. The number of core ties a person designates approximates the number of close ties they have and is representative of how socially-integrated a participant is.[170] *Core ties* were dichotomized, such that persons who named all three alters were coded '1' (highly socially integrated), and those who named less than three alters were coded '0' (less socially integrated).

A name interpreter was used to assess the rest of the participants' social network characteristics. The name interpreter consisted of several follow-up questions that asked for more details about alters listed in the name generator. First, participants were asked whether each of the three alters knew one another. From this, *network density* was calculated by dividing the number of actual ties between alters by the number of potential ties between alters.[112] These scores ranged from 0-1 and were recoded to range from 0-3

such that 0=0.0 (very low density), 1=0.33 (low density), 2=0.66 (medium density), and 3=1.0 (high density).

The name interpreter also included questions about alters' age, gender, educational attainment, and residential location. From these, we were able to assess *network education homophily*, or the extent to which alters' educational attainment matched with the participant's educational attainment, was assessed. For this, each of the alters' educational attainment was paired with the participant's educational attainment. A direct match was coded as -1 (homophilous) while a mismatch was coded as 1 (heterogeneous).[112] These scores were summed and divided by the number of alters within a network. These raw scores ranged from -1 to 1, and were reverse recoded as 0 through 3, where 0=1.0 (very heterogeneous), 1=0.66 (somewhat heterogeneous), 2=-0.66 (somewhat homophilous), and 3=-1 (very homophilous), so that higher values indicated increasing network education homophily, or similarity.

Next we calculated the *average educational attainment* of a participant's network. Alters were assigned a '1' for less than a high school diploma, '2' for a high school diploma, and '3' for more than a high school diploma. The average educational attainment of the network was calculated by summing these values and dividing by the number of alters within the network. These scores ranged from 1.0-3.0 and were treated as a continuous variable.

Additionally, participants also listed whether each of the three alters resided in their home, in their neighborhood, within the City of Greenville, or outside of Greenville. Similar to previous research,[25] the *number of alters who resided in their home or neighborhood* was calculated, and ranged from zero to three.

Socioeconomic and Demographic Characteristics

Socioeconomic status was assessed via annual household income and educational attainment. Participants were asked to report their annual household income and the highest level of education they had completed. *Annual household income* was categorized as follows: Very Low (less than $15,000), Low ($15,000-$29,999), Middle ($30,000-$59,999) and High (more than $60,000). *Educational attainment* was categorized as follows: Less than High School (HS), HS Diploma/GED, some college/Associate's degree, and college or graduate degree. Both of these variables were treated as categorical.

Demographic and other social characteristics, including age (continuous), gender (male or female), race (Black or White), employment status (employed or unemployed/disabled/retired), and marital status (married/cohabitating or single/separated/widowed/divorced) were used as covariates in all models. Participants who reported a race other than Black or White were not included in the analysis (n=3).

3.3 ANALYTIC APPROACH

Several analyses were used to evaluate the project aims. To answer the first research question (Aim 1a), mixed effect multivariate regression models were used to examine the relationship between SES (income and education) and each of the measures of cognitive and network social capital. Linear regression was performed for each of the cognitive social capital outcomes. Poisson regression was used to handle the positively skewed distribution of network diversity, and ordinal logistic regression was performed for network reach and range.

For the second research question (Aim 1b), multilevel linear and logistic regression models were used to examine the relationship between social capital and both BMI and hypertension, respectively. For each outcome, various models were explored to first examine the relationship between social capital and BMI or hypertension, and second, whether SES moderated these relationships. The models were built in the following order. First, direct effects were assessed by examining each social capital measure as an independent predictor of BMI or hypertension. Second, the models were further adjusted for both socioeconomic positioning (e.g., household income and educational attainment) and demographic characteristics to determine if the relationships remained after controlling for these variables. Lastly, the models tested whether the relationship between social capital and BMI or hypertension was moderated by individual SES by examining interaction effects between each of the social capital measures and both income and education.

As part of Aim 2 univariate statistics were used to describe sample demographics and social network characteristics. Next, to examine the third research question (Aim 2a) regarding the relationship between SES and network characteristics, a series of multilevel regression analyses, utilizing logistic, ordinal logistic, and linear regression models were used (depending on the outcome variable). Each of the five network characteristics were regressed onto SES (household income and educational attainment), while controlling for various demographic factors.

To examine the final research question (Aim 2b) regarding the relationship between social network characteristics and chronic disease, multilevel linear and logistic regression models were employed to explore the associations between social network

characteristics (as independent variables) and BMI and hypertension (outcomes), respectively. Each measure was modeled first by testing direct effects, and then further adjusted for both SES and demographic characteristics. Finally, using linear and logistic regression, respectively, each network characteristic was interacted with both household income and educational attainment to test whether SES moderated the relationship between social network characteristics and chronic disease (BMI and hypertension).

Due to the nature of RDS, a multilevel analytic approach was used to account for the clustering of observations within the sampling chains.[159] Originally, a three-level model was employed to account for additional clustering at the neighborhood level. Initially, modeling of the data was carried out for all analyses utilizing a three-level model. However, it was concluded that no variance existed at the neighborhood level, so all analyses were re-conducted with two-level hierarchical models, where individuals were nested within their respective sampling chains.

Furthermore, a robust (sandwich) covariance estimator was employed to account for additional errors associated with the unknown clustering of observations within the sampling chains. Under circumstances when the correlation structure among observations is unknown, as is true for RDS, the sandwich estimator permits a "working covariance matrix", allowing for flexibility during the estimation step.[171] In line with previous health studies that have utilized RDS,[159,172] the current study employed a mixed regression analysis with robust estimation to best account for the unknown clustering of observations.

Missing data were imputed with chained equations,[171] by utilizing STATA's mi impute command. These included household income, social capital measures, and social

network characteristics. All other variables with complete data (e.g. chronic disease outcome, age, race, gender, education, etc.) were used as predictors of the imputed variables. A total of twenty imputations were used to calculate missing entries on participant's age, income, and various social network characteristics. MI ESTIMATE in STATA was used to perform the regression analyses across these twenty imputed data sets. Mixed model estimations were performed using MIXED, MELOGIT, and MEOLOGIT commands in STATA software version 13.1.

3.4 PROTECTION OF HUMAN SUBJECTS

In order to maintain anonymity of study participants, we did not require participants to sign a consent form. In lieu of this, we included a consent letter as the first page of the household survey (see Appendix A) and asked participants to read it before beginning the survey. A research assistant was always available to answer any questions that participants had about taking part in the study.

In an effort to minimize the risks of participation, surveys and other study materials were anonymously completed. Participants were assigned a study ID upon entry into the study and no information was collected about their personal identity (i.e., name, date of birth, etc.). All surveys were maintained by the PI in a locked cabinet in a locked office on the USC campus. All electronic databases were stored on secured university network servers and on password protected computers.

Participants were reimbursed $10 for their time completing the survey and were eligible for a $50 raffle for successful recruitment of other residents. This research is designed to benefit society by gaining new knowledge about social capital and social networks among disadvantaged populations. The benefits to individuals may include

feelings of altruism for donating their time and information to the advancement of science.

As part of the RDS methodology a unique identifier was assigned to each participant at the beginning of the project. This identifier was used on survey documentation rather than names. Study records/data are stored in locked filing cabinets and protected computer files at the University of South Carolina. Study related documents that were stored on end-user/portable devices were kept secure by ensuring that all devices and servers were password protected.

The PI and Study Coordinator monitored for the safety of all participants in this research. The Participants were monitored for any adverse events during their participation in this research. Were any adverse event to arise as a result of participation in this research, participants were advised to seek immediate medical attention and to discontinue participation in the study, if appropriate. There were no adverse events reported during the course of this study.

Institutional Review Board approval was obtained from the University of South Carolina prior to study commencement. The University of South Carolina IRB provided oversight and monitoring for this research study.

CHAPTER IV

RESULTS

This chapter is comprised of two independent manuscripts that detail the findings of this study and partially fulfill the requirements of this dissertation. The first manuscript, "Cognitive and Network Social Capital Associated with Socioeconomic Status and Chronic Disease" will be submitted for publication consideration in Social Science and Medicine. The second manuscript, "Social Network Characteristics and Chronic Disease: Does Socioeconomic Status Matter?" will be submitted for publication consideration in Journal of Health and Social Behavior.

Cognitive and Network Social Capital Associated with

Socioeconomic Status and Chronic Disease[1]

[1]Child S, Kaczynski AT, Walsemann KM, Fleischer NL, McLain AC, and Moore DS. To be submitted to *Social Science and Medicine.*

Abstract

Social capital is important for health and may be linked with chronic disease, including obesity and hypertension. Socioeconomic status (SES) may influence access to social capital, and also moderate the relationship between social capital and health. Yet few studies have explored relationships between social capital and chronic disease among resource poor individuals. Data on cognitive (social cohesion, social support, and social control) and network measures of social capital (network diversity, network reach, and network range) were collected via a household survey among residents of low-income and socially disadvantaged neighborhoods in Greenville, SC using respondent driven sampling (*n*=360). Multilevel multivariable regression analyses first examined the relationship between SES (annual household income and educational attainment) and social capital. Next, the relationships between social capital and both body mass index and hypertension were assessed, including whether these relationships were moderated by SES. Participants with very low income reported lower levels of social cohesion (b=-0.44, 95% CI: -0.74, -0.14) than those with high income. Similarly, individuals with a high school diploma had lower odds of high network reach than individuals with a college degree (OR: 0.31, 95% CI: 0.13, 0.71). Greater network diversity was associated with higher BMI (b=0.28, 95% CI: 0.05, 0.51). The relationships between both network reach and range and BMI were moderated by education. For participants with some college a positive association existed between both network reach and range, and BMI. The relationship between social support and hypertension was moderated by educational attainment. While individuals with higher education saw no gains in health as social support increased, for those with less than a high school diploma, higher social support was associated with lower odds of hypertension (OR=0.23, 95% CI: 0.08-0.68). The data

suggest that low SES may be associated with lower access to social network capital, and that SES may moderate the associations between social capital and chronic disease. Future studies should continue to explore the interplay of SES, social capital, and chronic disease, especially among populations that experience inequity in health outcomes.

Key words:

Social cohesion;

Network social capital;

Chronic disease;

Socioeconomic status

INTRODUCTION

Research indicates that social capital is influential for both health behaviors (e.g., physical activity, sleep; Legh-Jones and Moore, 2012; Nieminen et al., 2013) and health outcomes alike, including mortality (Nyqvist et al., 2013), mental health (Riumallo-Herl et al., 2014), and overall well-being (Giordano et al., 2012).

There is also a growing interest in the effects of social capital on chronic disease outcomes. Obesity and hypertension are two chronic diseases that more commonly affect low-income and Black populations, although the reasons for these distributions are multifaceted and not well understood (Fuchs, 2011; National Center for Health Statistics, 2012). Suglia and colleagues (2016) argue that social capital may be linked to obesity through several mechanisms. Indeed, studies examining social capital and obesity have found that higher levels of capital are associated with lower BMI and smaller waist circumference (Holtgrave and Crosby, 2006; Moore et al., 2009b), suggesting there is a protective effect of social capital on weight status. Some studies have also explored the role of social capital on hypertension. For example, one study found that social cohesion, trust, and reciprocity within the workplace were negatively correlated with hypertension incidence over time among men, and moreover, that this relationship was partially mediated through obesity (Oksanen et al., 2012). To our knowledge, only one study has examined the role of network social capital on hypertension, and found that network diversity was protective against the development of hypertension over time (Moore, 2014).

However, previous studies examining the link between social capital and chronic disease, including obesity and hypertension, have not explored these relationships among

disadvantaged populations. The high prevalence of obesity and hypertension among non-Hispanic Blacks (hereafter referred to as Blacks) has led to behavioral intervention efforts specifically directed at this population (Whitt-Glover et al., 2013). However, Black women are least likely to benefit from such behavioral interventions (Fitzgibbon et al., 2012). This may occur in part because these efforts largely eschew root causes of these racial health inequities, including social capital, that lead to such disparities. Given the unequal distribution of obesity and hypertension across both racial minorities and economically disadvantaged populations, more studies that explore the potential link between social capital and chronic disease among these groups are warranted.

Additionally, most studies that link social capital with chronic disease have examined *cognitive* aspects of social capital, including social cohesion, reciprocity, and informal social control. These constructs can be traced to Putnam's work on civic communities (1994), as well as a widely-cited public health study which defined social capital as "civic engagement and levels of mutual trust among community members" (Kawachi et al., 1997, p.1492). However, this is a relatively narrow definition of social capital and some have argued that the widespread adoption of this definition and singular approach has limited our ability to think more broadly about the ways that social capital might affect health outcomes (Moore et al., 2006). Beyond cognitive measures, health researchers have also utilized *network* measures of social capital to explore the potential mechanisms linking social capital and health. While cognitive approaches tend to focus on group processes (i.e., social cohesion at the workplace), network capital focuses on the resources made available through one's own social network (Kawachi et al., 2008). From this, network social capital refers to "the amount and quality of resources that a person

might access through their social networks" (Legh-Jones and Moore, 2012, p. 1362). Others have articulated the importance of comparing these two approaches when studying the role of social capital for health (Moore et al., 2005), though few have done so. In contrast, we aim to examine the utility of both measurement approaches in analyzing the association between social capital and chronic disease.

Despite the dearth of scholarship in this area, hypertension and obesity are hypothesized to be linked to both cognitive and network social capital through numerous mechanisms. For example, a model put forth by Berkman and Glass (2000) identified several mechanisms by which social networks are thought to affect health, and through which we hypothesize that social capital may also be linked with chronic disease. These include both individual-level mechanisms, such as health behaviors (e.g., diet, physical activity) and physiological responses (e.g., stress), as well as interpersonal mechanisms, including social influence, social support, and the ability to access resources, including health care. Additionally, several scholars have argued that access to social capital and the resources that flow through social relationships may not be evenly distributed across socioeconomic positioning (Berkman and Glass, 2000; Lin, 2000), and that this may facilitate or hinder an individual's ability to access and leverage resources for health (Lin, 2000, 2002; Portes, 2000). These socioeconomic differences in access to social capital have been linked with health (Moore et al., 2011) and may be particularly relevant in explaining the disparities seen in chronic disease outcomes among racial minorities and low-income populations.

The first way that social capital and socioeconomic status (SES) may contribute to disparities in chronic disease outcomes is through the effect of SES on an individual's

ability to access capital. Lin (2000) argued that inequality in access to social capital occurs through the socioeconomic positioning of specific social groups. Because social capital is based on the ability of individuals to connect with others through common links, such as mutual friendships, working at the same company, or living in close proximity to one another (Ioannides and Loury, 2004; McPherson et al., 2001), factors that limit these opportunities may have important health ramifications. In the United States, certain social groups have been historically-disadvantaged based on their race, gender, and class, while others have benefitted. One such example is the historical and continued residential segregation of Blacks, which may have important ramifications for the structure of their social networks, and as well their ability to access social support and other resources (Wilson, 2012, 2003). For example, data suggest that the redistribution of low income individuals among more affluent communities was associated with greater access to diverse sources of information than those that remained in low income public housing (Kleit, 2001).

Second, social capital's influence on health may be moderated by SES. According to the buffering hypothesis, individuals with fewer resources (i.e., income, education), are more likely to experience health benefits as a function of their social capital than individuals with greater resources. Individuals with significant resources are unlikely to experiences any additional health benefits from their social capital. For example, one study found that access to co-ethnic social ties was associated with better self-rated health among Jews, with the strongest effect found among those with lower SES (Pearson and Geronimus, 2011). Additionally, some research suggests that social relationships, and in particular social integration, may buffer the negative effects of low education, unemployment, and

financial limitations to medical care, on self-rated health (Gorman and Sivaganesan, 2007).

Alternatively, the dependency hypothesis proposes that the health benefits derived from social capital are more readily available to individuals with the greatest access to social capital (Uphoff et al., 2013). According to this hypothesis, disadvantaged groups do not benefit because they cannot effectively utilize the resources made available through social capital. There is some evidence to support this hypothesis, including a study that found racial disparities in health status were moderated by income, such that low-income individuals benefitted less from social capital than more affluent individuals (Beaudoin, 2009). In spite of these hypotheses, no studies have explored whether SES moderates the relationship between social capital and chronic disease.

Despite the relevance of social capital for health, there remains a lack of research that explores the role of social capital on chronic disease among racial minorities and low-income populations. Few studies have examined social capital among Black communities (Brown and Brown, 2003; Domínguez and Watkins, 2003; Lochner et al., 2003), and none have examined the role of social capital on obesity or hypertension within this population. Given that Blacks are more likely to experience higher rates of hypertension and obesity than Whites (Centers for Disease Control and Prevention, 2012; Roger et al., 2012), the relationship between social capital, SES, and health has been mixed within the literature (Folland, 2007; Lin, 2000), and the link between social capital and health may operate differently according to individual socioeconomic positioning (Lin, 2000), more studies are warranted that examine how these factors operate simultaneously to contribute to chronic disease within this specific population. Examining the relationship between

social capital, socioeconomic status, and chronic disease among a predominantly Black population will thus address a glaring and significant gap in the literature.

The current study will address three main research questions: 1) Is there an association between SES and cognitive and network measures of access to social capital?, 2) Is there a direct relationship between cognitive and network measures of social capital and BMI and hypertension?, and 3) Does SES moderate the relationship between cognitive and network social capital and BMI and hypertension? In line with previous research (Beaudoin, 2009; Lin, 2000; Uphoff et al., 2013), we hypothesize that SES will be positively associated with both forms of social capital, that higher levels of social capital will be associated with a lower likelihood of chronic disease, and that individuals with higher SES will benefit the most from social capital.

METHODS

Study setting and sample

The Greenville Healthy Neighborhoods Project (GHNP) occurred in 2014 in eight 'Special Emphasis' neighborhoods located within the City of Greenville, South Carolina. The Special Emphasis designation represented a heightened effort on behalf of the City of Greenville to partner with disadvantaged communities in order to leverage existing resources and promote well-being among residents of those neighborhoods. Study neighborhoods represented a diverse mix of socioeconomic and demographic resident characteristics. The majority of the neighborhoods were historically and predominantly Black communities, ranging from 34% to 82% Black residents. In all of the neighborhoods, more than 30% of the residents lived at or below the Federal Poverty

Line and annual household incomes averaged less than $18,000 (U. S. Census Bureau, 2014).

Respondent-driven sampling (RDS) was used to engage residents from each of the eight neighborhoods to participate in a household survey. RDS was developed as a technique to estimate population proportions among groups that are traditionally hard to engage or monitor, such as the homeless (Schonlau and Liebau, 2012). RDS has two unique features that may enhance its ability to engage hard-to-reach populations such as those in this study setting. First, it includes a double incentive system, which not only provides compensation to participants for completing the survey, but also for successful recruitment of other participants. Second, new participants are invited to participate via community members, rather than study personnel. These features allow a community to take ownership of the referral process and may make participation more inviting to those who are less likely to engage otherwise (Malekinejad et al., 2008; Schonlau and Liebau, 2012).

In the current study, the neighborhood association president served as the initial seed (recruiter) in each neighborhood. Presidents were asked to select ten residents of varying demographic characteristics (i.e., gender, age, occupation) who would serve as the initial (first) wave of the sampling chain. These ten people were given a coupon from the president that served as their invitation to enter the study and which also tracked who recruited them. After participants of the first wave completed the survey, they were asked to recruit three more individuals (a second wave) who lived in their neighborhood into the survey by giving them similar invitation/tracking coupons. All participants were given a $10 gift card for completing the survey, and were incentivized to recruit other

residents with the use of a raffle. Specifically, for each of the three coupons that were returned by a subsequent participant, the recruiter was entered to win one of three $50 gift cards (per neighborhood) to a local grocery store. Participants of the second wave were also asked to recruit three others, and so forth, for a total of four waves of participants. Specific to RDS methodology, the coupons contained identification numbers that linked participants with their recruiters, giving detailed information about how each participant entered the study. These identification numbers were used to create sampling chains that were used as the cluster variable for multilevel analysis. A total of 180 sampling chains were created, ranging in size from one to fourteen people across four waves, with an average of two persons per chain.

Participants completed the survey at a community center or church located within their neighborhood. Eligibility for the survey included the ability to speak and comprehend English, being at least 18 years of age or older, non-institutionalized, and residing in one of the eight study neighborhoods. While most participants were invited to participate in the survey through RDS and the use of coupons, eligible residents who did not have coupons but had been informed of the study through a community member were also eligible to complete the survey. These participants (n=111) were treated as 'singletons', or single observations within their own sampling chain.

Measures

The GHNP survey included questions on a variety of health-related influences and outcomes, as well as social network characteristics and basic socio-demographic variables.

Dependent Variables

Hypertension status was assessed by asking participants if they had ever been told by a doctor, nurse, or other health professional that they had high blood pressure. For women, there was an option to specify whether this was during pregnancy only. Hypertensive status was assigned to males who indicated yes, and to women who indicated they had high blood pressure outside of pregnancy. Individuals who marked they were 'not sure' about their blood pressure status were not included in the analysis (n=4). Hypertension status was coded 1 (yes) or 0 (no). Self-reported hypertension has previously shown relatively high validity among both Black and White South Carolina residents (Giles et al., 1995).

Body Mass Index was calculated using self-reported height and weight. Participants reported their height in feet and inches, and their weight in pounds which was converted to a BMI score using the standard equation for adults: BMI = [weight (lbs.) / height $(in.)^2$] x 703kg/m2(in2/lbs). This value was kept as a continuous variable (raw BMI score) for analysis. In a previous cohort study, self-reported height and weight data that were used to calculate BMI scores were shown to be valid measures for examining relationships in epidemiological studies (Spencer et al., 2002).

Cognitive Social Capital

Cognitive social capital was assessed using three comprehensive scales employed most commonly to measure neighborhood social environments: social cohesion, social control, and social support from neighbors. Correlation between the three items was low (social cohesion and social control: r=0.3; social cohesion and social support: r=0.4; and social control and social support: r=0.2).

Social cohesion was measured using a 5-item scale that assessed perceived trust and shared values (Sampson et al., 1997). The scale included items such as "People in this neighborhood can be trusted", which were assessed on a 5-point scale (1=strongly disagree, 5=strongly agree). Two items were reverse-coded and a mean score was calculated across the five items such that higher scores represented greater social cohesion. The scale has shown good reliability and validity in previous studies among similar populations (Raudenbush and Sampson, 1999). Chronbach's alpha for these five items in the current study was α=0.71, and is similar to previous studies that have utilized this scale (Alegria et al., 2007; Mujahid et al., 2007).

Informal social control was measured using a 5-item scale that assessed a participant's perceptions about the willingness of their neighbors to intervene on behalf of the common good (Sampson et al., 1997). The scale included items such as "How likely would neighbors be to intervene if children were hanging out in the neighborhood or around a school at night?". Participants were asked to rate each of the scenarios using a 5-point likeliness scale (1=very unlikely, 5=very likely). A mean score was calculated across the five items where higher scores represented greater social control. Cronbach's alpha across these five items in the current study (α=0.87) was identical to previously reported data among African-American women living in the South (Andersen et al., 2015).

Social support from neighbors was used as an additional measure of cognitive social capital. Four items assessed perceived support received from neighbors across various domains (instrumental, informational, emotional). Participants were asked to rate their level of agreement using a 5-point Likert scale (1=strongly disagree, 5=strongly agree)

about different types of support they might receive from their neighbors, such as information and advice about job opportunities. These items, which were adapted from the Montreal Neighborhood Networks and Healthy Aging Panel Study (Moore et al., 2014), were assessed for internal consistency and a mean score was calculated across all four items. Similar to previous studies that assessed social support (Alegria et al., 2007; Andersen et al., 2015), Cronbach's alpha across these four items was α=0.80.

Network Social Capital

Network social capital was assessed using a position generator. Position generators are a common survey tool used to measure individual-level social capital and to specifically capture access to social resources useful in instrumental actions (Van der Gaag et al., 2008). The position generator asks respondents to identify whether they are on a 'first name basis' with people holding a range of occupations in society, such as an accountant, physician, or high school teacher. The twelve occupations in the position generator instrument have previously been assigned a prestige value (Nakao and Treas, 1994), which serve as indicators of accessible social capital (Van der Gaag et al., 2008). Table 4.2 provides detailed information about each of the twelve positions, their prestige scores, the total percentage of participants who reported they had access to each position, as well as this percentage broken down by educational attainment.

Key measures of network capital that were calculated using the position generator were *reach* (i.e., highest occupation accessed), *range* (i.e., difference between highest and lowest occupation accessed), and *diversity* or extensity (i.e., number of unique occupations accessed; range 0-12). Network diversity was positively skewed and was treated as a count variable (with Poisson regression) when diversity was the outcome

(question 1). Network reach and range were collapsed into uniformly-distributed quartiles and treated as ordinal variables. Specifically, network reach values were categorized as follows: None (reach=0; i.e., no known occupations), Low (reach=1-59), Middle (reach=60-79), and High (reach>80). Network range values were categorized as follows: None (range=0), Low (range=1-39), Middle (range=40-59) and High (range>60). Of the three measures, network diversity has been most often associated with health outcomes (Moore, 2014; Moore et al., 2009b). Although the correlations between these three measures were high (diversity and network reach: r=0.7, diversity and network range: r=0.8, and network reach and network range: r=0.8), it is cautioned that use of a single indicator can lead to the loss of potentially interesting and important information (Van der Gaag et al., 2008). As such, the current study included all three measures as indicators of individual-level network capital.

With respect to SES, *household income* was reported as a categorical variable and was collapsed into four categories: very low (less than $15,000), low ($15,000-$29,999), middle ($30,000-$59,999), and high ($60,000 or higher). E*ducational attainment* was reported as the highest level of education completed at the time of the study and was collapsed into the following four categories: less than high school, high school diploma or GED, some college or Associate's (two-year) degree, and college (four-year) or graduate degree.

Demographic characteristics included age (continuous), gender (male or female), race (Black or White), employment status (employed or unemployed/disabled/retired), and marital status (married/cohabitating or single/separated/divorced/widowed).

Analytic Approach

Descriptive statistics were used to explore the demographic characteristics of the sample (Table 4.1), as well the percentage of participants who had access to a specific occupation, using the position generator (Table 4.2). One-way ANOVA with Bonferroni corrections was used to examine differences in access to occupation by educational attainment (Table 2).

To account for the RDS methodology and inherent non-independence of the sample, multilevel modeling was used to control for the clustering of respondents (Rhodes and McCoy, 2015). First, a three-level model was employed to account for clustering of individuals within sampling chains within neighborhoods. However, after the completion of all analyses, no variance was found at the neighborhood cluster level, so the data were re-estimated utilizing a two-level model (individuals within sampling chains).

An additional approach to account for unknown clustering of observations within neighborhoods and sampling chains is a robust (sandwich) covariance estimator. The sandwich estimator allows for a "working covariance matrix" during the estimation step under circumstances when the correlation structure among observations, such as participants within an RDS-based sample, is unknown (Kauermann and Carroll, 2000). Similar to other studies that have employed an RDS approach to examine health outcomes (Rhodes and McCoy, 2015; Villanti et al., 2012), the current study combined both multilevel modeling and the robust estimator in order to account for the clustering of the data.

To answer the first research question, a series of multilevel multivariable regression models were used to examine the relationship between SES (income and education) and each of the measures of cognitive and network social capital (Table 4.3). Linear regression models were performed for each of the three cognitive social capital outcomes. Poisson regression was used to handle network diversity (count variable; range 0-12), and ordinal logistic regression was performed for network reach and range. Both income and education were entered into the models at the same time. Each model adjusted for age, gender, race, marital status, and employment status.

For the second research question, multilevel linear and logistic regression models were used to examine the relationship between social capital and both BMI and hypertension, respectively (Tables 4.4 and 4.5). For each outcome, models were estimated to first examine the relationship between social capital and BMI or hypertension, and second, to determine whether SES moderated these relationships. The models were estimated in the following order. First, direct relationships were assessed by examining each social capital measure and each SES indicator as independent predictors of BMI or hypertension. Second, the models were adjusted for socioeconomic (e.g., household income and educational attainment) and demographic characteristics to determine if the relationships remained after controlling for these variables. Lastly, the models tested whether the relationship between social capital and BMI or hypertension were moderated by individuals' SES through a set of interactions between each of the social capital measures and income or education. Post-hoc analyses utilized a Wald F-test to examine the overall significance of the interaction models. All model estimations were performed using the melogit and mixed commands in STATA software version 13.1.

The predicted means and prevalence depicted in the figures were calculated using each model's intercept and regression coefficients. Predicted probabilities for the hypertension figure were calculated by exponentiating the log-odds for each predictor and interaction item. Predicted mean values for BMI were calculated for each combination of network reach or network range, and educational attainment category. Predicted probabilities for hypertension were calculated across the range of the social support scale (range 1-5).

Missing data were handled using STATA's multiple imputation command (mi impute) with the chained equations option (White et al., 2011). Observations with missing data on income (*n*=35), age (*n*=1), and social capital measures (e.g., network reach missing *n*=9) were imputed a total of twenty times based on predictors with complete data (e.g., BMI score, hypertension status, education level, gender, race, etc.). MI ESTIMATE in STATA was used to replicate the subsequent regression analyses across the twenty computed values.

RESULTS

Sample Characteristics

Similar to previous studies using RDS (Frost et al., 2006), the current study had an average recruitment ratio of 1:1, meaning that on average, each participant recruited one additional participant. In total, 430 residents completed the survey across four waves of recruitment in the eight neighborhoods. A total of 70 observations were dropped due to missing data on the dependent variables (n=34 BMI scores, n=32 hypertensive status) or reporting a race other than Black or White (n=4).

The final sample for analysis included 360 residents with complete outcome data across the eight study neighborhoods. Table 4.1 provides descriptive statistics on the sample.

Participants had a mean age of 55.4 years (s.d.=15.0). More than two-thirds of the sample was female (70.3%). The majority of participants self-identified as Black (88.9%) and the remaining were White. Nearly half (42.5%) of the sample reported very low income (less than $15,000 annually). More than half of participants had a high school education (39.7%) or less (16.4%). Additionally, more than half of participants reported being hypertensive (55.3%) and the mean BMI score was 29.9 kg/m2 (s.d.=7.2).

Access to Social Capital

The results from Table 4.2 provide detailed information about the twelve occupations that comprised the position generator scale. The occupation with the lowest prestige score was a machine operator (20.83) and the highest prestige score was a physician (86.05). Over half of the sample knew (i.e., had access to) a mechanic (51.6%), whereas only a fifth of the sample knew an accountant (20.3%). Results from the one-way ANOVA with Bonferroni corrections reveal that there were statistically significant differences in access to occupation by educational attainment. For example, 72.7% of participants with a college degree knew a registered nurse on a first-name basis, whereas only 19.3% of participants with less than a high school diploma knew a registered nurse. Differences in access by education tended to occur among positions at both the lower and higher end of the prestige spectrum. Additionally, a clear pattern emerged (with few exceptions), such that access increased across most occupations as educational attainment increased.

To examine access to social capital by SES, Table 4.3 utilized multilevel models to regress SES indicators onto both cognitive and network social capital measures while controlling for demographic characteristics. Compared to those with high household income, participants with very low income reported less social cohesion among their

neighbors (*b*=-0.44, 95% CI: -0.74, -0.14). As well, participants with some college or a high school education had 0.47 times the odds and 0.31 times the odds, respectively, of having high reach as those with a college degree. Additionally, participants with less than a high school education had 0.34 times the odds of having greater network range (95% CI=0.12-0.96) compared to participants with a college degree

Blacks reported significantly less social cohesion and social control than Whites (*b*=-0.39, 95% CI: -0.57, -0.18 and *b*=-0.57, 95% CI: -0.83, -0.31, respectively). Furthermore, participants who were married or cohabitating, and employed reported higher levels of network diversity (*b*=0.26, 95% CI: 0.04, 0.48 and *b*=0.35, 95% CI: 0.16, 0.54, respectively) than those were single, separated/divorced, or widowed, and those who were not employed.

Social Capital and Chronic Disease

Table 4.4 presents results from multilevel linear regression models that examined the relationship between social capital and BMI, and whether these relationships were moderated by SES. Model 1 shows the unadjusted (bivariate) associations between each predictor and BMI. Models 2-7 report the adjusted main associations for each of the social capital indicators, controlling for income and education, as well as age, gender, race, marital status, and employment status. Model 2 confirms that the significant relationship between network diversity and BMI remained after controlling for demographic covariates (*b*=0.28, 95% CI: 0.05, 0.51).

All social capital measures were tested for moderating effects with SES on BMI. For each interaction model, a Wald F-test score with significance level is reported. Models 17

and 19 present the interactions that were statistically significant at $p<0.05$ (Wald F-test: 2.33 and 2.41, respectively). Network reach interacted with educational attainment, such that those with some college and a middle range of network reach had lower BMI (BMI=24.7kg/m2) than individuals with high network reach (BMI=27.1kg/m2; Figure 1a). Additionally, network range moderated the association between education and BMI (Figure 1b), such that among those with some college, individuals with no or low network range had significantly lower BMI scores (BMI= 22.3kg/m2 and 23.0kg/m2, respectively) than those with high network range (BMI=28.0kg/m2).

Table 4.5 presents results from multilevel logistic regression models that examined the relationship between social capital and hypertension status, and whether these relationships were moderated by SES. Model 1 shows the unadjusted (bivariate) associations between each predictor and hypertension. Models 2-6 illustrate that neither social capital nor SES, were statistically significantly associated with hypertension after adjusting for demographic covariates. However, all social capital predictors were tested for interaction effects with SES on hypertension. Model 11 presents the interaction between social support and educational attainment (Wald F-test=2.63, p=0.02). Social support was unrelated to hypertension except among participants with less than a high school diploma. Among this group, low levels of social support were associated with higher predicted probabilities of hypertension (PP=0.34), whereas high social support was associated with lower predicted probabilities of hypertension (PP=0.004; Figure 2).

DISCUSSION

The current study examines the role of social capital on chronic disease outcomes in a predominantly Black sample of residents living in economically-disadvantaged

neighborhoods in the US South. The historical and continued segregation of this population may have implications for their ability to access neighborhood social capital, as well as the structure of their social networks. There is mounting evidence to suggest that SES interacts with social capital to produce and widen health disparities, including rates of hypertension and obesity among low-income and low-educated adults. Data from the Greenville Healthy Neighborhoods Project were utilized to explore 1) the association between SES and two distinct forms of social capital; 2) the relationships between cognitive and network social capital, and chronic disease outcomes; and 3) whether SES moderated these relationships.

First, this study examined the relationship between SES and social capital, providing evidence to suggest there may be differences in access to social capital based on an individual's socioeconomic positioning. In support of previous hypotheses (Lin, 2000), the current data indicated that individuals with very low income reported significantly less social cohesion than individuals with high income. Consistent with previous data (Gorman and Sivaganesan, 2007), differences in access to network capital were seen across education levels such that participants with low educational attainment had lower network reach and range than those with college degrees. This indicates that individuals with higher educational attainment are more likely to have access to a wider array of social connections, including across both higher and lower occupational prestige scores. These data support the current hypothesis that individuals with higher SES may have greater access to social capital, and thus more leverage for improving health given their socioeconomic positioning (Berkman and Glass, 2000; Uphoff et al., 2013).

Second, data from the current analyses differentiated between two forms of social capital: cognitive and network. While extensive evidence has found positive associations between cognitive measures of social capital and self-rated health (Giordano et al., 2012), health behaviors (Nieminen et al., 2013), and mental health (Riumallo-Herl et al., 2014), the current study found no statistically significant main association between cognitive social capital and either BMI or hypertension in this setting. Additionally, unlike a previous study which found a protective relationship between network social capital and BMI (Moore et al., 2009b), the current study found that higher network capital was associated with higher BMI. Indeed, there is increasing evidence to suggest that social capital may be detrimental for health in some instances (Moore et al., 2009a). Previous work suggests that greater network capital may represent increased social integration, and thus opportunities to socialize with others (Lin et al., 2001), which may be linked with unhealthy behaviors. For example, another study found that network diversity was associated with higher odds of binge drinking, a largely social behavior, highlighting the detrimental impacts that social capital may have on health through increased socialization (Child et al., forthcoming). The current results did not support our hypothesis that higher levels of social capital would be associated with lower rates of chronic disease. The absence of statistically significant findings and moreover, the inverse association between network diversity and BMI in this study may underscore the uniqueness of these relationships among Blacks and low-income populations in particular. Limited research has examined the utility of social capital for health among Blacks and low-income populations. Therefore, it is not understood whether or how social capital pertains to health among poor and Black populations in the US South. For example, having social

capital may increase one's exposure to discrimination, which could help explain negative associations between social capital and health among racial minorities. Furthermore, there may be other types of capital, or different ways to measure social capital that may be more relevant for health among Black and low-income populations.

Next, we examined whether the relationship between social capital and chronic disease was moderated by SES. Network reach was moderated by education, such that the relationship between network reach and BMI was most pronounced, and positive, among those with some college education as compared to those with a college degree. These results did not support our hypothesis or previous literature which posited that social capital acts as a buffer for poor health among people with lower SES (Abdou et al., 2010; Uphoff et al., 2013). Instead, increasing levels of network capital were associated with increases in BMI among adults with some college education as opposed to those who were more educated. This suggests that greater network social capital may have negative consequences for those who did not complete a college degree, perhaps due to increased social freedoms, pressures, and peer influence initially experienced among college freshmen (Guo et al., 2015; Kim, 2009). Conversely, in support of our hypothesis and previous work (Gorman and Sivaganesan, 2007), increasing levels of social support were associated with decreased odds of hypertension among those with the lowest incomes. In summary, these results suggest that cognitive and network measures of social capital do not uniformly affect health outcomes across SES, and moreover that social capital may carry negative health consequences in particular situations.

The results of this study have implications for the growing body of work around social capital and health. The relative lack of significant associations between social capital and

chronic disease within this sample is perplexing, and may underscore several issues. First, is the issue of temporality; social capital may not be a static measure, but something that changes throughout the life course to impact health over time. Thus, simultaneously measuring social capital and health may be a misspecification. In order to capture this relationship, one might need to measure social capital at multiple time points (across the life course), since chronic disease is something that develops over time. (Berkman and Glass, 2000). Second, the type and measurement of social capital in the current study may not be relevant for health outcomes among this population, or setting, and would help to explain the null findings. Future studies may seek to validate the use of cognitive and network measures of social capital measures among Black and low-income populations living in the US south. Finally, the findings suggest that social capital may be detrimental for BMI among this population, supporting prior notions that not all social capital is beneficial (Moore et al., 2009a). Future studies should seek to explore potential mechanisms, including social influence and control, which may shed additional light on the potentially negative relationship between social capital and health.

Limitations

The results from the current study should be interpreted in light of some limitations. First, the cross-sectional nature of the data does not allow us to determine the directionality of the findings. Thus, it cannot be determined whether social capital effects health, or vice versa. This is an ongoing conversation within the literature, since it has been shown that poor health is associated with lower social engagement (Harwood et al., 2000; Rosso et al., 2013). Second, this study was limited by a relatively small sample size, which may hamper the ability to detect significant effects. Finally, the nature of the sampling

methodology may have selected for individuals who were more socially integrated. The RDS methodology requires that participants be invited into the study by another community member, which would likely not capture individuals who are socially isolated. However, RDS has been touted as an ideal sampling strategy for engaging hard-to-reach populations (Malekinejad et al., 2008), including populations who may have been reluctant to participate in research otherwise (Rhodes and McCoy, 2015). As such, the data represent an understudied and hard to engage population within the literature, and provide an opportunity to explore potential relationships between social capital and chronic disease among a sample with inequitably high rates of hypertension and obesity.

Conclusions

Results from the current analysis highlight potential differences in access to social capital by SES, and suggest that social capital may be important for chronic disease outcomes among residents of predominantly Black and low-income neighborhoods. Moreover, mixed relationships were observed between social capital and chronic disease, suggesting that some aspects of social capital may not be associated with improvements in health, as has been widely concluded and promoted in previous literature. Indeed, the relationship between social capital and health may be more nuanced than previously hypothesized, including variations in the directionality of this relationship by socioeconomic positioning. More studies that account for socioeconomic positioning while assessing the relationship between social capital and health, including chronic disease, are warranted in order to better understand and ultimately improve socioeconomic disparities in health outcomes.

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Table 4.1. Sample Characteristics (n=360)

	% or M(SD)
Household Income	
Very Low (less than $15,000)	42.5
Low ($15,000-$29,999)	22.1
Middle ($30,000-$59,999)	22.5
High ($60,000+)	12.9
Educational Attainment	
Less than High School	16.4
High School/GED	39.7
Some college/AA degree	25.6
College/graduate degree	18.3
Age (years)	55.0 (15.0)
Female	70.3
Black	88.9
Married	16.7
Employed	25.8
Social Capital	
Social Cohesion (range: 1-5)	3.4 (0.7)
Social Support (range: 1-5)	3.7 (1.0)
Social Control (range: 1-5)	3.1 (1.1)
Network Diversity (range: 0-12)	4.2 (3.4)
Network Reach	
None	15.3
Low	22.2
Middle	35.6
High	26.9
Network Range	
None	27.0
Low	23.3
Middle	28.1
High	21.6
Health Outcomes	
Body Mass Index (kg/m2)	29.9 (7.2)
Hypertensive	55.3

Table 4.2. Network Diversity Sample Characteristics (*n=360*)

Occupation	Prestige Score	Total Access (%)	Access by Educational Attainment (%)			
			Less than HS (n=59)	HS Diploma/GED (n=143)	Some College (n=92)	College Degree (n=66)
Machine Operator*	20.83	34.8	14.3[a]	36.8[b]	37.4[b]	44.6[b]
Janitor	22.33	37.5	28.1	41.8	38.9	34.9
Store Cashier*	29.45	45.4	28.6	47.0	57.1[b]	40.0
Carpenter*	38.92	38.7	25.9[a]	36.8	41.6	50.0[b]
Receptionist*	39.02	30.8	10.7[a]	30.8[b]	38.9[b]	36.9[b]
Mechanic	39.64	51.6	36.8	53.0	55.0	56.9
Welder	41.89	14.2	10.7	11.3	18.9	16.9
Musician/ Artist*	46.56	43.0	23.2[a]	32.3[a]	48.3[ab]	74.2[b]
Accountant*	65.38	20.3	10.5[a]	14.3[a]	23.3	36.9[b]
Registered Nurse*	66.48	42.4	19.3[a]	38.1[a]	48.4[b]	63.1[b]
High School Teacher*	73.51	45.7	21.4[a]	39.0[a]	51.1[ab]	72.7[b]
Physician*	86.05	25.6	10.5[a]	18.8[a]	27.3[a]	50.0[b]

*p<0.05; One-way Analysis of Variance with Bonferroni post-hoc comparisons
[a] significantly different from 'College Degree'
[b] significantly different from 'Less than HS'

Table 4.3. Multilevel linear[a], Poisson[b], and ordered logistic[c] regression estimates of income and education on cognitive and network capital measures (*n*=360)

	Social Cohesion[a] *b* (95% CI)	Social Support[a] *b* (95% CI)	Social Control[a] *b* (95% CI)	Network Diversity[b] *b* (95% CI)	Network Reach[c] OR (95% CI)	Network Range[c] OR (95% CI)
Household Income						
Very low	-0.44* (-0.74, -0.14)	-0.14 (-0.51, 0.23)	-0.17 (-0.62, 0.29)	0.13 (-0.21,0.47)	0.70 (0.30, 1.64)	0.55 (0.24, 1.23)
Low	0.02 (-0.26, 0.29)	0.07 (-0.23, 0.36)	0.13 (-0.25, 0.50)	0.24 (-0.09, 0.56)	0.91 (0.36, 2.26)	0.76 (0.32, 1.80)
Middle	-0.03 (-0.30, 0.24)	-0.12 (-0.47, 0.22)	0.10 (-0.30, 0.50)	0.16 (-0.08, 0.42)	1.29 (0.57, 2.92)	1.14 (0.51, 2.53)
Education Level						
Less than HS	0.18 (-0.14, 0.50)	0.32 (-0.06, 0.70)	0.18 (-0.33, 0.69)	-0.46 (-0.93, 0.01)	0.18* (0.05, 0.60)	0.34* (0.12, 0.96)
HS Diploma/GED	0.14 (-0.16, 0.43)	0.11 (-0.24, 0.46)	0.33 (-0.08, 0.75)	-0.12 (-0.40, 0.17)	0.31* (0.13, 0.71)	0.55 (0.26, 1.17)
Some college/2-year degree	0.12 (-0.16, 0.41)	0.02 (-0.27, 0.31)	0.19 (-0.27, 0.64)	0.06 (-0.21, 0.33)	0.47* (0.23, 0.95)	0.60 (0.29, 1.24)
Confounding Variables						
Age	0.01* (0.00, 0.01)	0.01 (-0.00, 0.01)	0.00 (-0.01, 0.01)	0.00 (-0.00, 0.01)	1.01 (0.99, 1.02)	1.00 (0.98, 1.02)
Female	-0.08 (-0.23, 0.06)	0.11 (-0.12, 0.33)	-0.19 (-0.41, 0.03)	0.08 (-0.10, 0.26)	1.17 (0.67, 2.05)	1.31 (0.73, 2.35)
Black	-0.39* (-0.60, -0.18)	-0.20 (-0.57, 0.17)	-0.57* (-0.83, -0.31)	-0.08 (-0.40, 0.23)	0.70 (0.32, 1.52)	1.44 (0.60, 3.45)
Married	0.14 (-0.07, 0.35)	0.12 (-0.16, 0.40)	0.02 (-0.26, 0.29)	0.26* (0.04, 0.48)	1.39 (0.73, 2.65)	1.37 (0.76, 2.46)
Employed	0.14 (-0.05, 0.32)	0.17 (-0.10, 0.44)	0.20 (-0.06, 0.46)	0.35* (0.16, 0.54)	1.51 (0.81, 2.81)	1.64 (0.93, 2.91)
Intercept	3.44* (3.09, 3.79)	3.41* (2.83, 3.98)	3.44* (2.86, 4.01)	0.77 * (0.32, 1.21)	-	-

[*] $p < 0.05$
Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Race: White; Marital Status: Single, widowed, divorced, separated; Employment Status: Unemployed, retired
[a]Linear models
[b]Poisson model
[c]Ordered logit models

Table 4.4a. Multilevel linear regression models of cognitive and network capital on BMI (*n*=360)

	Body Mass Index *b* (95% CI)						
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)	Model 7 (adjusted)
Household Income							
Very Low	0.93 (-0.78, 0.26)	-1.70 (-4.75, 1.37)	-1.31 (-4.39, 1.77)	-1.30 (-4.39, 1.79)	-1.45 (-4.52, 1.62)	-0.83 (-3.95, 2.28)	-1.11 (-4.31, 2.09)
Low	3.44* (1.06, 5.82)	1.42 (-1.85, 4.70)	1.42 (-1.91, 4.75)	1.41 (-1.93, 4.74)	1.23 (-2.17, 4.63)	1.84 (-1.48, 5.16)	1.34 (-1.98, 4.65)
Middle	1.92 (-0.48, 4.33)	0.71 (-1.82, 3.24)	0.75 (-1.85, 3.34)	0.72 (-1.89, 3.32)	0.48 (-2.10, 3.07)	0.97 (-1.46, 3.40)	0.80 (-1.73, 3.33)
Education Level							
Less than HS	1.03 (-2.98, 5.04)	1.40 (-3.44, 6.24)	1.26 (-3.62, 6.13)	1.25 (-3.64, 6.14)	1.58 (-3.17, 6.33)	1.75 (-3.30, 6.80)	1.41 (-3.36, 6.19)
HS Diploma/ GED	2.29* (0.58, 4.00)	2.38 (-0.82, 5.57)	2.25 (-0.95, 5.45)	2.21 (-1.00, 5.43)	2.47 (-0.70, 5.65)	2.37 (-1.35, 6.10)	2.03 (-1.41, 5.48)
Some college/ 2-year degree	3.48* (0.99, 5.97)	3.00 (-0.49, 6.48)	2.91 (-0.56, 6.37)	2.88 (-0.55, 6.31)	2.86 (-0.58, 6.30)	2.81 (-1.21, 6.82)	2.71 (-1.06, 6.48)
Cognitive Social Capital							
Social Cohesion	-0.88 (-1.92, 0.15)	-0.82 (-1.79, 0.14)					
Social Support	0.20 (-0.49, 0.89)		0.13 (-0.57, 0.83)				
Social Control	0.08 (-0.55, 0.71)			0.15 (-0.44, 0.75)			
Network Social Capital							
Diversity	0.33* (0.11, 0.55)				0.28* (0.05, 0.51)		

Table 4.4a (continued)

	Body Mass Index *b* (95% CI)						
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)	Model 7 (adjusted)
Reach							
None	-1.11 (-3.86, 1.64)					-2.67 (-5.91, 0.57)	
Low	1.45 (-1.07, 3.96)					-0.52 (-3.65, 2.61)	
Middle	1.39 (-0.56, 3.35)					-0.21 (-2.87, 2.44)	
Range							
None	-0.86 (-3.10, 1.39)						-1.77 (-4.48, 0.94)
Low	2.01 (-0.17, 4.18)						0.58 (-2.43, 3.59)
Middle	1.98 (-0.53, 4.49)						0.80 (-2.57, 4.16)

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Reach: High Reach; Network Range: High Range

Models 2-7 adjusted for age, gender, race, marital status, and employment status

Table 4.4b. Multilevel interaction models of SES and cognitive social capital on BMI (*n*=360)

	Body Mass Index *b* (95% CI)					
	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Household Income						
Very Low	-0.29 (-10.54-9.96)	-1.56 (-4.81-1.69)	-3.22 (-11.04, 4.60)	-0.99 (-3.92, 1.94)	-0.28 (-5.98, 5.42)	-1.17 (-4.22, 1.87)
Low	-1.71 (-25.40-21.99)	1.39 (-1.87-4.66)	-8.28 (-21.82, 5.27)	1.35 (-1.97, 4.68)	-1.58 (-9.14, 5.97)	1.41 (-1.94, 4.76)
Middle	-3.74 (-14.89-7.41)	0.73 (-1.83-3.30)	-1.94 (-10.35, 6.46)	0.94 (-1.60, 3.47)	-3.59 (-10.46, 3.27)	0.77 (-1.86, 3.40)
Education Level						
Less than HS	1.59 (-3.23-6.41)	13.84 (-2.45-30.12)	1.68 (-1.79, 5.14)	-0.40 (-15.17, 14.37)	1.54 (-3.39, 6.46)	4.47 (-7.75, 16.68)
HS Diploma/GED	2.52 (-0.68-5.73)	0.90 (-8.73-10.54)	2.70* (-0.12, 5.51)	-0.91 (-6.90, 5.08)	2.45 (-0.79, 5.69)	2.21 (-3.69, 8.10)
Some college/2-year degree	3.09 (-0.32-6.49)	-2.88 (-18.41-12.66)	3.02* (0.37, 5.67)	-5.57 (-17.19, 6.05)	3.06 (-0.37, 6.48)	-1.13 (-7.69, 5.43)
Cognitive Social Capital						
Social Cohesion	-0.93 (-2.13-0.27)	-0.87 (-2.09-0.34)				
Social Support			-0.24 (-1.30, 0.82)	-0.31 (-1.19, 0.57)		
Social Control					-0.03 (-0.78, 0.73)	0.01 (-0.73, 0.75)

Table 4.4b. (continued)

	Body Mass Index *b* (95% CI)					
	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Interactions	**Social Cohesion**	**Social Cohesion**	**Social Support**	**Social Support**	**Social Control**	**Social Control**
Household Income						
Very Low	-0.51 (-3.39-2.37)		0.44 (-1.53, 2.40)		-0.40 (-1.98, 1.17)	
Low	0.88 (-5.36-7.11)		2.48 (-0.89, 5.85)		0.87 (-1.05, 2.79)	
Middle	1.26 (-1.77-4.30)		0.69 (-1.46, 2.83)		1.28 (-0.70, 3.26)	
Education Level						
Less than HS		-3.87 (-7.96-0.22)		0.40 (-3.17, 3.97)		-1.07 (-4.86, 2.73)
HS Diploma/GED		0.43 (-2.02-2.87)		0.81 (-0.79, 2.41)		-0.02 (-1.59, 1.55)
Some college/2-year degree		1.70 (-2.61-6.02)		2.26 (-0.83, 5.35)		1.23 (-0.67, 3.13)
Wald F-test	1.66	0.30	0.76	0.88	0.88	0.80

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Reach: High Reach; Network Range: High Range

All models adjusted for age, gender, race, marital status, and employment status

Table 4.4c. Multilevel interaction models of SES and network social capital on BMI (*n*=360)

	Body Mass Index *b* (95% CI)					
	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Household Income						
Very Low	-0.59 (-4.67, 3.49)	-1.56 (-4.66, 1.54)	-2.71 (-8.16, 2.74)	-1.10 (-4.34, 2.13)	-3.35 (-9.15, 2.45)	-1.26 (-4.37, 1.84)
Low	4.11 (-0.72, 8.93)	1.11 (-2.38, 4.60)	1.42 (-2.50, 5.33)	0.77 (-2.41, 3.95)	2.01 (-2.87, 6.90)	0.68 (-2.56, 3.93)
Middle	1.43 (-3.23, 6.09)	0.43 (-2.19, 3.05)	1.78 (-1.21, 4.76)	0.55 (-1.86, 2.95)	2.56 (-0.79, 5.91)	0.41 (-2.02, 2.85)
Education Level						
Less than HS	1.26 (-3.56, 6.08)	1.94 (-4.35, 8.24)	2.41 (-2.54, 7.36)	5.31 (-5.14, 15.76)	1.02 (-3.34, 5.38)	1.42 (-9.72, 12.55)
HS Diploma/GED	2.09 (-1.17, 5.35)	3.41 (-0.88, 7.70)	2.94 (-0.84, 6.72)	1.44 (-2.19, 5.08)	2.02 (-1.44, 5.49)	2.03 (-1.75, 5.81)
Some college/2-year degree	2.87 (-0.63, 6.36)	2.83 (-1.11, 6.78)	3.39 (-0.53, 7.30)	8.01* (3.53, 12.49)	2.48 (-1.16, 6.12)	7.54* (2.07, 13.01)
Network Social Capital						
Diversity	0.41* (0.11, 0.72)	0.31* (0.01, 0.61)				
Network Reach						
None			-3.88 (-11.02, 3.26)	-1.01 (-6.49, 4.47)		
Low			-3.49 (-8.49, 1.52)	-1.23 (-9.26, 6.79)		
Middle			1.50 (-2.58, 5.59)	3.68 (-0.94, 8.30)		
Network Range						
None					0.76 (-4.68, 6.20)	0.04 (-4.13, 4.22)
Low					-3.85 (-7.12, 0.59)	4.17 (-1.71, 10.04)

Middle					5.07 (-0.19, 10.32)	2.12 (-2.90, 7.14)

Table 4.4c. (continued)

	Body Mass Index *b* (95% CI)					
	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Interactions	**Diversity**	**Diversity**	**Network Reach**	**Network Reach**	**Network Range**	**Network Range**
Household Income			No Reach		No Range	
Very Low	-0.17 (-0.86, 0.52)		2.29 (-7.30, 11.89)		0.54 (-7.30, 8.37)	
Low	-0.59 (-1.24, 0.06)		2.34 (-5.19, 9.88)		-2.09 (-8.69, 4.51)	
Middle	-0.22 (-0.87, 0.44)		1.37 (-3.33, 7.45)		-6.11 (-13.16, 0.95)	
			Low Reach		Low Range	
Very Low			6.27 (-2.63, 15.18)		7.63 (-0.98, 14.29)	
Low			2.76 (-3.00, 8.52)		4.24 (-1.77, 10.25)	
Middle			-0.11 (-7.30, 7.08)		5.74 (-0.20, 11.28)	
			Middle Reach		Middle Range	
Very Low			-1.04 (-7.01, 4.93)		-1.84 (-8.71, 5.02)	
Low			-1.51 (-7.63, 4.61)		-4.89 (-13.13, 3.34)	
Middle			-2.49 (-8.37, 3.38)		-7.24 (-13.97, 0.51)	

Table 4.4c. (continued)

	Body Mass Index *b* (95% CI)					
	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Interactions	**Diversity**	**Diversity**	**Network Reach**	**Network Reach**	**Network Range**	**Network Range**
Education Level				No Reach		No Range
Less than HS		-0.07 (-1.15, 1.02)		-6.77 (-19.82, 6.28)		-1.58 (-15.27, 12.12)
HS Diploma/GED		-0.20 (-0.83, 0.43)		1.46 (-5.37, 8.28)		-1.82 (-8.06, 4.41)
Some college/ 2-year degree		0.02 (-0.50, 0.53)		-3.20 (-10.09, 3.69)		-5.67 (-12.54, 1.21)
				Low Reach		Low Range
Less than HS				1.67 (-15.78, 19.12)		-0.07 (-13.68, 13.55)
HS Diploma/GED				3.76 (-6.09, 13.61)		-2.03 (-9.06, 5.01)
Some college/2-year degree				-7.08 (-16.42, 2.26)		-12.03* (-19.85, -4.21)
				Middle Reach		Middle Range
Less than HS				-9.65 (-21.85, 2.56)		-2.73 (-16.26, 10.81)
HS Diploma/ GED				-2.58 (-8.62, 3.47)		-0.82 (-7.53, 5.89)
Some college/2-year degree				-8.53* (-14.99, -2.08)		-4.95 (-12.02, 2.12)
Wald F-test	1.12	0.15	0.69	2.33*	1.53	2.41*

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Reach: High Reach; Network Range: High Range

All models adjusted for age, gender, race, marital status, and employment status

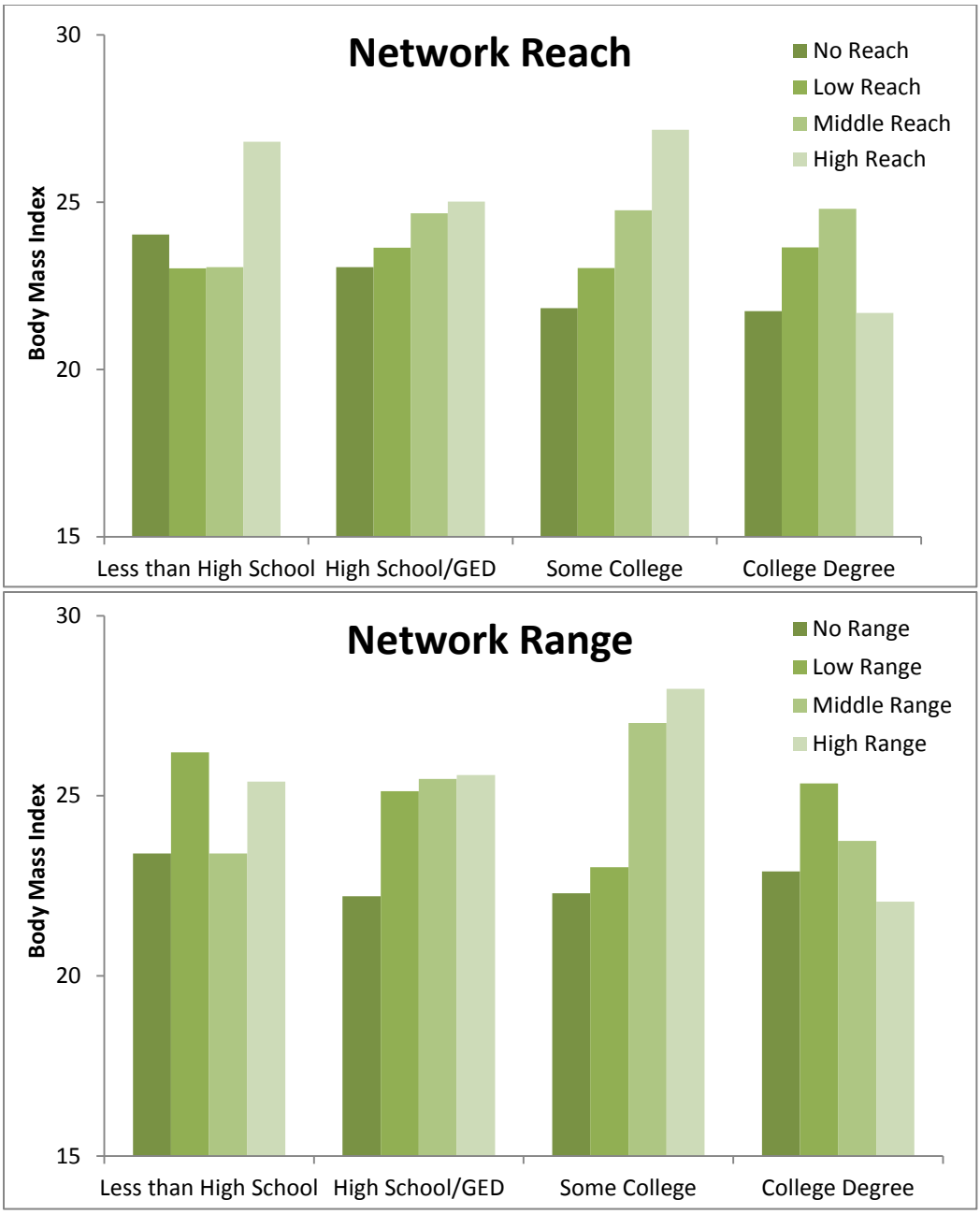

Figure 4.1a and 4.1b. Average body mass index score by network reach and range across educational attainment

Table 4.5a. Multilevel linear regression models of cognitive and network capital on hypertension (*n*=360)

	Hypertension OR (95% CI)						
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)	Model 7 (adjusted)
Household Income							
Very Low	1.48 (0.76, 2.88)	1.57 (0.60, 4.09)	1.50 (0.59, 3.80)	1.49 (0.58, 3.79)	1.43 (0.56, 3.67)	1.55 (0.58, 4.18)	1.75 (0.66, 4.67)
Low	1.45 (0.66, 3.20)	1.84 (0.64, 5.32)	1.86 (0.63, 5.47)	1.84 (0.63, 5.39)	1.83 (0.63, 5.34)	1.98 (0.68, 5.79)	2.15 (0.74, 6.27)
Middle	0.61 (0.30, 1.25)	0.71 (0.33, 1.53)	0.72 (0.34, 1.56)	0.70 (0.32, 1.51)	0.69 (0.32, 1.49)	0.75 (0.34, 1.69)	0.79 (0.35, 1.79)
Education Level							
Less than HS	2.44 (0.78, 7.67)	1.23 (0.31, 4.98)	1.18 (0.30, 4.71)	1.26 (0.31, 5.11)	1.31 (0.32, 5.35)	1.37 (0.31, 6.03)	1.47 (0.35, 6.28)
HS Diploma/ GED	1.03 (0.57, 1.87)	0.72 (0.27, 1.95)	0.72 (0.27, 1.95)	0.70 (0.26, 1.89)	0.76 (0.28, 2.04)	0.87 (0.28, 2.66)	0.84 (0.28, 2.54)
Some college/ 2-year degree	1.48 (0.75, 2.93)	1.25 (0.54, 2.89)	1.26 (0.55, 2.90)	1.24 (0.54, 2.87)	1.27 (0.55, 2.90)	1.51 (0.60, 3.79)	1.45 (0.58, 3.64)
Cognitive Social Capital							
Social Cohesion	1.08 (0.75, 1.54)	1.19 (0.81, 1.74)					
Social Support	1.18 (0.95, 1.46)		1.15 (0.92, 1.44)				
Social Control	1.04 (0.85, 1.26)			1.14 (0.94, 1.38)			

Table 4.5a. (continued)

	Hypertension OR (95% CI)						
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)	Model 7 (adjusted)
Network Social Capital							
Diversity	1.02 (0.95, 1.09)				1.03 (0.96, 1.10)		
Reach							
None	1.11 (0.52, 2.39)					1.13 (0.27, 4.74)	
Low	0.58 (0.28, 1.19)					0.76 (0.28, 2.06)	
Middle	0.70 (0.38, 1.30)					0.70 (0.29, 1.70)	
Range							
None	0.69 (0.35, 1.33)						0.68 (0.23, 1.91)
Low	0.62 (0.30, 1.31)						0.77 (0.26, 2.28)
Middle	0.73 (0.37, 1.44)						0.66 (0.27, 1.62)

*$p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Reach: High Reach; Network Range: High Range
Models 2-7 adjusted for age, gender, race, marital status, and employment status

Table 4.5b. Multilevel interaction models of SES and cognitive social capital on hypertension (*n*=360)

	Hypertension OR (95% CI)					
	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Household Income						
Very Low	3.22 (0.25, 40.83)	1.54 (0.56, 4.24)	4.40 (0.26, 75.65)	1.33 (0.54, 3.29)	5.56 (0.71, 43.68)	1.29 (0.49, 3.41)
Low	0.19 (0.00, 58.62)	1.83 (0.64, 5.27)	4.53 (0.06, 328.09)	1.63 (0.54, 4.88)	3.30 (0.14, 78.77)	1.63 (0.54, 4.90)
Middle	0.40 (0.01, 14.57)	0.69 (0.32, 1.50)	0.86 (0.07, 10.97)	0.72 (0.33, 1.58)	2.46 (0.30, 20.05)	0.66 (0.29, 1.49)
Education Level						
Less than HS	1.32 (0.32, 5.40)	77.12 (0.32, 18847.74)	1.16 (0.28, 4.73)	367.00 (4.86, 27734.20)	1.16 (0.29, 4.57)	0.81 (0.01, 45.30)
HS Diploma/GED	0.75 (0.27, 2.07)	1.60 (0.13, 20.10)	0.70 (0.25, 1.98)	1.62 (0.12, 22.20)	0.68 (0.25, 1.90)	5.62 (0.47, 66.65)
Some college/2-year degree	1.29 (0.55, 3.00)	0.44 (0.01, 23.35)	1.23 (0.53, 2.85)	1.60 (0.06, 44.31)	1.20 (0.51, 2.81)	0.55 (0.05, 5.65)
Cognitive Social Capital						
Social Cohesion	1.19 (0.70, 2.04)	1.33 (0.83, 2.11)				
Social Support			1.25 (0.86, 1.83)	1.30 (0.92, 1.83)		
Social Control					1.34 (0.99, 1.83)	1.23 (0.91, 1.65)

Table 4.5b (continued)

	Hypertension OR (95% CI)					
	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Interactions	**Social Cohesion**	**Social Cohesion**	**Social Support**	**Social Support**	**Social Control**	**Social Control**
Household Income						
Very Low	0.78 (0.37,1.66)		0.75 (0.36, 1.57)		0.66 (0.36, 1.18)	
Low	1.89 (0.37, 9.54)		0.80 (0.27, 2.31)		0.84 (0.37, 1.92)	
Middle	1.17 (0.44, 3.12)		0.96 (0.50, 1.85)		0.68 (0.38, 1.22)	
Education Level						
Less than HS		0.28 (0.06, 1.42)		0.23* (0.08, 0.68)		1.20 (0.33, 4.36)
HS Diploma/GED		0.80 (0.38, 1.63)		0.82 (0.41, 1.62)		0.54 (0.30, 1.00)
Some college/2-year degree		1.36 (0.45, 4.18)		0.95 (0.38, 2.37)		1.32 (0.70, 2.49)
Omnibus F-test	0.56	1.10	0.25	2.63*	0.90	2.33

*$p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Reach: High Reach; Network Range: High Range
All models adjusted for age, gender, race, marital status, and employment status

Table 4.5c. Multilevel interaction models of SES and network social capital on hypertension (*n*=360)

	Hypertension OR (95% CI)					
	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Household Income						
Very Low	1.53 (0.43, 5.50)	1.20 (0.48, 2.99)	4.66 (0.98, 22.15)	1.51 (0.69, 3.31)	5.05 (0.78, 32.82)	1.58 (0.57, 4.33)
Low	1.13 (0.18, 7.19)	1.68 (0.57, 4.91)	3.45 (0.70, 16.99)	2.54* (1.06, 6.11)	2.97 (0.60,14.74)	2.16 (0.72, 6.48)
Middle	1.09 (0.28, 4.28)	0.63 (0.29, 1.37)	0.36 (0.08, 1.60)	0.72 (0.33, 1.55)	0.40 (0.10, 1.62)	0.78 (0.34, 1.77)
Education Level						
Less than HS	1.22 (0.28, 5.26)	2.88 (0.51, 16.27)	0.98 (0.34, 2.83)	1.29 (0.20, 8.38)	1.06 (0.41, 2.71)	0.23 (0.03, 1.88)
HS Diploma/GED	0.74 (0.26, 2.06)	1.30 (0.30, 5.51)	0.67 (0.29, 1.56)	0.81 (0.20, 3.33)	0.67 (0.31, 1.48)	0.86 (0.14, 5.44)
Some college/2-year degree	1.17 (0.49, 2.77)	2.01 (0.51, 7.89)	0.67 (0.28, 1.57)	1.39 (0.34, 5.65)	0.71 (0.32, 1.58)	1.88 (0.30, 11.61)
Network Social Capital						
Diversity	1.03 (0.93, 1.15)	1.08 (0.97, 1.19)				
Network Reach						
None			0.59 (0.09, 3.70)	0.09 (0.00, 2.57)		
Low			0.56 (0.09, 3.58)	1.28 (0.14, 11.95)		
Middle			0.77 (0.22, 3.58)	0.89 (0.23, 3.43)		
Network Range						
None					0.66 (0.14, 3.11)	0.20 (0.02, 1.88)
Low					0.29 (0.06, 1.34)	0.71 (0.07, 6.96)

Middle					1.42 (0.35, 5.77)	1.08 (0.25, 4.76)

Table 4.5c. (continued)

	Hypertension OR (95% CI)					
	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Interactions	**Diversity**	**Diversity**	**Network Reach**	**Network Reach**	**Network Range**	**Network Range**
Household Income			No Reach		No Range	
Very Low	0.99 (0.82, 1.20)		1.03 (0.10, 10.60)		0.35 (0.04, 3.40)	
Low	1.10 (0.81, 1.51)		0.26 (0.02, 4.16)		0.36 (0.04, 3.36)	
Middle	0.92 (0.75, 1.14)		1.02 (0.03, 29.55)		1.37 (0.16, 11.65)	
			Low Reach		Low Range	
Very Low			0.21 (0.02, 2.71)		0.38 (0.04, 3.91)	
Low			0.75 (0.07, 8.45)		2.89 (0.31, 26.50)	
Middle			2.06 (0.17, 25.00)		8.46 (1.03, 69.42)	
			Middle Reach		Middle Range	
Very Low			0.18* (0.03, 0.92)		0.13 (0.01, 1.12)	
Low			0.77 (0.11, 5.46)		0.46 (0.05, 4.02)	
Middle			3.15 (0.48, 20.85)		1.02 (0.14, 7.34)	

Table 4.5c. (continued)

	Hypertension OR (95% CI)					
	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Interactions	**Diversity**	**Diversity**	**Network Reach**	**Network Reach**	**Network Range**	**Network Range**
Education Level				No Reach		No Range
Less than HS		0.83 (0.63, 1.08)		15.01 (0.34, 670.32)		26.49 (0.94, 742.72)
HS Diploma/GED		0.90 (0.72, 1.14)		9.68 (0.25, 375.59)		4.62 (0.23, 94.51)
Some college/ 2-year degree		0.92 (0.75, 1.14)		1.62 (0.03, 101.53)		3.40 (0.15, 76.59)
				Low Reach		Low Range
Less than HS				0.33 (0.02, 5.93)		12.36 (0.11, 1366.73)
HS Diploma/GED				0.34 (0.03, 4.53)		1.00 (0.06, 18.22)
Some college/2-year degree				0.23 (0.02, 3.33)		0.94 (0.03, 25.73)
				Middle Reach		Middle Range
Less than HS				0.34 (0.02, 4.90)		5.31 (0.26, 107.98)
HS Diploma/ GED				0.79 (0.13, 4.74)		0.60 (0.07, 5.22)
Some college/2-year degree				0.50 (0.08, 3.25)		0.38 (0.04, 3.27)
Wald F-test	0.50	0.77	1.60	0.83	1.40	0.68

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Reach: High Reach; Network Range: High Range

All models adjusted for age, gender, race, marital status, and employment status

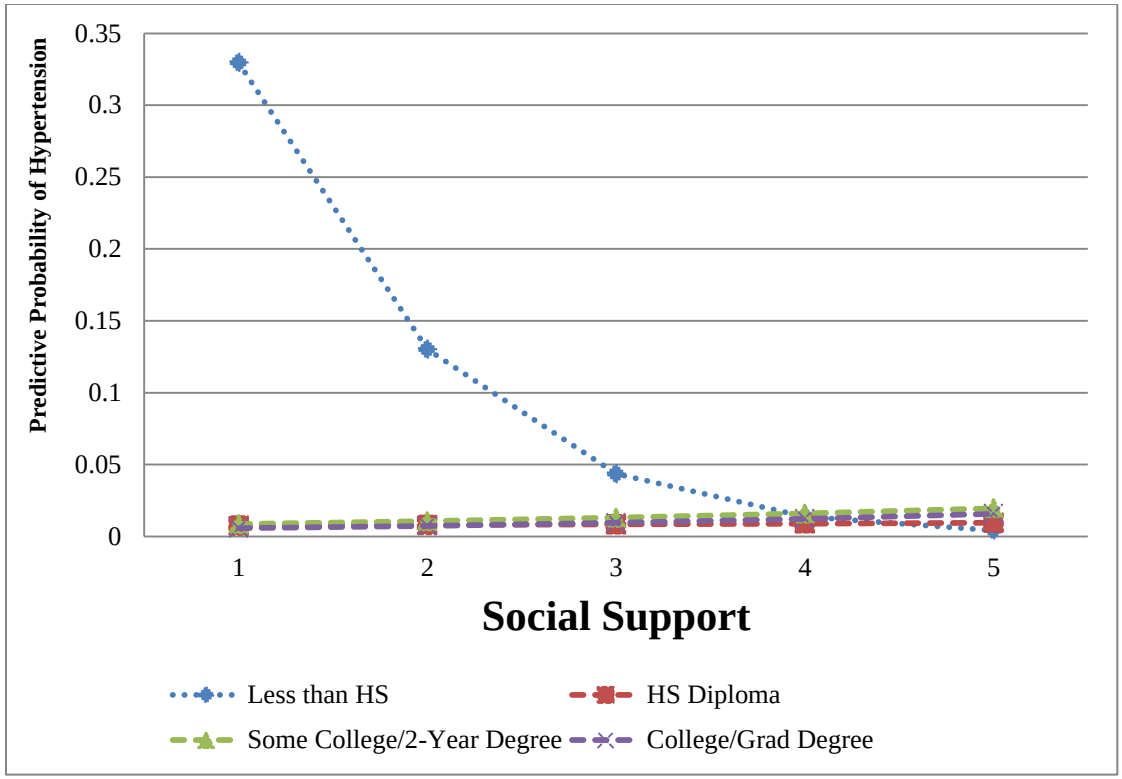

Figure 4.2. Predictive probability of hypertension by social support and educational attainment.

Social Network Characteristics and Chronic Disease:

Does Socioeconomic Status Matter?[1]

[1]Child S, Kaczynski AT, Walsemann KM, Fleischer NL, McLain AC, and Moore DS. To be submitted to *Journal of Health and Social Behavior*.

Abstract

Social network characteristics known to influence health may be shaped by socioeconomic factors. Additionally, socioeconomic status (SES) may moderate the association between network characteristics and health outcomes. Respondent-driven sampling was employed to recruit participants (*n*=430) from low-income communities in the US South for a household survey as part of the Greenville Healthy Neighborhoods Project. The survey collected information about participants' SES (household income and educational attainment), body mass index and hypertension status, as well as their core network characteristics (i.e., density, educational attainment, proximity). Multilevel regression analyses were performed, accounting for clustering in respondent chains. Low education was associated with lower levels of social integration and with higher odds of network education homophily. Educational attainment also modified the relationship between network density and BMI, such that higher density was associated with lower BMI among college educated participants, and higher BMI among those with less than a college degree. The current data suggest that education may shape the social network characteristics of residents of low-income neighborhoods, and additionally impact the effect of social network characteristics on health.

Previous research on social relationships indicates that social networks may be critical for health outcomes (Cacioppo and Hawkley 2003; House, Landis, and Umberson 1988; Uchino 2004). Indeed, social relationships, and in particular a lack of relationships, may be more strongly associated with mortality and morbidity than other well-established risk factors, including excessive alcohol consumption, physical inactivity, and pneumococcal vaccination (Holt-Lunstad, Smith, and Layton 2010). Conversely, social networks and the resources extended through those relationships may be harmful for health (Moore et al. 2009). This may be especially true when members of a social network engage in risky behaviors, such as alcohol consumption, that can influence other members' behavior within the network (Rosenquist et al. 2010). Moreover, not only behaviors, but chronic diseases, including obesity, have been found to be transmitted through social networks (Christakis and Fowler 2007), prompting researchers to explore potential mechanisms driving these relationships.

Network characteristics serve to highlight the types of relationships that may be beneficial versus detrimental for health. For example, social networks vary in terms of their size, geographic proximity, and composition. These characteristics may promote health and well-being differentially through their ability to provide support. For example, large, diffuse networks are considered to be more helpful in solving a problem than networks that are smaller, denser, and family-based (Lin, Cook, and Burt 2001).

Moreover, there is some evidence to suggest that socioeconomic status contributes to the types of relationships people form and the ways in which people utilize those resources, which can perhaps in turn affect health. For example, disadvantaged populations tend to use close ties, such as family members and close friends, when

searching for job opportunities (Granovetter 1995). This may limit the potential of individuals to find new opportunities, since kin network members tend to be homogenous and thus may have redundant information. Similarly, network structure and composition have been found to influence an individual's health opinions and behaviors (Christakis and Fowler 2013), including the decision to seek preventative health care (Torres, Ross, and Johnson 2014).

In the current study we seek to extend the literature on social networks and chronic disease by exploring the role of socioeconomic status, first as a predictor of social network characteristics, and second as a potential moderator of the relationship between social networks and both body mass index and hypertension.

BACKGROUND

Social networks are hypothesized to influence health through their ability to provide individuals with increased access to resources. For example, social networks can provide individuals with social support, including informational support and monetary resources, self-esteem, and feelings of belongingness which can influence health and health behaviors (Cohen and Leonard 1985; Umberson, Crosnoe, and Reczek 2010). Similarly, Berkman and Glass proposed several mechanisms by which social networks are thought to affect health, including both individual-level mechanisms, such as behaviors and physiological responses, and more upstream, interpersonal mechanisms, including social influence.

Social Networks and Chronic Disease

While several studies have examined social networks and health related behaviors, such as drug and alcohol use (Christakis and Fowler 2008; Latkin et al. 1995; Rosenquist et al. 2010), fewer studies have examined the role of social networks on

chronic diseases, including hypertension and body mass index (Christakis and Fowler 2007; Vogt et al. 1992). Yet, similar mechanisms involving social network characteristics are believed to be at play for both. For example, one study found that network characteristics were associated with hypertension diagnosis and control, such that the risks of undiagnosed and uncontrolled hypertension were lower among those with larger social networks, if health issues were discussed within these networks (Cornwell and Waite 2012). Additionally, a longitudinal study found that low social integration was predictive of increased risk of hypertension among older adults (Yang, Boen, and Harris 2015). Similarly, research suggests that social networks are closely linked to BMI, indicating that not only do people tend to cluster with others of similar weight status, but that social processes, including social influence and behavioral norming, can contribute to weight gain among individuals who are connected to obese and overweight peers (Bahr et al. 2009; Christakis and Fowler 2007). However, we are unaware of any studies that have examined the role of social network characteristics and chronic disease among residents of predominantly low-income and Black communities. Given that Blacks are disproportionately affected by hypertension compared to Whites, and even to other minority populations, including Hispanics (Cooper and Rotimi 1997; Roger et al. 2012), that low-income and low-educated populations are more susceptible to chronic disease, including obesity (Adler and Ostrove 1999), and that the social network characteristics of low income and Black populations may differ from their more advantaged counterparts (Granovetter 1983; Tigges, Browne, and Green 1998; Wilson 2012), it seems imperative to examine these relationships among this group.

Social Integration

Social networks are thought to impact health through the promotion of social engagement and attachment of individuals to their friends, family, and more broadly, their community (Gorman and Sivaganesan 2007). Social integration is closely related with other mechanisms linking networks with health since those who are more socially integrated often have higher levels of social support and access to resources (Berkman and Glass 2000). Previous studies have suggested a link between integration and hypertension, although results have been mixed (Gorman and Sivaganesan 2007; Vogt et al. 1992; Yang, Li, and Ji 2013). A recent study, which examined social integration as a mediator between socioeconomic status and hypertension, found that the odds of hypertension decreased as social integration increased (Gorman and Sivaganesan 2007). Conversely, they found the opposite relationship between social integration and hypertension among those with low educational attainment, such that higher rates of integration were associated with higher odds of hypertension. These results suggest that the role of social networks on health may operate differently at various levels of SES. .

Social Influence

The role of social influence on health can best be summarized as the control that social networks may have on the attitudes, beliefs, and ultimately, the behavior of individuals within those networks. For example, a recent review of the literature examining social influence and obesity reported that both social network structure and social influence are significant factors associated with the obesity epidemic (Hammond 2010). The report highlighted the role of social norms, including norms around eating and body image, as a major source of influence on obesity. Additionally, a study that examined the role of social influence in a team-based weight loss intervention found that

weight loss tended to cluster within teams and that those who reported higher levels of social influence experienced a greater percentage of weight loss (Leahey et al. 2012). This body of research demonstrates that health outcomes tend to occur within social groups and suggests that social influence may be a driving factor of overweight and obesity.

Network Proximity

Some research has examined the role of network proximity on health. This research has largely stemmed from hypotheses that having connections with neighbors, or people within a close geographical distance, who are able to help one another out, lend things in need, and visit with one another (Ross and Jang 2000) may foster health through social control (Rountree and Warner 1999), collective efficacy and cohesion (Morenoff, Sampson, and Raudenbush 2001), and reductions in stress (Mair, Diez Roux, and Morenoff 2010). Moreover, strong connections between neighbors in which they can seek information and help from one another may buffer the negative effects of both individual and neighborhood poverty, and isolation (Ross and Jang 2000; Sampson 1999). Similar to other social network characteristics, network proximity has been shown to vary by SES. For example, one study reported that higher income residents were less likely to have core ties that resided in the same neighborhood (Moore et al. 2011). Other studies have found that SES predicts network location, and specifically that low-income, low-educated, and minority residents tend to have more locally-oriented networks (Berg and Timmermans 2015; Fischer 1982). It is unclear whether locally-oriented networks are beneficial or harmful for health among low-income populations. While having proximal ties may provide tangible support that is essential to well-being (Fischer 1982), including

transportation or child care, networks bound by location, especially within low-income communities, may be limited in their ability to offer new or unique resources and information, including job referrals, that could lift these residents out of economic strife (Wilson 2012).

Social Networks among Disadvantaged Populations

A growing literature suggests that network characteristics operate differently across socioeconomic status (Lin 2000; Umberson and Montez 2010), and that this may affect health since access to social resources is determined largely by the structural properties of one's social network (Lin 1999). For example, individuals with larger networks theoretically have greater access to resources due to the likelihood that they have someone in their network with the information or support they need. Additionally, network structure, such as density, may facilitate some opportunities, while limiting others. Dense networks, composed of similar others and characterized by high levels of trust, may foster the sharing of available resources (Portes 2014). However, these networks are also limited by their ability to access new information and by the lack of bridging ties to resources outside of the network. As such, denser networks among low SES populations may not provide access to the sort of resources that would help improve their economic situation (Granovetter 1983; Wilson 2012).

While research on the network characteristics of disadvantaged populations is limited, there is some research to suggest that those who are poor (and arguably in greatest need of support generated by social ties) tend to have smaller, more homogenous networks. Granovetter (1983) argues that the perpetual reliance of poor individuals on kin networks and relationships with similar others "has the impact of fragmenting communities of the poor into encapsulated networks" (p. 213) that are further

disconnected from other networks which may be beneficial. Indeed, prior notions about the resources that can be provided by kin networks and strong core ties are contradicted by research suggesting these networks may actually contribute to the cyclical nature of poverty and poor health (Nyqvist and Forsman 2015; Tigges et al. 1998; Wilson 2012). According to Wilson (2012), much of the disadvantage faced by poor African Americans, in particular, stems from the lack of social structure in high-poverty neighborhoods. Residents of these neighborhoods are less likely to be employed, and thus may have limited access to occupational information or other sources of support beyond their neighborhood (Granovetter 1983; Tigges et al. 1998; Wilson 2012).

Tigges, Browne, and Green (1998) examined the effect of race, class, and neighborhood poverty on social networks. They compared household data from poor and non-poor African Americans to non-poor Whites living in Atlanta, Georgia. They found significant class differences among Blacks in the likelihood of living with another adult, and in being closely-tied to someone with a college education. For both Blacks and Whites, high levels of neighborhood poverty were also associated with lower probabilities of living with another adult. They also found class differences in the odds of having at least one close tie outside the household. While they found strong evidence to suggest that Blacks living in high poverty neighborhoods were more likely to experience social isolation and decreased access to social resources as opposed to low poverty neighborhoods, they also reported differences by individual wealth. Their results suggest that poor individuals may have differential access to social network resources independent of race and neighborhood effects (Tigges et al. 1998).

Despite evidence to suggest that social network characteristics may differ by socioeconomic and demographic characteristics, few studies have explored the social networks of residents from historically Black and disadvantaged neighborhoods. The historical and continued segregation of Blacks and low-income populations may have important ramifications for the structure of their social networks and may contribute to the health disparities seen in these populations. As such, the purpose of this study was to 1) assess whether socioeconomic status was associated with social network characteristics, 2) explore whether these characteristics were associated with BMI and hypertension, and 3) examine whether socioeconomic status moderated the relationships between social network characteristics and health among this sample.

METHODS

Data were collected as part of the Greenville Healthy Neighborhoods Project (GHNP), an effort that engaged residents in thinking about ways in which neighborhood factors contributed to health. Eight 'Special Emphasis' neighborhoods were selected to take part in the project, which included the use of focus groups and a household survey. The 'Special Emphasis' title denoted neighborhoods experiencing economic adversity, and with whom the City of Greenville had partnered with to identify resources within the community that could be utilized to enhance the health and well-being of its residents. The City of Greenville is located in upstate South Carolina and is comprised of 62,252 residents, approximately 30% of whom are Black. Across the Special Emphasis neighborhoods, the average household income was less than $18,000, with more than 30% of residents living at or below the federal poverty limit. The study neighborhoods ranged in the percentage of Black residents from 34%-82% (U. S. Census Bureau, 2014).

The current study employed a respondent-driven sampling (RDS) methodology in an attempt to engage members of the study population who may be less likely to participate in research (Frost et al. 2006; Salganik and Heckathorn 2004; Schonlau and Liebau 2012). This approach had several advantages over conventional convenience sampling for the current study, including a potential increase in sample size and the ability to reach individuals who are less socially-involved (Frost et al. 2006). RDS has two unique features that may enhance its ability to engage hidden populations. First, it includes a double incentive system, which not only provides compensation to participants for completing the survey, but also for successful recruitment of other participants. Second, new participants are invited to participate via community members, rather than study personnel. These features allow a community to take ownership of the referral process and may make participation more inviting to those who are less likely to engage in research or otherwise.

In the current study, neighborhood association presidents served as the initial seed (recruiter) in each neighborhood. The presidents were asked to identity ten diverse residents (of varying age, gender, occupation, etc.) in their neighborhood who would serve as the initial (first) wave of the sampling chain. These ten people were given a coupon from the president that served as their invitation to enter the study and which also tracked how they entered the study (i.e., who recruited them). These initial participants were then asked to recruit three more individuals (a second wave) who lived in their neighborhood to complete the survey. This second wave was also given coupons to track how they entered the study. All participants were given a $10 gift card for completing the survey, and were incentivized to recruit other residents with the use of a raffle.

Specifically, for each of the three coupons that were returned by a subsequent participant, the recruiter was entered to win a $50 gift card to a local grocery store. Participants of the second wave were also asked to recruit three others, and so forth, for a total of four waves of participants. The identification numbers on coupons were used to create sampling chains which informed the cluster variable for multilevel analysis. In total, 180 sampling chains were formed, with an average of two participants, and ranging from 1 to 14 participants per chain.

Participants completed the survey at a local community center or church located within their neighborhood. Eligibility for the survey included the ability to speak and comprehend English, being at least 18 years of age or older, non-institutionalized, and residing in one of the eight study neighborhoods.

Measures

The two primary outcome variables were *Body Mass Index (BMI)* and *hypertension*. *BMI* was calculated using self-reported height and weight data. The standard BMI calculation used for adults was BMI = [weight (lbs.) / height (in.)^2] x 703kg/m2(in2/lbs). Previous research indicates that self-reported height and weight used to calculate BMI scores are valid for measurement of overweight and obesity in epidemiological studies (Spencer et al. 2002). Raw BMI scores were maintained and used as a continuous variable for analyses. *Hypertension* was a self-reported measure asking participants if they had ever been told by a physician or other health care worker that they had high blood pressure. Men who reported high blood pressure and women who reported high blood pressure outside of pregnancy were coded '1' for hypertensive status. All others were coded '0'. Participants who were unsure of their hypertensive status (n=4) were not included in the analyses.

Participants' social network characteristics were assessed using a variety of measures. Correlations between the five network characteristics were low, and ranged from -0.10 to 0.27. First, the number of *core ties* was assessed using a name generator (McPherson, Smith-Lovin, and Brashears 2006). This asked participants to name up to three people (alters) with whom they had discussed important personal matters over the last six months. The number of core ties a person designates approximates the number of close ties they have and is representative of the level of an individual's social integration (McPherson et al. 2006). *Core ties* were dichotomized, such that persons who named all three alters were coded '1' (highly socially integrated), and those who named less than three alters were coded '0' (less socially integrated).

A name interpreter was used to assess the rest of the participants' social network characteristics. The name interpreter consisted of several follow-up questions that asked for more details about alters listed in the name generator. First, participants were asked whether each of the three alters knew one another. From this, *network density* was calculated by dividing the number of actual ties between alters by the number of potential ties between alters (Valente 2010). These scores ranged from 0-1 and were recoded to range from 0-3 such that 0=0.0 (very low density), 1=0.33 (low density), 2=0.66 (medium density), and 3=1.0 (high density).

The name interpreter also included questions about alters' age, gender, educational attainment, and residential location. From these, we were able to assess *network education homophily*, or the extent to which alters' educational attainment matched with the participant's educational attainment. Each of the alters' educational attainment was paired with the participant's educational attainment. A direct match was

coded as -1 (homophilous) while a mismatch was coded as 1 (heterogeneous; Valente 2010). These scores were summed and divided by the number of alters within a network. These raw scores ranged from -1 to 1, and were reverse recoded as 0 through 3, where 0=1.0 (very heterogeneous), 1=0.66 (somewhat heterogeneous), 2=-0.66 (somewhat homophilous), and 3=-1 (very homophilous), so that higher values indicated increasing network education homophily.

Next we calculated the *average educational attainment* of a participant's network. Alters were assigned a '1' for less than a high school diploma, '2' for a high school diploma, and '3' for more than a high school diploma. The average educational attainment of the network was calculated by summing these values and dividing by the number of alters within the network. These scores ranged from 1.0-3.0 and were treated as a continuous variable.

Additionally, participants reported network proximity by indicating whether each of the three alters resided in their home, in their neighborhood, within the City of Greenville, or outside of Greenville. Similar to previous research (Moore et al. 2011), the *number of alters who resided in their home or neighborhood* was calculated, and ranged from zero to three.

Socioeconomic status was assessed via annual household income and educational attainment. Participants were asked to report their annual household income and the highest level of education they had completed. *Annual household income* was categorized as follows: Very Low (less than $15,000), Low ($15,000-$29,999), Middle ($30,000-$59,999) and High (more than $60,000). *Educational attainment* was categorized as follows: Less than High School (HS), HS Diploma/GED, some college/Associate's

degree, and college or graduate degree. Both of these variables were treated as categorical. The correlation between household income and educational attainment was 0.39.

Demographic characteristics included age in years (continuous), gender (male or female), race (Black or White), marital status (married/cohabitating or single/widowed/ divorced), and employment status (employed or unemployed/retired/disabled).

Analytic Approach

First, univariate statistics were used to describe sample demographics and social network characteristics. Next, to examine the first research question regarding the relationship between SES and network characteristics, a series of multilevel regression analyses, utilizing logistic, ordinal logistic, and linear regression models were used (depending on the outcome variable). Both household income and education level were regressed on each of the five network characteristics, while controlling for age, gender, race, marital and employment status.

To examine the second research question regarding the relationship between social network characteristics and chronic disease, multilevel linear and logistic regression models were employed to explore the associations between social network characteristics (as separate predictors) and BMI and hypertension (outcomes), respectively. Each measure was modeled first by testing main (bivariate) associations, and then further adjusted for SES and demographic characteristics.

Finally, using linear and logistic regression for BMI and hypertension, respectively, each network characteristic was interacted with household income and educational attainment separately to test whether SES moderated the relationship between social network characteristics and chronic disease (BMI and hypertension). A Wald F-test

was used to determine the significance of the interaction effects within each model. All interaction models controlled for age, gender, race, marital status and employment status. Predicted means for the interactions in Figure 1 were calculated using the model's intercept and regression coefficients. Predicted mean values for BMI were calculated for each combination of network density level and educational attainment level.

Due to the nature of RDS, a multilevel analytic approach was used to account for the clustering of observations within the sampling chains (Rhodes and McCoy 2015). Originally, a three-level model was employed to account for additional clustering at the neighborhood level. However, it was observed that no variance existed at the neighborhood for any of the models. Subsequently, all analyses were re-estimated using two-level hierarchical models, where individuals were nested within their respective sampling chains.

Furthermore, a robust (sandwich) covariance estimator was employed to account for additional errors associated with the unknown clustering of observations within the sampling chains. Under circumstances when the correlation structure among observations is unknown, as is true for RDS, the sandwich estimator permits a "working covariance matrix", allowing for flexibility during the estimation step (Kauermann and Carroll 2000). In line with previous health studies that have utilized RDS (Rhodes and McCoy 2015; Villanti et al. 2012), the current study employed a multilevel regression analysis with robust estimation to best account for the unknown clustering of observations.

Missing data were imputed with chained equations (White, Royston, and Wood 2011) utilizing STATA's mi impute command. These imputations were estimated from demographic characteristics with complete data including race, gender, and educational

attainment. A total of twenty imputations were used to calculate missing entries on participant's age, income, and various social network characteristics. The command mi estimate in STATA was used to perform the regression analyses across these twenty imputed data sets. Multilevel model estimations were performed using mixed, melogit, and meologit commands in STATA software version 13.1.

RESULTS

Sample Characteristics

A total of 430 respondents were recruited for the household survey using RDS. Consistent with previous literature (Frost et al. 2006), respondents recruited, on average, one additional household for survey completion, for a total of 180 recruitment chains, which were used as the cluster variable in multilevel modeling. A total of 70 observations were dropped due to missing data of the dependent variable (BMI n=34, hypertension n=32) or reporting a race other than Black or White (n=4). The final sample consisted of 360 residents across the eight study neighborhoods with complete data for BMI and hypertension.

As shown in Table 4.6, more than forty percent of respondents had an annual household income of less than $15,000, whereas fewer than 13% of these households earned more than $60,000 annually. Most of the sample had low educational attainment with more than half having earned a high school diploma (39.7%) or less (16.4%). The sample was predominantly female (70.3%) and Black (88.9%), with an average age of 55 years (s.d.=15.0). A quarter of the sample was employed full or part-time (25.8%) and less than one-fifth were married or living with a partner (16.7%). The average BMI of participants was 29.9 kg/m2 (s.d.=7.2), bordering between overweight and obese. More than half of the sample indicated they had been diagnosed with hypertension (55.3%).

More than half of respondents listed all three alters in the name generator measure (56.4%), indicating high social connectivity (Table 4.6). Nearly half of respondents (48.9%) had highly dense networks, where each alter knew one another, yet nearly one-fifth of respondents (16.9%) had very low network density, such that none of the alters knew one another. Network educational homophily was fairly evenly distributed, with the highest percentage of participant networks being somewhat heterogeneous (34.4%). The mean educational attainment of the alters in participants' networks was 2.37 (s.d.=0.5), indicating that most alters had at least a high school education. A quarter of participants had none of their core ties living in their home or neighborhood (27.7%), while another quarter had all three core ties living in their home or neighborhood (29.8%).

Association of SES and Social Network Characteristics

To examine the association between SES and social network characteristics, Table 4.7 displays the multilevel regression analyses of education and income regressed on each social network characteristic. The number of core ties a participant reported was positively associated with participants' educational attainment, such that compared with having a college degree, having less than a college degree was associated with approximately 0.2 times the odds of naming all three alters (less than high school: OR=0.17, 95% CI: 0.05, 0.54; high school diploma/GED: OR=0.22, 95% CI: 0.07, 0.72; some college: OR=0.21, 95% CI: 0.07, 0.65). Participants' educational attainment was also associated with their network education homophily. Compared to those with a college degree, participants with less than a high school diploma had higher odds of having higher network education homophily (OR=2.25, 95% CI: 1.05, 4.81), indicating that their social contacts were more likely to be of a similar educational background. Additionally, educational attainment of participants was associated with the average

educational attainment of their network. Compared to those with a college degree, participants with less than a high school education or those with a high school diploma/GED had lower average network education (b= -0.38, 95% CI: -0.61, -0.15; b= -0.19, 95% CI: -0.36, -0.01, respectively), Participants' educational attainment was not associated with network density or with the number of alters who live in the home/neighborhood. Household income was not associated with any social network characteristics.

Social Network Characteristics and Chronic Disease

Table 4.8 presents the multilevel linear regression models that examined associations between each of the network characteristics and BMI. Model 1 presents the unadjusted (bivariate) associations between all social network characteristics and SES measures, and BMI. Here, having no core ties in the neighborhood, compared to having three, was associated with higher BMI (b=2.84, 95% CI: 0.38, 5.31). However, no statistically significant predictors of BMI remained after adjustment for socioeconomic and demographic characteristics (Models 2-6). Models 7-16 present the interactions between SES, network characteristics, and BMI, of which only one model was statistically significant (Model 10). Figure 4.3 displays this interaction between network density and educational attainment on BMI. Among participants with a college degree, those with very low network density had a predicted mean BMI of 29.9 kg/m2 while those with high network density had a predicted mean BMI of 23.3 kg/m2. Somewhat opposite patterns were seen for those with lower levels of educational attainment, such that high density was associated with the highest predicted mean BMI among those with less than a high school diploma (BMI=28.3 kg/m2), and among those with a high school diploma (BMI=27.8 kg/m2).

Table 4.9 presents the multilevel logistic models that examined the association between each of the network characteristics and hypertension. As shown in Model 1, no statistically significant predictors were found when examining the unadjusted (bivariate) estimates of the social network characteristics and SES measures on hypertension. Similar relationships occurred when controlling for confounding variables (Models 2-6). Additionally, each network characteristic was interacted with both household income and educational attainment to examine whether the relationship between network characteristics and hypertension was moderated by SES. No statistically significant interactions were found (Models 7-16).

DISCUSSION

The current study examined the association between SES and social network characteristics, as well as the association between social network characteristics and chronic disease outcomes among residents of low-income, historically disadvantaged communities. Previous research indicates that social network characteristics are associated with numerous health behaviors (Christakis and Fowler 2008; Rosenquist et al. 2010) and chronic disease, including obesity (Christakis and Fowler 2007) and hypertension (Vogt et al. 1992). Additionally, mounting evidence suggests that SES shapes social networks (Lin 2000; Tigges et al. 1998), and moreover, may moderate the relationships between social network characteristics and health (Uphoff et al. 2013). Yet, few studies have explored the social network characteristics of residents of low-income and Black communities despite previous evidence to indicate that social networks differ by socioeconomic characteristics (Ajrouch, Blandon, and Antonucci 2005), and that SES may not yield the same health benefits for economically disadvantaged and Black populations. In the absence of consistent evidence linking SES with cardiovascular

among Blacks (Walsemann, Goosby, and Farr 2016), the examination of social network characteristics may provide insight into potential mechanisms associated with chronic disease outcomes among this population. Participants in the current study were predominantly female, low-income, Black, and older adults and thus represented an important and understudied sample within which to examine issues related to social networks and health.

The current study finds that SES is associated with social network characteristics among residents of low-income and predominantly Black neighborhood in the US South. Compared to those with a college degree, participants with lower educational attainment (less than a high school diploma, high school diploma, or some college) had lower odds of reporting three core ties, an indicator of social integration. This is similar to previous studies that have found a positive association between SES and social integration (Ashida et al. 2015; Gorman and Sivaganesan 2007; Uphoff et al. 2013). Additionally, participants with less than a high school diploma had higher odds of having higher levels of network education homophily (indicating that their education level was more likely to be similar to their peers) than were their more educated counterparts. Granovetter (1995) argued that this kind of homophily, where resource poor adults socialize with similar others, is likely to perpetuate cycles of poverty through reduced or redundant opportunities, resources, and information. Moreover, homophily may contribute to socioeconomic disparities in health outcomes through the propagation of health behaviors, which have been shown to travel through social networks (Christakis and Fowler 2008; Rosenquist et al. 2010). While educational attainment was associated with social network characteristics in the current study, income was not. This is in contrast to

previous studies which have found an association between household income and social network characteristics, including the number and location of core ties (Berg and Timmermans 2015; Fischer 1982; Moore et al. 2011). It remains to be seen whether these differences are a function of the social network characteristics of residents living in historically low-income and Black communities, and furthermore, whether the lack of findings were due to a limitation of the current study or some other unknown factor, including the relative low income of study participants. As such, more research around the role of SES on the social networks of resource-poor populations is warranted.

We hypothesized that the relationships between social network characteristics and chronic disease outcomes would be moderated by SES. Our results showed this was only the case for network density, whose relationship with BMI varied by educational attainment. Among those with a college degree, higher network density was associated with lower BMI, but was associated with higher BMI among those with less education. The data indicate that while network density may be beneficial or inconsequential for more educated groups, it may be associated with poorer health for those with less than a college degree. Consistent with previous research (Child, Stewart, and Moore, forthcoming), the current study highlights potentially negative ramifications of social network characteristics on health outcomes. Taken together, the differences in the relationships between network characteristics and BMI by SES may help to explain potential pathways through which SES-related disparities in health outcomes occur.

Unlike previous research (Gorman and Sivaganesan 2007), education did not moderate the association between social network characteristics and hypertension. Moreover, there were no statistically significant main effects of social network

characteristics on hypertension status among this population. This may signify the complexity of the relationship between social networks and hypertension, both in terms of the causes associated with the disease (e.g., diet, stress, gene/environment interaction), as well as the association between these causes or behaviors and social networks. An early longitudinal study that explored the impact of social network characteristics on cardiovascular outcomes, including hypertension, found an association between social networks and cardiovascular mortality, but not with hypertension itself (Vogt et al. 1992). This has subsequently lead to numerous studies that examined the ability of social networks to impact the course of the disease (i.e., screening, treatment, control), rather than its prevention (Cornwell and Waite 2012; Menéndez-Villalva et al. 2015; Shaya et al. 2013). Adding further complexity, the associations between SES and hypertension have not always occurred in expected directions for Black populations. Future directions for work around social networks and chronic disease might include larger, more representative samples, longitudinal assessments of Black populations, who are at high risk of hypertensive outcomes, and refinement of the conceptual pathways that potentially link social networks and chronic disease.

Limitations

The current findings should be discussed in light of several limitations. First, the relatively small sample size may limit the ability to detect significant relationships within this sample. However, limited research has explored the social network characteristics of residents of low-income communities, and moreover how these characteristics are associated with chronic disease among this population. As such, the data provide a unique, if preliminary, opportunity to explore these relationships. Second, the study is cross-sectional and does not allow us to determine the directionality of the findings.

Thus, it remains to be seen whether social capital affects health, or vice versa. Previous research indicates that poor health is associated with lower social engagement (Harwood, Pound, and Ebrahim 2000; Rosso et al. 2013), which could account for the relationships seen in this relatively older sample. Finally, the nature of RDS may have selected for individuals who were more socially integrated. This sampling methodology involves the recruitment of study participants through other community members, which may have made it more likely for individuals who are more social engaged to be selected. However, RDS has been touted as an ideal sampling strategy for engaging hard-to-reach populations (Malekinejad et al. 2008), including populations who may have been reluctant to participate in research otherwise (Rhodes and McCoy 2015). Despite these limitations, the current study contributes to the literature around social networks, SES, and health by extending the research to chronic disease outcomes, namely BMI and hypertension, exploring these relationships within the context of low-income and predominantly Black communities, and testing whether these relationships are conditional upon SES.

Conclusions

These data provide evidence to suggest that SES, and in particular educational attainment, is associated with the social network characteristics of residents of low-income neighborhoods. The data also showed that network density was beneficial for BMI among residents with a college education, but was detrimental for those with less education. The contingency of this relationship on SES has important ramifications for public health research, including disparities in chronic disease outcomes, and challenges the framework for social relationships and health among low-income communities,

Moreover, study raises important questions for future research regarding the interplay of social network characteristics and SES on health disparities, and in particular for communities most strongly afflicted with chronic disease and poor health.

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Representative Longitudinal Study of Older Adults." *Journal of Aging and Health* 27(3):403–31.

Table 4.6. Sample Characteristics (n=360)

	% or Mean (SD)
Health Outcomes	
Body Mass Index	29.9 (7.2)
Hypertensive	55.3
Social Network Characteristics	
Core Ties	
Less than Three	43.6
Three	56.4
Network Density	
Very Low	16.9
Low	11.1
Medium	23.1
High	48.9
Network Education Homophily	
Very Homophilous	23.9
Somewhat Homophilous	21.4
Somewhat Heterogenous	34.4
Very Heterogenous	20.3
Average Network Education (range 1-3)	2.4 (0.5)
Core Ties who Live in Neighborhood (range 0-3)	
None	27.7
One	25.5
Two	17.0
Three	29.8
Sociodemographic Characteristics	
Household Income	
Very Low (less than $15,000)	42.5
Low ($15,000-$29,999)	22.2
Middle ($30,000-$59,999)	22.5
High ($60,000+)	12.9
Educational Attainment	
Less than High School	16.4
High School/GED	39.7
Some college/AA degree	25.6
College/graduate degree	18.3
Age	55.0 (15.0)
Female	70.3
Black	88.9
Married	16.7
Employed	25.8

Data: Greenville Healthy Neighborhoods Project, Greenville, SC (2014)

Table 4.7. Multilevel logistic[a], ordered logistic[b], and linear[c] regression models of network characteristics regressed on SES (*n*=360)

	Core Ties[a]	Network Density[b]	Network Education Homophily[b]	Average Network Education[c]	Ties in Home/ Neighborhood[b]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	b (95% CI)	OR (95% CI)
Household Income					
Very Low	1.28 (0.67, 2.46)	0.99 (0.35, 2.78)	1.53 (0.83, 2.81)	0.14 (-0.06, 0.33)	0.70 (0.24, 2.03)
Low	1.38 (0.61, 3.11)	0.61 (0.22, 1.70)	1.31 (0.76, 2.24)	0.08 (-0.12, 0.27)	1.12 (0.31, 4.08)
Middle	1.51 (0.69, 3.33)	0.80 (0.29, 2.16)	1.19 (0.71, 1.97)	0.17 (0.00, 0.33)	0.56 (0.19, 1.67)
Education Level					
Less than HS	0.17* (0.05, 0.54)	0.91 (0.34, 2.43)	2.25* (1.05, 4.81)	-0.38* (-0.61, -0.15)	0.64 (0.18, 2.30)
HS Diploma/GED	0.22* (0.07, 0.72)	0.52 (0.24, 1.14)	1.14 (0.66, 1.95)	-0.19* (-0.36, -0.01)	0.80 (0.27, 2.34)
Some college/2-year degree	0.21* (0.07, 0.65)	1.18 (0.51, 2.73)	0.74 (0.44, 1.24)	0.06 (-0.10, 0.22)	3.18 (0.95, 10.68)
Confounding Variables					
Age	0.98* (0.96, 0.99)	1.02 (0.98, 1.05)	0.98* (0.97, 0.99)	0.00 (-0.00, 0.01)	0.98 (0.95, 1.00)
Female	1.83 (0.98, 3.42)	0.76 (0.43, 1.34)	1.36 (0.88, 2.10)	0.01 (-0.12, 0.15)	0.48 (0.22, 1.05)
Black	1.35 (0.52, 3.49)	2.14* (1.06, 4.30)	1.96* (1.05, 3.67)	-0.33* (-0.50, -0.16)	1.58 (0.53, 4.69)
Married	1.14 (0.61, 2.16)	2.72* (1.31, 5.64)	0.88 (0.61, 1.28)	0.06 (-0.06, 0.18)	2.88* (1.17, 7.07)
Employed	0.84 (0.42, 1.66)	1.78 (0.86, 3.66)	0.83 (0.56, 1.24)	-0.01 (-0.14, 0.12)	1.22 (0.53, 2.80)

[*]p < 0.05; Reference Groups: Income: High ($60,000 or more); Education: College/Graduate Degree; Race: White; Marital Status: Single, widowed, divorced, separated; Employment Status: Unemployed, retired
[a]Logistic Regression
[b]Ordered Logistic Regression
[c]Linear Regression

Table 4.8a. Multilevel linear regression models of social network characteristics on BMI (*n*=360)

	Body Mass Index b (95% CI)					
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)
Social Network Characteristics						
Core Ties (having at least 3)	1.50 (-0.14, 3.13)	0.25 (-3.72, 4.21)				
Network Density						
Very Low	2.00 (-1.40, 5.41)		0.82 (-2.79, 4.43)			
Low	1.22 (-1.78, 4.22)		0.38 (-2.95, 3.72)			
Medium	-2.15 (-5.38, 1.06)		-1.64 (-4.66, 1.39)			
Network Educational Homophily						
Very heterogeneous	2.63 (-0.10, 5.37)			1.92 (-1.04, 4.89)		
Somewhat heterogeneous	2.12 (-0.22, 4.46)			0.73 (-2.27, 3.72)		
Somewhat homophilous	1.13 (-0.84, 3.09)			-0.18 (-2.29, 1.92)		
Average Network Education (range 1-3)	-0.50 (-1.88, 0.87)				-0.27 (-1.62, 1.09)	
Ties in Home/Neighborhood						
None	2.84* (0.38, 5.31)					2.27 (-0.84, 5.37)
One	1.59 (-0.91, 4.09)					0.52 (-2.11, 3.15)
Two	0.79 (-1.22, 2.81)					0.30 (-1.78, 2.37)

Table 4.8b. Multilevel interaction models of SES and social network characteristics on BMI (*n*=360)

	Body Mass Index *b* (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Social Network Characteristics						
Core Ties	1.13 (-2.91, 5.17)	1.45 (-2.49, 5.40)				
Network Density						
Very Low			-1.94 (-11.71, 7.82)	5.91* (1.32, 10.50)		
Low			-5.06* (-8.31, -1.81)	9.14* (2.45, 15.82)		
Medium			1.67 (-3.00, 6.35)	1.61 (-3.47, 6.69)		
Network Educational Homophily						
Very heterogeneous					0.19 (-5.91, 6.28)	4.04 (-3.70, 11.78)
Somewhat heterogeneous					8.17* (0.40, 15.95)	7.44 (-1.28, 16.15)
Somewhat homophilous					-1.06 (-4.35, 2.23)	-2.10 (-4.58, 0.39)
Household Income						
Very Low	2.93 (-16.09, 21.94)	-2.09 (-5.44, 1.26)	-1.31 (-4.24, 1.61)	-2.89* (-5.39, -0.39)	-2.88 (-7.09, 1.34)	-1.95 (-4.82, 0.92)
Low	-4.40 (-9.38, 0.58)	0.37 (-3.08, 3.83)	0.64 (-2.28, 3.56)	0.39 (-2.37, 3.15)	2.73 (-2.58, 8.05)	0.57 (-2.78, 3.92)
Middle	4.64 (-2.64, 11.92)	0.04 (-2.83, 2.92)	0.12 (-2.94, 3.18)	-1.13 (-3.56, 1.30)	1.93 (-0.91, 4.77)	0.15 (-2.36, 2.66)

Table 4.8b. (continued)

	Body Mass Index *b* (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Education Level						
Less than HS	1.10 (-3.86, 6.06)	14.13 (-7.71, 35.97)	1.50 (-3.28, 6.29)	4.99* (0.69, 9.30)	-0.18 (-4.72, 4.35)	-6.47 (-9.76, -0.18)
HS Diploma/GED	1.85 (-1.74, 5.45)	2.73 (-8.93, 14.39)	2.35 (-1.06, 5.75)	4.55* 1.72, 7.39)	1.69 (-1.78, 5.15)	3.28 (-0.08, 6.47)
Some college/ 2-year degree	2.65 (-0.92, 6.22)	2.42 (-4.01, 8.85)	3.25 (-0.07, 6.57)	5.20* (1.93, 8.46)	2.59 (-0.81, 5.98)	3.56 (-0.41, 7.53)
Interactions	**Core Ties**	**Core Ties**	**Network Density**	**Network Density**	**Educational Homophily**	**Educational Homophily**
Household Income			Very Low		Very Low	
Very Low	-5.03 (-24.24, 14.19)		2.74 (-8.00, 13.48)		4.58 (-2.49, 11.66)	
Low	5.52* (0.21, 10.83)		-1.77 (-12.18, 8.64)		-0.78 (-10.35, 8.79)	
Middle	-4.83 (-12.78, 3.12)		6.29 (-5.64, 18.23)		-0.83 (-9.15, 7.49)	
			Low		Low	
Very Low			5.71 (-0.95, 12.36)		-5.92 (-14.29, 2.45)	
Low			6.85 (-0.06, 13.64)		-10.72* (-19.30, -2.13)	
Middle			5.36 (-1.33, 12.05)		-9.88 (-19.22, 0.54)	

Table 4.8b. (continued)

	Body Mass Index *b* (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Interactions	**Core Ties**	**Core Ties**	**Network Density**	**Network Density**	**Educational Homophily**	**Educational Homophily**
Household Income (cont.)			Medium		Medium	
Very Low			-6.76 (-13.05, 0.47)		1.29 (-4.00, 6.59)	
Low			1.69 (-7.77, 11.16)		0.97 (-5.81, 7.75)	
Middle			-8.92 (-14.68, 3.15)		0.34 (-5.31, 6.00)	
Education Level				Very Low		Very Low
Less than HS		-14.35 (-36.53, 7.82)		-7.08 (-20.61, 644)		4.90 (-4.50, 14.29)
HS Diploma/GED		-0.94 (-13.48, 11.59)		-6.69* (-13.17, -0.21)		-3.52 (-12.03, 5.00)
Some college/2-year degree		0.16 (-7.04, 7.36)		-5.03 (-12.40, 2.34)		-3.31 (-12.71, 6.09)
				Low		Low
Less than HS				-16.76* (-26.66, -10.85)		3.30 (-8.30, 14.91)
HS Diploma/GED				-11.17* (-17.98, -4.35)		-6.99 (-16.80, 2.83)
Some college/2-year degree				-11.07* (-19.52, 2.62)		-11.30 (-20.70, 1.90)

Table 4.8b. (continued)

	Body Mass Index *b* (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Interactions	**Core Ties**	**Core Ties**	**Network Density**	**Network Density**	**Educational Homophily**	**Educational Homophily**
Education Level (cont.)				Medium		Medium
Less than HS				-8.15* (-15.46, -0.84)		8.02 (-0.12, 12.93)
HS Diploma/GED				-1.82 (-8.36, 4.71)		-0.53 (-5.94, 4.88)
Some college/2-year degree				-9.28* (-16.18, -2.38)		4.91 (-0.16, 9.65)
Wald F-test	2.52	0.55	1.91	3.85*	1.68	2.17

*$p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Density: High; Network Educational Homophily: Very Homophilous; Ties in Home/Neighborhood: Three

All models adjusted for age, gender, race, marital status, and employment status

Table 4.8c. Multilevel interaction models of SES and social network characteristics on BMI (cont., *n*=360)

	Body Mass Index *b* (95% CI)			
	Model 13	Model 14	Model 15	Model 16
Social Network Characteristics (cont.)				
Average Network Education (range 1-3)	-0.45 (-2.21, 1.32)	-0.90 (-2.68, 0.87)		
Ties in Home/Neighborhood				
None			8.91* (2.73, 15.09)	4.74 (-1.47, 10.95)
One			1.41 (-2.89, 5.70)	0.86 (-3.97, 5.70)
Two			0.94 (-3.20, 5.08)	0.46 (-2.99, 3.91)
Household Income				
Very Low	-4.21 (-13.44, 5.02)	-1.11 (-4.40, 2.18)	-1.26 (-5.25, 2.74)	-2.21 (-5.49, 1.07)
Low	5.07 (-6.16, 16.30)	1.55 (-1.80, 4.90)	3.61 (-1.85, 9.06)	0.40 (-3.29, 4.09)
Middle	-1.25 (-14.15, 11.65)	0.81 (-1.85, 3.47)	1.92 (-2.88, 6.72)	-0.25 (-2.91, 2.41)
Education Level				
Less than HS	1.31 (-3.85, 6.48)	-9.18 (-26.74, 8.39)	0.18 (-4.54, 4.91)	4.30 (-5.58, 14.19)
HS Diploma/GED	2.17 (-1.26, 5.61)	1.12 (-6.76, 9.00)	0.95 (-2.17, 4.06)	3.65 (-0.22, 7.51)
Some college/ 2-year degree	2.97 (-0.47, 6.42)	-2.46 (-14.64, 9.71)	1.77 (-1.65, 5.20)	1.95 (-2.38, 6.28)

Table 4.8c. (continued)

	Body Mass Index *b* (95% CI)			
	Model 13	Model 14	Model 15	Model 16
Interactions	**Network Education**	**Network Education**	**Ties in Home/ Neighborhood**	**Ties in Home/ Neighborhood**
Household Income			None	
Very Low	1.24 (-2.48, 4.96)		-5.03 (-11.78, 1.72)	
Low	-1.54 (-5.65, 2.56)		-13.93 (-21.94, 1.93)	
Middle	0.79 (-3.96, 5.54)		-8.27 (-15.90, -0.64)	
			One	
Very Low			-0.87 (-6.59, 4.85)	
Low			0.64 (-6.93, 8.20)	
Middle			-3.54 (-10.42, 3.35)	
			Two	
Very Low			-1.18 (-6.69, 4.33)	
Low			-3.30 (-10.56, 3.96)	
Middle			3.20 (-3.71, 10.11)	

Table 4.8c. (continued)

Interactions	Body Mass Index *b* (95% CI) Model 13 **Network Education**	Model 14 **Network Education**	Model 15 **Ties in Home/ Neighborhood**	Model 16 **Ties in Home/ Neighborhood**
Education Level				None
Less than HS		4.84 (-3.73, 13.05)		-6.60 (-19.37, 6.16)
HS Diploma/GED		0.38 (-2.92, 3.68)		-4.21 (-11.79, 3.38)
Some college/2-year degree		2.10 (-2.54, 6.75)		-0.01 (-10.26, 10.24)
				One
Less than HS				-6.19 (-18.24, 5.86)
HS Diploma/GED				-0.31 (-7.08, 6.45)
Some college/2-year degree				1.39 (-5.21, 8.00)
				Two
Less than HS				-0.73 (-10.90, 9.43)
HS Diploma/GED				-3.03 (-8.43, 2.36)
Some college/2-year degree				3.23 (-3.30, 9.77)
Wald F-test	0.48	0.62	1.83	0.99

*$p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Density: High; Network Educational Homophily: Very Homophilous; Ties in Home/Neighborhood: Three

All models adjusted for age, gender, race, marital status, and employment status

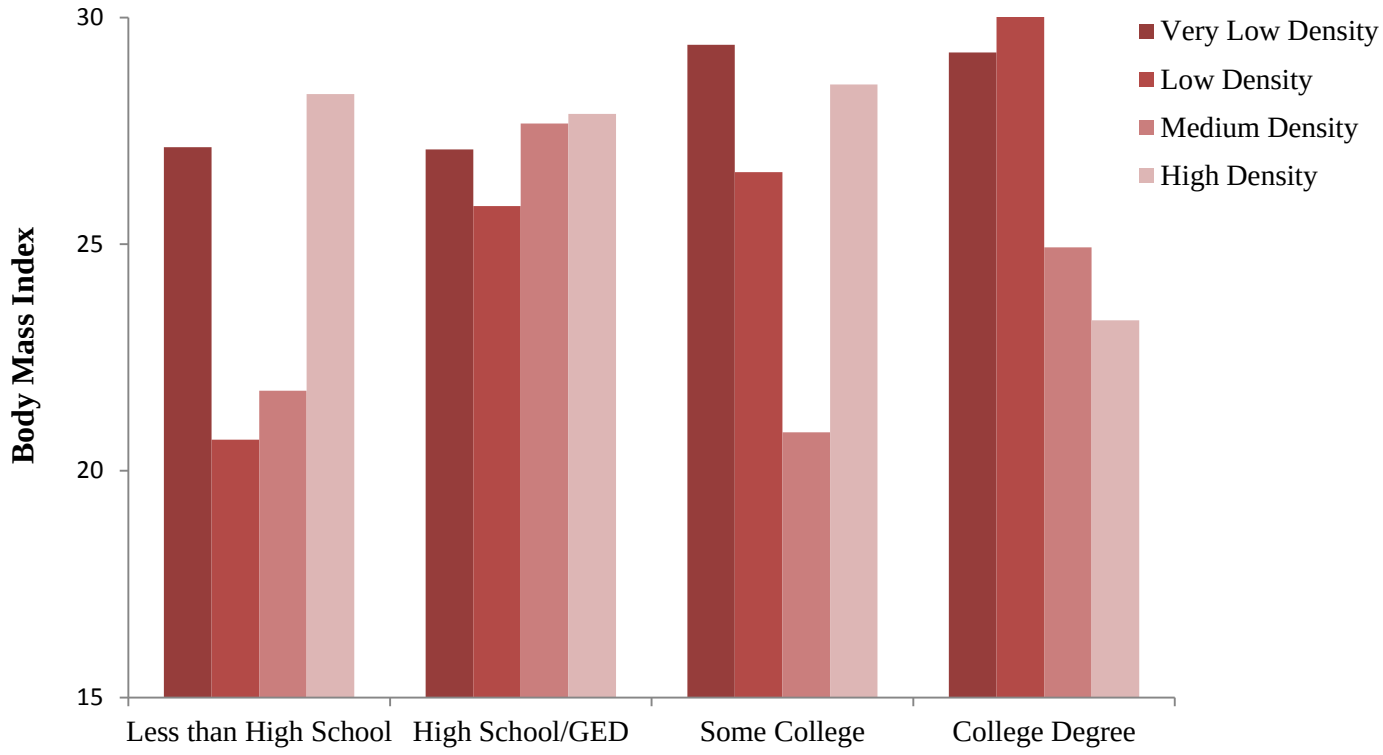

Figure 4.3. Interaction of network density and educational attainment on BMI. (Data: GHNP 2014)

Table 4.9a. Multilevel logistic regression models of social network characteristics on hypertension (*n*=360)

	Hypertension OR (95% CI)					
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)
Social Network Characteristics						
Core Ties (having at least 3)	0.86 (0.52, 1.42)	0.83 (0.29, 2.42)				
Network Density						
Very Low	0.82 (0.35, 1.91)		0.86 (0.35, 2.13)			
Low	0.65 (0.29, 1.47)		0.62 (0.23, 1.70)			
Medium	0.50 (0.18, 1.41)		0.43 (0.13, 1.37)			
Network Educational Homophily						
Very heterogeneous	1.20 (0.65, 2.21)			0.83 (0.33, 2.10)		
Somewhat heterogeneous	1.35 (0.71, 2.55)			1.53 (0.63, 3.70)		
Somewhat homophilous	1.28 (0.70, 2.34)			1.38 (0.61, 3.12)		
Average Network Education (range 1-3)	0.95 (0.57, 1.57)				1.19 (0.69, 2.03)	
Ties in Home/Neighborhood						
None	1.19 (0.58, 2.45)					0.92 (0.37, 2.28)
One	0.61 (0.30, 1.22)					0.61 (0.27, 1.38)
Two	0.72 (0.36, 1.47)					0.62 (0.25, 1.55)

Table 4.9a. (continued)

	Hypertenstion OR (95% CI)					
	Model 1 (unadjusted)	Model 2 (adjusted)	Model 3 (adjusted)	Model 4 (adjusted)	Model 5 (adjusted)	Model 6 (adjusted)
Household Income						
Very Low	1.25 (0.68, 2.30)	1.60 (0.54, 4.76)	1.69 (0.64, 4.50)	1.42 (0.54, 3.71)	1.41 (0.56, 3.57)	1.66 (0.62, 4.43)
Low	1.61 (0.78, 3.30)	2.05 (0.63, 6.74)	2.32 (0.75, 7.23)	1.81 (0.59, 5.52)	1.84 (0.64, 5.31)	2.14 (0.73, 6.27)
Middle	0.65 (0.32, 1.34)	0.78 (0.32, 1.91)	0.81 (0.36, 1.83)	0.67 (0.30, 1.50)	0.69 (0.32, 1.47)	0.79 (0.35, 1.80)
Education Level						
Less than HS	1.69 (0.58, 4.96)	1.33 (0.31, 5.65)	1.31 (0.33, 5.24)	1.37 (0.30, 6.17)	1.35 (0.33, 5.48)	1.34 (0.34, 5.33)
HS Diploma or GED	1.08 (0.61, 1.92)	0.78 (0.27, 2.22)	0.77 (0.28, 2.18)	0.69 (0.24, 1.97)	0.77 (0.29, 2.06)	0.78 (0.29, 2.10)
Some college/2-year degree	1.37 (0.69, 2.71)	1.32 (0.57, 3.05)	1.27 (0.54, 2.98)	1.15 (0.49, 2.68)	1.26 (0.55, 2.87)	1.42 (0.60, 3.34)

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Density: High; Network Educational Homophily: Very Homophilous: Ties in Home/Neighborhood: Three

Models 2-6 adjusted for age, gender, race, marital status, and employment status

Table 4.9b. Multilevel interaction models of SES and social network characteristics on hypertension (*n*=360)

	Hypertension OR (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Social Network Characteristics						
Core Ties	1.01 (0.28, 3.58)	1.05 (0.30, 3.71)				
Network Density						
Very Low			0.52 (0.12, 2.28)	1.61 (0.25, 10.29)		
Low			1.57 (0.09, 26.21)	3.05 (0.69, 13.43)		
Medium			0.45 (0.13, 1.52)	0.74 (0.15, 3.59)		
Network Educational Homophily						
Very heterogeneous					0.51 (0.06, 4.39)	0.42 (0.06, 3.10)
Somewhat heterogeneous					6.06 (0.53, 69.69)	3.05 (0.33, 28.14)
Somewhat homophilous					1.88 (0.32, 11.07)	1.08 (0.25, 4.70)
Household Income						
Very Low	7.00 (0.42, 116.41)	1.50 (0.46, 4.85)	1.22 (0.45, 3.33)	1.39 (0.62, 3.15)	2.61 (0.56, 12.11)	1.61 (0.74, 3.53)
Low	0.18 (0.00, 21.19)	1.95 (0.58, 6.51)	1.91 (0.50, 7.32)	2.38 (0.92, 6.15)	2.29 (0.37, 14.35)	2.65* (1.11, 6.34)
Middle	1.47 (0.19, 11.50)	0.66 (0.25, 1.74)	0.66 (0.23, 1.91)	0.56 (0.25, 1.25)	0.73 (0.23, 2.33)	0.65 (0.30, 1.39)

Table 4.9b. (continued)

	Hypertension OR (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Education Level						
Less than HS	1.31 (0.34, 5.01)	0.42 (0.00, 4262.80)	1.07 (0.39, 2.93)	1.35 (0.28, 6.46)	1.32 (0.28, 6.16)	0.68 (0.19, 2.49)
HS Diploma/GED	0.72 (0.26, 2.00)	3.56 (0.23, 55.78)	0.73 (0.30, 1.77)	1.00 (0.29, 3.49)	0.56 (0.19, 1.61)	0.58 (0.20, 1.69)
Some college/ 2-year degree	1.28 (0.52, 3.12)	1.87 (0.27, 12.91)	0.80 (0.35, 1.83)	1.41 (0.50, 3.99)	1.03 (0.44, 2.40)	0.55 (0.19, 1.64)
Interactions	**Core Ties**	**Core Ties**	**Network Density**	**Network Density**	**Educational Homophily**	**Educational Homophily**
Household Income			Very Low		Very Low	
Very Low	0.19 (0.01, 3.74)		3.26 (0.57, 18.48)		1.08 (0.08, 14.78)	
Low	11.39 (0.08, 1584.17)		1.00 (0.11, 9.14)		2.03 (0.08, 53.87)	
Middle	0.44 (0.04, 4.67)		2.46 (0.31, 19.16)		1.52 (0.09, 26.58)	
			Low		Low	
Very Low			0.33 (0.01, 7.67)		0.15 (0.01, 2.64)	
Low			1.03 (0.03, 41.27)		0.45 (0.01, 16.91)	
Middle			0.33 (0.01, 7.40)		0.14 (0.01, 2.25)	

Table 4.9b. (continued)

	Hypertension OR (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Interactions	**Core Ties**	**Core Ties**	**Network Density**	**Network Density**	**Educational Homophily**	**Educational Homophily**
Household Income (cont.)			Medium		Medium	
Very Low			1.08 (0.25, 4.71)		0.37 (0.03, 4.37)	
Low			1.65 (0.18, 15.37)		0.39 (0.02, 7.81)	
Middle			0.35 (0.03, 4.50)		1.45 (0.13, 15.62)	
Education Level				Very Low		Very Low
Less than HS		3.10 (0.00, 34397.18)		0.64 (0.06, 7.21)		4.58 (0.38, 54.87)
HS Diploma/GED		0.18 (0.01, 2.90)		0.58 (0.07, 4.67)		2.26 (0.27, 19.10)
Some college/2-year degree		0.64 (0.07, 5.71)		0.62 (0.06, 6.39)		2.32 (0.20, 26.24)
				Low		Low
Less than HS				0.36 (0.03, 4.69)		0.82 (0.07, 9.15)
HS Diploma/GED				0.17 (0.03, 1.10)		0.32 (0.02, 3.99)
Some college/2-year degree				0.14 (0.01, 1.49)		0.55 (0.05, 6.48)

Table 4.9b. (continued)

	Hypertension OR (95% CI)					
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Interactions	**Core Ties**	**Core Ties**	**Network Density**	**Network Density**	**Educational Homophily**	**Educational Homophily**
Education Level (cont.)				Medium		Medium
Less than HS				0.88 (0.09, 8.53)		0.42 (0.01, 16.27)
HS Diploma/GED				0.71 (0.10, 4.87)		2.54 (0.39, 16.56)
Some college/2-year degree				0.27 (0.03, 2.31)		2.29 (0.30, 17.54)
Wald F-test	0.94	0.52	0.96	0.75	0.73	0.50

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Density: High; Network Educational Homophily: Very Homophilous; Ties in Home/Neighborhood: Three

All models adjusted for age, gender, race, marital status, and employment status

Table 4.9c. Multilevel interaction models of SES and social network characteristics on hypertension (cont., *n*=360)

	Hypertension OR (95% CI)			
	Model 13	Model 14	Model 15	Model 16
Social Network Characteristics (cont.)				
Average Network Education (range 1-3)	1.16 (0.58, 2.31)	1.22 (0.59, 2.52)		
Ties in Home/Neighborhood				
None			1.65 (0.17, 15.90)	1.41 (0.31, 6.33)
One			0.47 (0.07, 3.27)	0.41 (0.07, 2.30)
Two			0.22 (0.02, 2.39)	0.19 (0.02, 1.66)
Household Income				
Very Low	7.15 (0.41, 123.96)	1.45 (0.56, 3.77)	1.04 (0.25, 4.30)	1.58 (0.53, 4.73)
Low	0.25 (0.00, 36.01)	1.83 (0.62, 5.38)	2.30 (0.38, 13.79)	2.23 (0.67, 7.44)
Middle	0.05 (0.00, 2.81)	0.69 (0.32, 1.46)	1.27 (0.35, 4.54)	0.74 (0.28, 2.01)
Education Level				
Less than HS	1.55 (0.37, 6.48)	5.68 (0.03, 1060.69)	1.27 (0.28, 5.79)	2.21 (0.37, 13.23)
HS Diploma/GED	0.99 (0.37, 2.65)	0.95 (0.05, 18.08)	0.61 (0.21, 1.76)	0.61 (0.16, 2.35)
Some college/ 2-year degree	1.36 (0.60, 3.07)	0.56 (0.01, 52.33)	1.34 (0.50, 3.54)	1.10 (0.21, 5.66)

Table 4.9c. (continued)

	Hypertension OR (95% CI)			
	Model 13	Model 14	Model 15	Model 16
Interactions	**Network Education**	**Network Education**	**Ties in Home/ Neighborhood**	**Ties in Home/ Neighborhood**
Household Income			None	
Very Low	0.46 (0.14, 1.50)		1.73 (0.10, 30.35)	
Low	2.22 (0.28, 17.30)		0.08 (0.00, 2.10)	
Middle	2.82 (0.64, 12.41)		0.36 (0.03, 5.09)	
			One	
Very Low			1.50 (0.13, 16.83)	
Low			7.15 (0.29, 174.77)	
Middle			0.53 (0.05, 5.44)	
			Two	
Very Low			7.82 (0.37, 163.16)	
Low			2.12 (0.09, 48.84)	
Middle			1.57 (0.06, 38.50)	

Table 4.9c. (continued)

	Hypertension OR (95% CI)			
	Model 13	Model 14	Model 15	Model 16
Interactions	**Network Education**	**Network Education**	**Ties in Home/ Neighborhood**	**Ties in Home/ Neighborhood**
Education Level				None
Less than HS		0.50 (0.05, 5.35)		0.29 (0.02, 4.84)
HS Diploma/GED		0.90 (0.27, 2.98)		0.71 (0.08, 5.91)
Some college/2-year degree		1.36 (0.24, 7.71)		1.00 (0.08, 11.94)
				One
Less than HS				0.70 (0.03, 14.80)
HS Diploma/GED				2.10 (0.23, 19.22)
Some college/2-year degree				2.20 (0.18, 26.84)
				Two
Less than HS				3.48 (0.08, 145.45)
HS Diploma/GED				5.90 (0.45, 77.96)
Some college/2-year degree				3.51 (0.24, 50.49)
Wald F-test	2.10	0.19	1.22	0.35

$^{*}p \leq 0.05$

Reference Groups: Income: $60,000 or more; Education: College/Graduate Degree; Network Density: High; Network Educational Homophily: Very Homophilous; Ties in Home/Neighborhood: Three

All models adjusted for age, gender, race, marital status, and employment status

CHAPTER V

DISCUSSION

Summary of Major Findings

Over the past thirty years, a growing interest in the role of social relationships and social environments on well-being has led to a substantive number of studies examining social capital and social networks in the context of health and health disparities.[174,175] Many of the early studies within the public health field employed neighborhood and cognitive measures of social capital,[96,104] though researchers have pointed to the benefits of utilizing more comprehensive measures, including network social capital and social network characteristics.[17,85] As such, limited research has explored the associations between social networks and chronic disease,[176] especially among populations most often afflicted by such conditions, including obesity and hypertension.[27] Additionally, while the majority of studies have reported positive associations between social capital, social networks, and health,[104,132] there is emerging data to suggest that not all gains in social capital result in gains in health.[177,178] This is particularly concerning, given that in the current data the majority of the negative associations between social capital and health were seen among those with low SES.

Similar to prior research,[179] and in support of our hypotheses, the current studies provide evidence to suggest that individuals with low income and low educational attainment may have reduced access to social capital, and furthermore may have social network characteristics that are distinct from those with higher SES. For example, the

data highlight the association between low educational attainment and lower levels of network reach and network range. Previous research might interpret this as an opportunity to improve access to resources,[115] including access to information about employment opportunities or social support, and subsequently, health. Yet, the current studies also suggest that higher levels of network reach and range were associated with higher BMI among individuals with less education than those with a college degree. This underscores the potential for higher levels of capital to negatively impact health, particularly among individuals with fewer personal resources. This may occur through a number of mechanisms. Increased social connectivity may be associated with greater social control,[136] social influence,[78,137] and pressure to conform to culture norms.[180] Thus while increased social connectivity may impart social resources, these relationships may also increase exposure and pressure to conform to social and cultural norms, such as alcohol or drug abuse, the consumption of high calorie foods, or even negative attitudes or beliefs. Previous research suggests these influences may be stronger particularly among smaller and denser networks.[113,178] The current data suggest that both diverse and dense networks (among individuals with low education) are associated with higher BMI, suggesting more research is warranted to understand the potential mechanisms linking social networks with chronic disease.

In support of the stated hypotheses, these studies also provided evidence that SES moderates the association between social capital, social networks, and health. Moreover, the data suggest that what may be inconsequential for one group may be harmful for another. Similar to the two hypotheses put forth about the role of SES on social capital and health,[29] the current study found that social capital and social networks operated

differently on health outcomes across SES. Yet, contradictory to these two hypotheses which postulate increasing levels of social capital would be beneficial to health,[29] the current study found that certain factors were in fact associated with poorer health. Future studies may seek to explore mechanisms through which this occurs, including whether social network characteristics, such as network density are associated with increased social pressures, including social influence and control. While social influences may serve to promote health in more affluent settings, these same social pressures may contribute to poorer health outcomes in low-income neighborhoods where social and cultural norms may not support health.

There were common themes that emerged across both studies. For example, many of the statistically significant relationships between social capital, social network characteristics, and chronic disease were found for BMI but not for hypertension. One possible explanation includes increased power to detect significant relationships using linear versus logistic regression analysis in the current study. However, these data are similar to previously published literature, which provides substantial evidence for the relationships between social capital and social networks and overweight or obesity,[5,32,82] and less so with hypertension.[120] This may signify the complexity of the relationship between social capital and social networks and hypertension, both in terms of the causes associated with the disease (e.g., diet, stress, gene/environment interaction), as well as the association between social networks and these upstream mechanisms. An early longitudinal study that explored the impact of social network characteristics on cardiovascular outcomes, including hypertension, among a diverse sample found an association between social networks and cause-specific mortality, but not with the disease

itself.[132] This has subsequently lead to numerous studies that examined the ability of social networks to impact the course of the disease (i.e., screening, treatment, control), rather than its prevention.[181–183] Yet, there is a wealth of data that has found associations between more proximal factors of hypertension, including the role of social networks on stress and support,[184,185] diet,[137,186] access to health information,[187,188] and preventative health behaviors[176,189]. Future directions of this work might include larger, more representative samples, longitudinal assessments of populations at high risk of hypertensive outcomes, and refinement of the conceptual pathways that potentially link social networks and chronic disease.

Implications for Public Health

The potential for social capital and social networks to disrupt cycles of poverty and mediate the ill effects of low SES on health outcomes makes these constructs a worthwhile pursuit for public health researchers and practitioners alike.[14,15,41,115] However, policies and strategies aimed at improving the public's health have the potential to cause more harm than good, particularly when social and contextual factors are not taken into consideration. Such may be the case with social capital and the general hypothesis that improvements in capital and social network characteristics will parallel improvements in health across all populations.

As such, understanding the ways in which SES and social capital intersect to inform health outcomes is essential for the development of intervention strategies aimed at narrowing the gaps in chronic disease outcomes. For example, the buffer hypothesis, which postulates that low-income individuals can accrue better health with increased social capital,[29] suggests that intervention strategies could target social capital, as

opposed to income or education, in order to improve health among low-income and low educated populations. Conversely, the dependency hypothesis suggests that only individuals with higher levels of SES can benefit from social capital,[29,127] lends support to policies and interventions aimed at increasing income and education. However, neither of these hypotheses predicted there would be negative consequences associated with increasing social capital, as was seen in the current study. The potential for increasing levels of social capital to impart negative effects on health, particularly among low SES populations, further complicates these scenarios.

The results from these studies provide support for other emerging literature that suggests social capital and social networks may impart negative effects on health. Portes was one of the first sociologists to discuss the potential downsides of social capital, pointing to mechanisms such as excessive demands and down-leveling pressures associated with social relationships.[190] More recently, Moore pointed out that it is not the social connections themselves, but rather the context and content of these relationships, including socioeconomic conditions and whether these connections carry additional resources or burdens.[177] For example, a study found that social capital was associated with reduced mastery, a mental health outcome that has previously been associated with cardio-metabolic outcomes, among individuals with low educational attainment.[177] This study underscored educational attainment as a moderator of the effect of social capital on a health-related outcome, and furthermore that social capital could have a negative impact on health. Another study found that neighborhood social support was associated with increased rates of smoking and binge drinking.[86] Carpiano points out that these unhealthy activities are often group behaviors, and an increase in opportunities to

socialize may be associated with increased frequency of such behaviors. There is also some research on proposed mechanisms that link social networks with poorer health. For example, Portes suggests that high levels of social control among dense, multiplex networks can impose social norms on the members within that community.[190] The effect of social norms on health has been studied most extensively with substance abuse among college students.[191] However social norms and the idea of 'social contagion' via social networks are emerging areas of health research, and are hypothesized to be responsible for both health behaviors, such as dietary practices[192] and health screenings,[193] and health outcomes, including happiness,[194] loneliness,[195] and depression.[196] Moreover, there is research to suggest that social control and behavioral norming may be stronger in smaller and denser networks.[113,178] Taken together, this body of research underscores the pathways by which social networks and social capital contribute to negative health behaviors and outcomes.

The current studies suggest that interventions seeking to improve health should first target individual resources, including enhancing educational attainment and reducing poverty as a means of increasing social capital and further improvements in well-being. In line with prior research,[29,121] both educational attainment and household income were associated with access to social capital and the characteristics of social networks in the current study. Specifically, lower levels of income and education were associated with reduced access to social capital, highlighting potential mechanisms through which cycles of poverty are reproduced. This has important ramifications for public health, including underscoring the challenges that low SES individuals face in overcoming economic adversity.

Additionally, this study highlights potential intervention and policy challenges, including the prospect that increasing levels of social capital may be associated with poorer health outcomes among certain populations. This has been shown most frequently among college populations in relation to problematic drinking.[197,198] As network diversity increases, individuals are presented with more opportunities, resources, and even social pressures, in which poor behaviors, including binge drinking, occur. Similar processes may occur for energy balance behaviors (e.g., poor diet and physical inactivity) that lead to an increase in BMI, as well as unhealthy behaviors and stressors that lead to hypertension.

Limitations and Challenges

The results from the current study should be interpreted in light of several limitations. First, the nature of the sampling methodology may have selected for individuals who were more socially integrated. The RDS methodology requires that participants be invited into the study by another community member, which would likely not capture individuals who are extremely socially isolated. However, RDS has been touted as an ideal sampling strategy for engaging hard-to-reach populations,[158] including populations who may have been reluctant to participate in research otherwise.[159]

Additionally, the relatively small sample size may limit the ability to detect significant relationships within this sample. The sample, which was predominantly older, Black, female, and low SES, also limits the generalizability of the findings to other populations or contexts. However, the data represent an understudied and hard-to-engage population within the literature and provided an opportunity to explore potential

relationships between social capital and chronic disease among a sample with inequitably high rates of hypertension and obesity.

Finally, due to the cross-sectional nature of the study, these data cannot assess whether SES precedes access to social capital and social network characteristics, or whether social capital and social networks lead to gains in SES. Similarly, the data cannot articulate whether social capital and social networks are associated with increases in BMI and decreases in hypertension or vice versa. Previous research has indicated that chronic disease may limit the ability of an individual to engage in social relationships.[199] This would lend support to the notion that chronic disease outcomes influence social capital and social networks. Yet, there is mounting longitudinal research that indicates social capital and social networks influence obesity and hypertension outcomes over time.[82,132] Future studies should also assess whether changes in income or educational attainment are associated with gains in social capital and changes in social networks.

Other major challenges of the project included buy-in from community stakeholders (i.e., neighborhood presidents), recruitment of a historically hard-to-engage population, and limited referrals from study participants. Yet, the use of RDS allowed for preliminary testing of this recruitment technique to engage residents of low-income neighborhoods, as well as the potential for community members to take ownership of the project, ultimately enhancing participation and building partnerships and trust within these communities.

Next Steps

Future applications of this work include the examination of social capital and social networks by gender, as well as by race. The current sample is limited in its ability

to stratify across race or gender, given that it is predominantly Black and female. Yet, there is emerging evidence to suggest that social capital and social networks may operate differently for these groups, and may subsequently affect health outcomes. Additionally, future analyses will include the examination of social capital and social networks in relation to health behaviors (i.e., diet, physical activity) and perceived levels of stress within this population, given their previous associations with chronic disease. For example, preliminary analyses of the current data suggest that social network characteristics are associated with meeting national physical activity recommendations among this population. Future analyses will also include whether residents have access to or frequently use community space (including recreation centers, parks, a local church) and their association with social capital and social networks. These findings could lead to a better understanding of the potential mechanisms through which social environments impact health.

In the future, studies may seek to compare the relationships between social capital, social networks, and chronic disease across both high and low SES populations. In the current study, there was some diversity in SES within the sample; however these individuals all still resided in low-income neighborhoods. As was discussed previously, there may be contextual factors, including neighborhood characteristics, which contribute to the types of social networks and resources available to residents. For example, neighborhood environments may provide opportunities that only those with high social capital or high SES are able to take advantage of. Conversely, disadvantaged neighborhoods may present more opportunities that deter health, including access to unhealthy foods, criminal activity, and violence that may be harder to avoid in the

absence of personal resources. For example, some research suggests that social capital may mediate the association between neighborhood disadvantage and health.[200,201] In the current study, low income was associated with decreased social cohesion among neighbors, underscoring the relationship between SES and social capital. Given that low income populations tend to rely on proximal networks, this lack of social cohesion among neighbors may be associated with reduced trust and heightened tensions that contribute to poorer health.

In addition to the examination of social capital across neighborhoods of varying SES, future research should seek to examine social capital within the context of specific social environments, such as the worksite or place of worship. For example, in the current study, increased social network capital overall was associated with an increase in BMI. Yet, broader network reach within the context of a work environment, perhaps with colleagues or supervisors who might be able to connect an individual to a job opportunity, may have a very different impact on health outcomes as opposed to network capital in general. For example, multiple studies have found that higher workplace capital and network diversity are associated with better health,[88] including both decreased hypertension and improved mental health.[202,203] Oksanen and colleagues suggest that "high vertical social capital at work might encourage employees to comply with preventative measures, heed advice on health behaviour from the supervisor, and to follow norms set by the leaders, such as getting regular health check-ups." (p. 687)[203] However, these same mechanisms, including network diversity and reach, may operate distinctly across a variety of settings, including the workplace or religious community, to

impact health. Newer measures of network social capital, including context specific items, may reveal new patterns through which social environments impact health.

Finally, one promising avenue of research includes the ability of interpersonal resources, including perceived control, to moderate the potentially negative effects of social capital on health. Indeed, forthcoming research suggests that among those with higher levels of network diversity (which was associated with higher BMI in the current study), individuals with higher levels of perceived control were less likely to engage in problem drinking behaviors.[204] This highlights the potential for interpersonal resources to dampen or weaken the ill effects of social network pressures on health behaviors to impact health outcomes. Interventions aimed at increasing social capital for the purposes of disrupting cycles of poverty and improving health should also seek to improve interpersonal resources so as to avoid the potentially damaging consequences associated with increased capital and broader social networks.

Conclusion

In summary, this work contributes to mounting evidence that socioeconomic factors, including household income and educational attainment, work synergistically with social capital and social networks to impact chronic disease outcomes. SES was associated with both access to social capital and social network characteristics, suggesting that these resources are not equitably distributed across populations. Although, SES moderated only a few of the relationships between social capital and social networks, and chronic disease in this population, previous work suggests that these relationships should be stratified to explore potential differences by socioeconomic positioning.

Contrary to previous hypotheses, social capital and social networks were not associated with better health. More research is warranted that explores the potentially negative consequences of social capital on health, and in particularly, the role that social capital and social networks may play in ameliorating or exacerbating disparities in chronic disease outcomes.

This study was one of the first to examine access to social capital and social network characteristics among residents of low-income communities in correlation with chronic disease. Additionally, this work adds to the growing body of literature to suggest that socioeconomic factors may offer contextual clues through which social capital and social networks impact health. For example, social norms, which often operate through social networks, can serve to either promote or deter health within given settings.

Research that accounts for the contextualization of social capital and social networks both within and across socioeconomic circumstances and environments may lead to a better understanding of the role that social relationships have on health.

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APPENDIX A – HOUSEHOLD SURVEY

Healthy Neighborhoods Project

Greenville, SC

A survey about life and recreation for people

who live in Greenville

We greatly appreciate you completing this survey.

Your answers are very important!

Dear Resident of Greenville,

On behalf of the XXX Neighborhood Association and Greenville Dreams we would like to invite you to participate in the Greenville Healthy Neighborhoods Project. As part of this project, we hope to learn more about XXX and the health of our residents. We have partnered with LiveWell Greenville and the University of South Carolina to complete the project, which has been funded by the BlueCross BlueShield Foundation of South Carolina. You are being asked to participate in this project because you are a resident of XXX.

If you decide to participate, you will be asked to complete a survey about your neighborhood and your health. Participation is anonymous, which means that no one (not even the research team) will know what your answers are. So, please do not write your name or other identifying information on any of the study materials. You may feel uncomfortable answering some of the questions. You do not have to answer any questions that you do not wish to.

You will receive a $10 gift card to reimburse you for your time. Although you probably won't benefit directly from participating in this study, we hope that others in the community will benefit from future projects as we learn more about how to create healthy neighborhoods.

We will be happy to answer any questions you have about the study. You may contact the project coordinator, Stephanie Child at 803-777-1502 or childst@email.sc.edu if you have study related questions or problems. If you have any questions about your rights as a research participant, you may contact the Office of Research Compliance at the University of South Carolina at 803-777-7095.

Thank you for your consideration. If you would like to participate, please begin filling out the attached survey. When you are done, please return the completed survey to a project staff member.

Sincerely,

Yvonne Reeder

President

Greenville Dreams

Healthy Neighborhoods Project

Thank you very much for your willingness to complete this survey.

Please remember:

- There are no right or wrong answers, we just want to know what YOU think
- Provide only one answer for each item
- Many questions are similar, but completing each one will help us greatly
- Your answers will be kept strictly **PRIVATE AND CONFIDENTIAL**

NEIGHBORHOOD PERCEPTIONS

The next several questions ask about features of your neighborhood. For all questions, please think about your neighborhood as the area within a 10-15 minute walk from your home.

1. How long have you lived at your current address? _____ years and _____ months

2. Overall, how would you rate your neighborhood as a place to live?

❑ Poor ❑ Fair ❑ Good ❑ Very Good ❑ Excellent

3. Please tell us how much you agree or disagree with each of these statements about your neighborhood surroundings.

		Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a.	There is lots of greenery around my neighborhood (trees, bushes, household gardens).	1	2	3	4	5
b.	There are well-maintained sidewalks along most of the streets in my neighborhood.	1	2	3	4	5
c.	There is shade along many of the sidewalks in my neighborhood.	1	2	3	4	5
d.	My neighborhood is generally free from litter and trash.	1	2	3	4	5
e.	There are attractive buildings and homes in my neighborhood.	1	2	3	4	5
f.	There are pleasant natural features in my neighborhood (ex: parks, walking trails, riverfront).	1	2	3	4	5
g.	My neighborhood is generally free from unattractive graffiti.	1	2	3	4	5
h.	There are many shops, stores, markets, or other places to buy things I need within easy walking distance of my home.	1	2	3	4	5
i.	A large selection of fresh fruits and vegetable is available in my neighborhood.	1	2	3	4	5

		Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
j.	The fresh fruits and vegetables in my neighborhood are of high quality.	1	2	3	4	5
k.	There is a safe park in my neighborhood.	1	2	3	4	5
l.	It is easy to walk to a bus stop from my home.	1	2	3	4	5
m.	There are many interesting things to look at in my neighborhood.	1	2	3	4	5
n.	There are major barriers to walking in my neighborhood that make it hard to get from place to place (ex: busy streets, rivers, train tracks).	1	2	3	4	5
o.	There are many four-way intersections in my neighborhood.	1	2	3	4	5
p.	There is a lot of crime in my neighborhood.	1	2	3	4	5
q.	There are unleashed/stray dogs in my neighborhood.	1	2	3	4	5
r.	Children are safe walking around the neighborhood during the day.	1	2	3	4	5
s.	Crime in my neighborhood makes it unsafe to walk the streets at night.	1	2	3	4	5
t.	There are rowdy youth on the streets or hanging around in parks in my neighborhood.	1	2	3	4	5
u.	Crime in my neighborhood makes it unsafe to walk on the streets during the day.	1	2	3	4	5

4. Approximately how many people do you know who live in your neighborhood?

_____

5. How many family members do you have in your neighborhood who you feel at ease with, can talk to about what is on your mind, and call on for help?

❑ None ❑ 1-5 ❑ 6-10 ❑ Over 10

6. How many friends do you have in your neighborhood who you feel at ease with, can talk to about what is on your mind, and call on for help?

❑ None ❑ 1-5 ❑ 6-10 ❑ Over 10

7. How many people in your neighborhood do you know well enough to ask for a favor?

❑ None ❑ 1-5 ❑ 6-10 ❑ Over 10

8. These questions are about the people you know well (on a first-name basis) and the type of work they do. If you know more than one person in an occupation, answer for the person you know the best.

Do you know someone who is a…

a.	High school teacher?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
b.	Carpenter?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
c.	Musician/artist?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
d.	Mechanic?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
e.	Physician?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
f.	Janitor?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
g.	Registered nurse?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
h.	Welder?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
i.	Accountant?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
j.	Receptionist		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other

k.	Store cashier?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other
l.	Plant machine operator?		❑ Yes	❑ No	
	If Yes:	Is this person a…	❑ Relative	❑ Friend	❑ Acquaintance
	If Yes:	Does this person live in your…	❑ Household	❑ Neighborhood	❑ Other

The following questions ask about people with whom you discuss important personal matters such as health, family, work, and money issues. These people may live in your household, may be relatives, friends, work colleagues, neighbours or other persons living outside your household. You can give a fake name rather than the real name if you prefer. Remember, all information in this survey will be kept confidential.

9. Please list up to three people with whom you have discussed important matters in the last six months.

Person 1 _____

Person 2 _____

Person 3 _____

Do Person 1 and Person 2 know each other? ❑ Yes ❑ No ❑ Don't know

Do Person 1 and Person 3 know each other? ❑ Yes ❑ No ❑ Don't know

Do Person 2 and Person 3 know each other? ❑ Yes ❑ No ❑ Don't know

The next set of questions asks you about these people that you have discussed important matters with in the last six months:

	Person 1	**Person 2**	**Person 3**
How old is this person?	_____ yrs.	_____yrs.	_____yrs.
Is this person:	❑ Male ❑ Female	❑ Male ❑ Female	❑ Male ❑ Female
How much formal education has this person had?	❑ Less than High School ❑ High School ❑ More than High School ❑ Don't know	❑ Less than High School ❑ High School ❑ More than High School ❑ Don't know	❑ Less than High School ❑ High School ❑ More than High School ❑ Don't know
Is this person a….	❑ Relative ❑ Friend ❑ Acquaintance	❑ Relative ❑ Friend ❑ Acquaintance	❑ Relative ❑ Friend ❑ Acquaintance
Where does this person live?	❑ In your household ❑ In your neighborhood ❑ Outside of Greenville ❑ Other part of Greenville:_____	❑ In your household ❑ In your neighborhood ❑ Outside of Greenville ❑ Other part of Greenville:_____	❑ In your household ❑ In your neighborhood ❑ Outside of Greenville ❑ Other part of Greenville:_____
Does this person walk/exercise regularly?	❑ Yes ❑ No ❑ Don't know	❑ Yes ❑ No ❑ Don't know	❑ Yes ❑ No ❑ Don't know
What occupation does this person have?	_____	_____	_____

These questions are about interactions with your neighbors. Neighbors are people who live nearby. They do not have to live on your same street, but they should live within a short (10-15 minutes) walking distance.

10. The following questions ask about the relationships among the people that live in your neighborhood. Please indicate how much you agree or disagree with each statement.

		Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
a.	People around my neighborhood are willing to help their neighbors.	1	2	3	4	5
b.	This is a close knit neighborhood.	1	2	3	4	5
c.	People in this neighborhood can be trusted.	1	2	3	4	5
d.	People in this neighborhood generally don't get along with each other.	1	2	3	4	5
e.	People in this neighborhood do not share the same values.	1	2	3	4	5
f.	You have someone in your neighborhood who you can talk to about important things.	1	2	3	4	5
g.	You have someone in your neighborhood who could help you out with things like give you a ride, watch the house or kids, or fix something.	1	2	3	4	5
h.	I receive helpful information and advice (about child rearing, job opportunities, etc.) from my neighbors.	1	2	3	4	5
i.	I receive information and advice about health (healthy recipes, reminders about flu shots) from my neighbors.	1	2	3	4	5

11. For the following questions, <u>how likely is it that your neighbors could be counted on to intervene if</u>:

		Very Unlikely	Unlikely	Neither Likely or Unlikely	Likely	Very Likely
a.	People were spray-painting graffiti on a local building or were vandalizing the local park or park equipment.	1	2	3	4	5
b.	A fight or domestic dispute broke out in front of their house.	1	2	3	4	5
c.	A local service in your neighborhood, such as a library, community center or a health clinic was in danger of closing down.	1	2	3	4	5
d.	Children were hanging out in the neighborhood or around a school at night.	1	2	3	4	5
e.	A neighbor was acting unfairly toward another neighbor.	1	2	3	4	5

12. Have you ever used any of the following facilities in your neighborhood for <u>social gatherings or recreation with others</u>? If no, please check 'never'. If yes, circle the number showing how recently AND give the name of the facility you used most often.

	Never	Yes, in the last month	Yes, 1-12 months ago	Yes, more than a year ago	Name of Facility
Community Park	❑	1	2	3	
Indoor facility (community center, local meeting room)	❑	1	2	3	
Outdoor facility (sports field, walking trail)	❑	1	2	3	
Coffee shop, café, restaurant	❑	1	2	3	
Neighborhood church	❑	1	2	3	
Other location	❑	1	2	3	

PHYSICAL ACTIVITY, DIET, AND HEALTH

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

13. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

❑ No vigorous physical activities → ***Skip to question 14***

13a. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

❑ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

14. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads,

bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

❑ No moderate physical activities → ***Skip to question 15***

14a. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

❑ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

17. During the past month, how often did you drink 100% fruit juice such as orange, apple, grape? Please check only one answer.

❑ Never
❑ 1-3 times last month
❑ 1-2 times per week
❑ 3-4 times per week
❑ 5-6 times per week
❑ 1 time per day
❑ 2 times per day
❑ 3 times per day
❑ 4 times per day
❑ 5 or more times per

15. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

❑ No walking → ***Skip to question 16***

15a. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**
_____ **minutes per day**

❑ Don't know/Not sure

15b. Where do you normally go for a walk? _____

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

16. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**
_____ **minutes per day**

❑ Don't know/Not sure

18. During the past month, how often did you eat fruit? Count fresh, frozen, and canned fruit. Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

19. During the past month, how often did you eat a green leafy or lettuce SALAD, with or without other vegetables? Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

20. During the past month, how often did you eat FRENCH FRIES, home fries, or hash brown potatoes? Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

21. During the past month, how often did you eat other WHITE POTATOES? COUNT baked potatoes, boile potatoes, mashed potatoes and potato salad? Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

22. During the past month, how often did you eat COOKED DRIED BEANS, such as refried beans, baked beans, bean soup, and pork and beans? Do NOT include green beans. Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

23. During the past month, how often did you eat vegetables? Count fresh, frozen, and canned vegetable Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

24. During the past month, how often did you have TOMATO SAUCES such as spaghetti sauce or pizza witl tomato sauce? Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

25. During the past month, how often did you have SALSA? Please check only one answer.

❑ Never ❑ 3-4 times per week ❑ 1 time per day ❑ 4 times per day
❑ 1-3 times last month ❑ 5-6 times per week ❑ 2 times per day ❑ 5 or more times per
❑ 1-2 times per week ❑ 3 times per day

26. Where do you typically shop for groceries? (Please give name and approximate address)

_____

27. Where do you typically purchase *fresh fruit and vegetables*? (Please give name and approximate address)

_____

28. Has a doctor, nurse, or other health professional EVER told that you had any of the following?

High blood pressure?	❑ Yes	❑ No	❑ Not sure
If 'YES' and you are female, was this *only* during pregnancy?	❑ Yes	❑ No	❑ Not sure
High cholesterol?	❑ Yes	❑ No	❑ Not sure
Heart attack (myocardial infarction)?	❑ Yes	❑ No	❑ Not sure
Coronary heart disease (angina)?	❑ Yes	❑ No	❑ Not sure
Stroke?	❑ Yes	❑ No	❑ Not sure
Asthma?	❑ Yes	❑ No	❑ Not sure
Arthritis?	❑ Yes	❑ No	❑ Not sure
Cancer?	❑ Yes	❑ No	❑ Not sure
Chronic Obstructive Pulmonary Disease (COPD), emphysema or chronic bronchitis?	❑ Yes	❑ No	❑ Not sure
Diabetes?	❑ Yes	❑ No	❑ Not sure
If 'YES' and you are female, was this *only* during pregnancy?	❑ Yes	❑ No	❑ Not sure

29. Overall, would you say your general health is:

❑ Poor ❑ Fair ❑ Good ❑ Very Good ❑ Excellent

30. These questions are about how you feel and how things have been with you <u>during the past month</u>. For each question, please indicate the one answer that comes closest to the way you have been feeling.

	<u>During the past month</u>, *how often*:	**Never**	**Rarely**	**Sometimes**	**Fairly Often**	**Very Often**
a.	Has your health limited your social activities (like visiting friends or close relatives)?	1	2	3	4	5
b.	Have you felt that you were unable to control the important things in your life?	1	2	3	4	5
c.	Have you felt confident about your ability to handle your personal problems?	1	2	3	4	5
d.	Have you felt that things were going your way?	1	2	3	4	5
e.	Have you felt difficulties were piling up so high that you could not overcome them?	1	2	3	4	5
f.	Have you felt lonely or isolated?	1	2	3	4	5

DEMOGRAPHIC INFORMATION

Finally, please tell us a bit more about you and your household. All information will be kept confidential. Once you have returned your survey, all specific address information will be kept separate from the answers you provide.

31. What is your gender? ❑ Male ❑ Female

32. What is your current age? _____ years

33. About how tall are you without shoes? _____ feet _____ inches

34. About how much do you weigh without shoes? _____ lbs

35. Are you of Hispanic, Latino/a, or Spanish origin? ❑ Yes ❑ No

36. Which one or more of the following would you say is your race?

❑ Black ❑ White ❑ American Indian or Alaska Native
❑ Asian ❑ Pacific Islander

37. What is your current marital status? *(check only one)*

❑ Single, never married ❑ Divorced ❑ Married
❑ Separated ❑ Widowed ❑ Unmarried couple/Cohabitating

38. What is the highest level of education you have completed? *(check only one)*

❑ Less than high school ❑ High school/GED ❑ Some college
❑ Two-year college degree ❑ Four-year college degree ❑ Advanced degree

39. What is your current work status? *(check one option that indicates primary role)*

❑ Employed full-time ❑ Retired ❑ Full-time student
❑ Employed part-time ❑ Unemployed ❑ Part-time student
❑ Homemaker ❑ On disability or other work ❑ Other _____

40. What is your annual household income before taxes? *(check only one)*

❑ less than $15,000 ❑ $15,000-29,999 ❑ $30,000-44,999
❑ $45,000-59,999 ❑ $60,000-75,999 ❑ $75,000 or more

41. How many adults (including yourself) live in your household? _____# of adults

42. How many children under the age of 18 live in your household? _____# of children

43. Do you own or rent your home? ❑ Own ❑ Rent ❑ Other arrangement

44. How many total motor vehicles are owned by the members of your ____ # of vehicles

In order to help us identify local resources near you, **please provide your home address:**

_____

We would like to remind you that all information is **confidential**. However, if you would prefer not to list your exact address, please provide us with your street name and block number (ex: 600 block of Beck Avenue).

Block number and street name:

_____