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Doctor of Philosophy
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A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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Abstract

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By Izraelle I McKinnon

For Black adults, residential segregation, or racial/ethnic density, is believed to be a fundamental driver of the socioeconomic, environmental, and psychosocial inequalities that contribute to the disproportionately high rates of cardiovascular disease (CVD) in this group. However, this is not the case for other racial/ethnic minority groups, where racial/ethnic density is hypothesized to increase the potential availability of health-promoting psychosocial resources associated with living in minority communities, often referred to as ethnic enclaves. This dissertation seeks to determine whether associations between ethnic density and CVD risk are more consistent with a residential segregation or racial/ethnic enclaves framework, in a cohort of young to middle-aged Black women in the southeast US. First, we estimated associations between residential racial composition and activity space racial composition and ambulatory blood pressure (ABP) outcomes. We found higher Black racial/ethnic density across activity spaces was associated with a higher risk of daytime hypertension, and neither residential nor activity space racial composition were associated with nighttime blood pressure. Second, we estimated moderating effects of neighborhood-level psychosocial resources related to ethnic enclaves, neighborhood social cohesion and activities with neighbors, on associations between residential and activity space Black racial/ethnic density and ABP outcomes. While neighborhood social cohesion showed modest protective effects, contrary to our hypotheses, more activities with neighbors were associated with higher risk for daytime hypertension, and results indicate higher Black racial/ethnic density had more adverse effects among those reporting more activities. Finally, we estimated moderating effects of dimensions of individual-level racial identity as protective resources related to racial/ethnic enclaves, shown to have protective associations with mental health outcomes. Contrary to hypotheses, results indicate holding race more central to one's identity was associated with higher risk for daytime hypertension. Effect sizes driving all associations were small. Our findings contribute to studies of Black communities and health outcomes by highlighting potential health implications of the spaces where individuals conduct their activities beyond home. However, our findings suggest that the adverse conditions associated with being Black in the US and/or living in segregated Black neighborhoods may override protective features related to living in racially/ethnically dense communities in the southeast US.

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Chapter 1. Background and Significance

New and worsening concerns: Cardiovascular health among young and middle-aged Black women

Racial disparities in cardiovascular disease (CVD) outcomes have persisted and widened over time (G. K. Singh et al., 2015), with recent studies highlighting concerning trends among young to middle-aged Black women (Kalinowski et al., 2019). Despite declines in CVD mortality among all race-gender groups since the 1960s and 1970s, declines have been slower among Black women compared to White women (Cooper et al., 2000), particularly among Black women 35 to 54 years old (Smilowitz et al., 2016). Within this age group, Black women have higher CVD mortality risk not only than White women, but also than Black and White men (Smilowitz et al., 2016). Among those 35-44 years old, Black women have higher prevalence of CVD than White women *and* Black and White men (Jolly et al., 2010). However, research focusing on factors driving cardiovascular risk among young Black women is limited.

Additionally, among the population 35-44 years old, counties in which Black women have higher heart disease mortality than White men and women has almost doubled since the 1970s, with nearly half of counties in the US exhibiting this disparity (Vaughan et al., 2019). Evidence of young to middle-aged Black women experiencing worse cardiovascular health than men contradicts theories of greater biological protection for women relative to men against CVD, which is thought to be strongest at younger age (Pérez-López et al., 2010; Villablanca et al., 2010). These findings suggest the importance of exogenous factors, including social and environmental context in many counties, in overriding biological protectiveness against CVD among young to middle-aged Black women (Vaughan et al., 2019, p.). The increasing number of counties with Black women experiencing greater heart disease mortality than White men is driven by faster rates of decline among White men compared to Black women. Such population-level differences in rates of decline indicate the need to examine more upstream, population-level exposures which would explain inequitable access to health-promoting advancements and resources by race and place (Javed et al., 2022; Kramer et al., 2017). These recent findings indicate the need to examine population-level exposures which would explain inequitable access to health-promoting advancements and resources by race and place (Javed et al., 2022; Kramer et al., 2017), as well as factors which may be protective or buffer adverse exposures among young and middle-aged Black women.

Residential Segregation: A fundamental determinant of poor CVD health among Black populations

Residential segregation has often been the lens to examine neighborhood context and Black-White health disparities. Racial residential segregation refers to the process of separating racial groups into disparate residential contexts, not only to protect White populations from exposure to Black populations, but to restrict Black populations to the least desirable areas (Williams & Collins, 2001). Thus, disparate residential environments for Black versus White Americans is part of the legacy of slavery in the US which has persisted over time in virtually every metropolitan area, despite civil rights efforts which have made segregation and inequalities on the basis of race unconstitutional (Kawachi & Berkman, 2014). While overt interpersonal discrimination such as White flight and race-based violence (i.e., Ku Klux Klan) are commonly discussed means of creating and maintaining segregation, the US government has played a far-reaching, systematic role (Rothstein, 2017). Residential segregation practices find their origins as early as the end of the Civil War with the enforcement of Jim Crow laws, state and local laws which enforced segregation in the US South until 1965. Additionally, public housing projects, part of Franklin D. Roosevelt's New Deal programs in 1933, created segregated housing projects even where there was integrated housing before. The Federal Housing Administration (also part of the New Deal) would not insure loans for housing developments in or near Black neighborhoods (known as "redlining"), or if any homes were sold to Black people (with deeds required to include language prohibiting reselling or renting to Blacks) (Rothstein, 2017). Despite declines in residential segregation since the 1970s, the effects of these laws, policies and practices persist to this day, with the majority of Black people in metropolitan areas of the US living in segregated neighborhoods as recently as 2010 (Massey & Tannen, 2015). Also in 2010, the average White individual lived in a neighborhood that was 75% White while the average Black individual (approximately 16% of the US population) lived in a neighborhood that was 35% White (Logan, 2013). An analysis of 2017 American Community Survey (ACS) data shows that despite modest declines since the beginning of the century, Black-White residential segregation continues to persist above and beyond that of segregation of other racial/ethnic minorities, with 52.6% of Black residents needing to relocate in order to be fully integrated with Whites for the median metropolitan neighborhood (closer to 80% in the more segregated areas) (Quick, 2019).

Residential segregation is also viewed as having persistent effects on economic opportunity among Black neighborhoods and populations long after fair housing laws (Grusky, 2019). Public housing projects were meant to provide working-class families with housing in a time of a major shortage, but focus on White housing led to conspicuous vacancies in White housing projects while Black people still needed housing. This eventually led to filling White housing projects with Black people as White people moved to buy homes in the suburbs and Black people stayed in cities while industry diminished and jobs left – which is why housing projects are now associated with concentrated poverty, or "ghettos," rather than working-class families. Furthermore, Black people were prohibited from buying homes in a time when they were much more affordable in the 1940s to 60s (Rothstein, 2017). By the time the Fair Housing Act was passed in 1968 (enforcement mechanisms added in 1988), providing protections from discrimination when renting or buying homes, homes were much less affordable for working-class families. Meanwhile, White homeowners were able to gain equity in their homes which provided wealth that could be used for unexpected expenses or loss of employment or passed on to children for college expenses or their own homes (Yinger, 1995).

Studies today show that for Black populations, living in majority Black neighborhoods is typically associated with worse health outcomes; in terms of CVD specifically, segregation has been found to be associated with greater risk for obesity, hypertension, and diabetes, as well as increased mortality from heart disease and stroke, beyond the effects of socioeconomic and traditional CVD risk factors (Kershaw & Albrecht, 2015). Black women may be particularly susceptible to the effects of residential segregation as studies have also found associations between segregation and CVD risk and outcomes among Black women where they have not found them among Black men (Barber, Hickson, Wang, et al., 2016; Kershaw et al., 2013). Mechanisms relating residential segregation with health outcomes include differential investment and placement of services, such as access to healthy physical environments (i.e., food, walkability, green space) and preventive healthcare, educational and economic opportunity, social disorganization, concentrated poverty, and stress from exposure to psychosocial risk factors such as violence and discrimination (Greer et al., 2014; Williams & Collins, 2001). Studies have demonstrated that poverty, occupational status, and social disorganization are potential mediating pathways through which segregation adversely affects health (Collins & Williams, 1999; Greer et al., 2014).

Activity Spaces Segregation: Integrating a "spatial polygamy framework" into studies of place and health

Underlying the residential segregation hypotheses is the conceptualization of residential neighborhoods as capturing a wide variety of the contextual areas, resources and exposures residents have access to, including locations where they engage in routine activities and interactions (Pinchak et al., 2021). While there is a large literature examining how where one lives affects their behaviors and health, such an approach to examining the effects of socioenvironmental context has been criticized as being too narrow, not accounting for the complexity and heterogeneity in spaces one occupies daily (Matthews & Yang, 2013). Recent studies highlight the concept of "spatial polygamy," recognizing that individuals are generally mobile and exposed to multiple locations throughout their daily lives, with few routine activities (i.e., work, shopping, socializing) and little time spent within the boundaries of their neighborhood census tract (Pinchak et al., 2021; Tamura et al., 2018). Studies have shown that as little as 6% of day-to-day activities (i.e., food shopping, physical activity, working, service use, etc.) and very little time takes place in residential census tracts (Zenk et al., 2011). Focusing on residential space in studies of segregation and health may only offer a partial, or even biased, assessment of the contextual spaces in which individuals spend time, potentially misclassifying their spatial exposures and the level of segregation an individual may experience (Wong & Shaw, 2011). Focusing only on residential neighborhoods assumes all residents within a neighborhood are exposed to the same level of segregation and same contextual environment, ignoring the variation in mobility and spatial exposures among individuals living in the same neighborhood (Wong & Shaw, 2011). Studies of segregation and health can provide a more holistic, comprehensive assessment of socio-geographical exposures and health related to race by considering activity spaces beyond the residential neighborhood.

Ethnic Enclaves: Evidence of positive CVD outcomes in racially/ethnically-isolated communities

While the racial residential segregation hypothesis asserts greater exposure to psychosocial risk factors and stress in concentrated minority communities which results in worse health outcomes among residents (Basile Ibrahim et al., 2021), an alternative hypothesis, known as the ethnic density hypothesis, highlights the potential availability of health-promoting psychosocial resources associated with living in concentrated minority communities (Bécares et al., 2012; Viruell-Fuentes et al., 2012). The ethnic density hypothesis proposes the presence of protective and buffering factors, including social cohesion/capital, social support, and sense of community and belongingness, which may be enhanced among minority populations when living in concentrated communities composed of those with whom they racially/ethnically identify (Bécares et al., 2009, 2012). The term “ethnic enclave” came about when describing Cuban immigrants in Miami who tended to become employed by Cuban-owned businesses rather White-owned secondary sector businesses (i.e., low-wage, part-time/temporary work), and often experienced more upward economic mobility in the US when employed by coethnics (Waldinger, 1993). (Bécares et al., 2009, 2012).

Studies examining ethnic density have often investigated and found protective effects among Latino, Asian, and other non-Black minority and immigrant populations living in ethnic enclaves/communities in the US, including for CVD risk factors and outcomes (Bécares et al., 2012; Kershaw et al., 2016; Viruell-Fuentes et al., 2012; T.-C. Yang et al., 2017), despite the presence of material deprivation in many of these communities (Osypuk et al., 2009). Theory and evidence around ethnic enclaves has continued to motivate exploration of protective factors among these communities and the potential for interventions targeted at these communities. Notably, benefits vary for enclave residents by individual-level factors such as gender, nativity, and acculturation status (Chang et al., 2010; Kershaw & Albrecht, 2015; Li et al., 2013). However, studies examining ethnic density among US Black and African-American populations have predominantly found the detrimental effects of living in majority Black areas (Bécares et al., 2012), providing further evidence supporting the relevance of the residential segregation hypothesis. This difference in effects of ethnic density between Black and non-Black minority populations is likely related to documented differences in segregation processes between these groups: while Black Americans have been constrained into segregated spaces characterized by area-level deprivation as a result of centuries of racist processes and policies, non-Black racial and ethnic minorities and immigrants are more likely to strategically self-segregate as a means of building social and financial capital, close-knit social and community support, and protection from discriminatory experiences among community members with whom they share language, culture, and norms (T.-C. Yang et al., 2017). Though studies have found protective effects of ethnic density for mental health outcomes among Black communities, including depression and anxiety (Shaw et al., 2012), few studies have found these effects for physical health outcomes.

Although the forces creating and contexts of ethnic enclaves among non-Black ethnic minorities may differ from those of Black populations, if there is something the ethnic enclaves literature shows us, it is that being a racial or ethnic minority living in a neighborhood with people who look like you is not always bad for health, even in the context of material deprivation. Moreover, many studies of segregation and health do not consider heterogeneity in associations between segregation and CVD among Black neighborhoods and populations. Classifying Black populations as a single group assumes homogeneity of risk, though there may be differences across a range of community- and individual-level factors. As Kershaw and colleagues note in their review of the literature on segregation and health, “accounting for heterogeneity in risk among Blacks and their neighborhoods would help elucidate how and why segregation has implications for cardiovascular health” (Kershaw & Albrecht, 2015).

Psychosocial Resources in Ethnic Enclaves: The protective effects of strong community ties

While the far reaching effects of structural racism and residential segregation may be overriding the potential positive effects of living in concentrated Black communities on physical health outcomes, select studies have found the potential for the positive buffering and moderating effects of psychosocial resources on CVD risk factors in concentrated Black neighborhoods (Leak-Johnson et al., 2021; R. Singh et al., 2021). Two recent studies found that better social environment, characterized as higher perceived aesthetic quality, safety, and social cohesion of neighborhoods, modified associations between historic and contemporary measures of segregation and CVD risk (Gao et al., 2022; Mujahid et al., 2021). Specifically, while Black residents living in historically redlined (more “hazardous”) areas had lower odds of ideal cardiovascular health, as social environment improved this association weakened (Mujahid et al., 2021); and while Black residents living in more segregated census tracts had a greater hazard of incident hypertension, as social environment improved this hazard decreased and was more comparable to associations found among Black residents living in less segregated census tracts (Gao et al., 2022). These recent studies point to protective and buffering effects of psychosocial resources in majority Black communities, and prompts further examination of the potential for the protective aspects of ethnic density to override the negative effects of residential segregation.

Much of the theory underlying the protective effects of living in ethnic enclaves refers to the benefits of living within a close-knit community – a community where there are civic bonds among community members promoting a sense of trust, belonging, solidarity, and norms of reciprocity among community members; a community where members come together for collective action and civic participation (Kawachi & Berkman, 2014; Osypuk et al., 2009). Through these community ties there can be a flow of resources, including more tangible material resources (i.e., money lending, employment networking) as well as more symbolic social and psychosocial resources (i.e., information, trust, perceived control, social support), which can directly and indirectly impact health behaviors and outcomes (58).

Strong community ties can impact the health of individuals within communities through mechanisms such as 1) the spread of behaviors through tightly-knit networks; 2) the ability of socially connected adults within a community to use social control to maintain norms and social order, such as intervening when they witness deviant behavior by others; 3) and the ability of the community to mobilize for collective action, usually a result of when residents are connected to each other through civic and voluntary associations (termed collective efficacy) (Kawachi & Berkman, 2014). Since the presence of social capital at the community-level is highly dependent on the presence of cohesive bonds among community members, it is often measured through social cohesion, defined as feelings of connectedness and solidarity and civic engagement among community members; communities with high levels of social cohesion are characterized by closely-knit social relationships among residents, where people are willing to intervene for the common good (Inoue et al., 2013). Social cohesion measures often tap into two domains: 1) cognitive aspects of social capital, including people's perceptions of trust, reciprocity, and support, and 2) structural aspects of social capital, referring to informal or formal structures or activities through which network members can develop social ties (i.e., civic or volunteer associations, clubs, or other associational activities) (Moore & Kawachi, 2017).

The literature examining neighborhood social capital and health among Black populations is quite mixed (Rodgers et al., 2019). Most studies use self-reported, subjective measures of social cohesion as indicators of close-knit communities in which members are willing to help each other. Previous research in the Jackson Heart Study (JHS) – which includes a large population of Black participants – examining neighborhood social environment have found perception of neighborhood social cohesion to be associated with a lower odds of smoking, but not with CVD risk; however, they have found stronger associations between neighborhood disadvantage and cumulative biological risk for individuals living in neighborhoods with low social cohesion, though this result was found only among men and not among women (Barber, Hickson, Kawachi, et al., 2016; Barber, Hickson, Wang, et al., 2016; Wang et al., 2017). Research in the Multi-Ethnic Study of Atherosclerosis (MESA) have found mixed results with social cohesion and hypertension (Kaiser et al., 2016). Two studies in the Atlanta metropolitan area have found neighborhood social cohesion and activities with neighbors were associated with ideal cardiovascular health, mainly in terms of diet, exercise and BMI, and particularly among Black women (Islam et al., 2022) and social cohesion was associated with lower levels of interleukin-6, an inflammatory biomarker indicative of CVD risk, again with associations particularly strong among Black women (Neergheen et al., 2019).

Even beyond studies among Black populations, studies examining social capital and cardiovascular health tend to be mixed (Rodgers et al., 2019). A glaring potential reason for differences in findings across studies is the use of different measures of social capital across studies. For instance, among studies examining social capital and cardiovascular diseases, measures of social capital used include the Putnam Social Capital Index, voting participation, social and organized participation, trust, networks, and election participation (Rodgers et al., 2019). Another important consideration for differences in findings across studies is that social capital can have negative effects on communities. At its best, social capital can improve physical health by spreading information and norms that promote positive health behaviors, such as access to and utilization of health services, and providing economic resources and psychological support. However, negative health behaviors can also spread through communities, and there may be restrictions on individual freedoms of group members as a result of social control that can have negative psychological consequences. It is also important to consider bonding and bridging types of social capital when interpreting the effects of social capital. Bonding social capital refers to resources accessed within networks or groups in which the members share similar characteristics such as race/ethnicity or class; bridging social capital refers to resources accessed across such networks. Some theory and research suggests that among disadvantaged communities, strong bonds may develop between members (i.e., sense of belonging, trust) but resources within those networks may be limited; members seeking support from one another may result in excessive financial or psychological strain on group members. Bridging social capital allows residents to access resources outside those gained from their bonding social capital, such as through non-profit organizations, which may be important for connecting to health promoting resources (Kawachi & Berkman, 2014). Still, the World Health Organization in their Health 2020 European policy for health identified social capital as a protective and promoting factor (World Health Organization & Regional Office for Europe, 2013).

Psychosocial Resources in Ethnic Enclaves: Strong, positive racial identity

The difference in effects of ethnic density between Black and non-Black minority populations is likely a function of different segregation processes between these groups. Decades of research has documented that Black Americans have been constrained into segregated spaces characterized by area-level deprivation as a result of centuries of racist practices and policies (Williams & Collins, 2001). Non-Black racial and ethnic minorities and immigrants, on the other hand, have been found to be more likely to strategically self-segregate to be within community among those with whom they share ethnic identity and cultural norms, facilitating the creation of close-knit communities characterized by social support and capital, and insulated from the discrimination associated with interracial contact, which are factors highlighted as resources promoting health in ethnic enclaves (T.-C. Yang et al., 2017). Members of ethnic enclaves are often the least acculturated to American society, ethnic enclaves allowing maintenance of cultural identity and practices through providing a community with familiar cultural resources, norms and language (spoken and written), eliminating potential language, social, and cultural barriers to working and residing in the majority community (Osypuk et al., 2009). Racial/ethnic identity, or sense of collective identity based on sharing cultural and racial/ethnic heritage (Demo & Hughes, 1990), may therefore be an important aspect of the creation and protectiveness of ethnic enclaves.

Among Black populations, strong racial identity has been posited to be a psychosocial resource, contributing to a sense of closeness and attachment to Black populations which promotes meaningful roles and purpose in families and communities, and allows healthy psychological adjustment despite the stressors associated with being Black in the US (Ida & Christie-Mizell, 2012). While studies of racial identity were born out of observations that Black Americans may internalize the racist sentiments of larger society and have negative feelings about their racial identity and group (i.e., Black children choosing White dolls instead of Black dolls) (Neblett et al., 2004), much of the research examining racial identity has demonstrated the buffering effects of more positive racial identity against the adverse effects of stress related to perceived prejudice and discrimination on mental health outcomes (Neblett et al., 2004). For instance, studies have found that Black Americans who hold their race more central to their identity, and feel more belonging and positive feelings toward other Black people, are more likely to attribute unfair treatment to racial discrimination (Sellers & Shelton, 2003); however, due to positive feelings about their racial identity and their racial group, and racial discrimination being consistent with their world view and expectations, are better equipped to cope with experiences of discrimination (Neblett et al., 2004; Sellers & Shelton, 2003). Thus, studies have found that positive racial identity among Black populations is directly associated with better mental health outcomes, including better psychological well-being and less depression, and buffers effects of adverse psychosocial exposures, such as discrimination, on mental health outcomes (Caldwell et al., 2002; Huguley et al., 2019; Ida & Christie-Mizell, 2012; Neblett et al., 2004). Few studies have examined racial identity in Black populations with physical health outcomes. Yet, there is some evidence that dimensions of racial identity are associated with more self-reported heart disease, though findings are mixed (Christie-Mizell et al., 2010; Dagadu & Christie-Mizell, 2014). Other studies have found that dimensions of racial identity moderated associations between discrimination and autonomic responses (Neblett & Roberts, 2013) and allostatic load (Thomas Tobin et al., 2021) among Black adults, such that effects of discrimination could be either buffered or enhanced by aspects of strong racial identity.

Ambulatory Blood Pressure: A gold standard measure of hypertension

Hypertension is a major risk factor for CVD, with Black Americans among those having the highest prevalence of hypertension in the world, and racial disparities in hypertension prevalence are greater among women compared to men (Benjamin et al., 2019). Most studies measure blood pressure with measures taken during study or clinic visits, which has conventionally been used for diagnosis of hypertension. Ambulatory blood pressure (ABP) monitoring takes several BP readings throughout the day and night for thorough description and quantification of BP outcomes, including daytime and nighttime systolic BP (SBP) and diastolic BP (SBP) (O'Brien et al., 2013). ABP is considered the gold standard method for diagnosis of hypertension, and is more predictive of poor CVD outcomes and mortality than clinic BP alone (W.-Y. Yang et al., 2019), particularly among women (Boggia et al., 2011).

Research Motivation

Motivating this dissertation are concerning trends in cardiovascular disease (CVD) development, prevalence, and mortality among young and middle-aged Black women (Kalinowski et al., 2019). As the number of counties in which White men have had faster rates of decline in CVD mortality than Black women have doubled since 1988 (Vaughan et al., 2019), it is important to examine factors which contribute to adverse outcomes and slow decline in this understudied population, as well as protective factors and those which may buffer the effects of adverse exposures. In this dissertation, we examine beyond residential segregation hypotheses commonly underlying research in Black populations and neighborhoods, which investigate the adverse health effects associated with segregated residential spaces among Black populations. We integrate a “spatial polygamy” framework which has been relatively understudied in segregation research (Wong & Shaw, 2011), including the context of spaces where individuals spend most of their time do their daily routines (Tamura et al., 2018). Additionally, we investigated the potential for protective and buffering effects of psychosocial resources associated with living in racially/ethnically-dense minority communities – an examination of the racial/ethnic density hypothesis which posits the presence of health-promoting resources related to sense of community and belongingness which may be enhanced in minority communities (Bécares et al., 2012). Examinations of such neighborhood- and individual-level resilience factors are relatively understudied in racially/ethnically dense, or segregated, Black communities. We estimate effects of these exposures on ambulatory blood pressure (ABP) outcomes, a gold standard measure of blood pressure which allows 48-hour assessment of blood pressure (BP) throughout the day, elevated blood pressure being a major risk factor for CVD that is important to investigate in this population.

Specific Aims

Aim 1. Estimate associations between residential racial composition, and separately activity space racial composition, and ABP in Black women.

Hypothesis: Higher % Black residential and activity spaces will be associated with worse ABP outcomes.

Aim 2. Estimate associations between neighborhood social environment, including social cohesion and activities with neighbors, and ABP in Black women; further investigate whether neighborhood social environment moderate associations between residential/activity space racial composition and CVD risk in Black women.

Hypotheses: (a) Higher neighborhood social cohesion and more activities with neighbors will be associated with better ABP outcomes. (b) Neighborhood social cohesion and activities with neighbors will moderate the effects of both residential and activity space racial composition on ABP outcomes.

Aim 3. Estimate associations between dimensions of racial identity and ABP outcomes in Black women; further investigate whether dimensions of racial identity moderate associations between residential/activity space racial composition and ABP outcomes in Black women.

Hypotheses: (a) Stronger, positive racial identity dimensions will be associated with better ABP outcomes. (b) Racial identity dimensions will moderate the effects of both residential and activity space racial composition on CVD risk.

Chapter 2. Residential and activity space racial composition and ambulatory blood pressure among young and middle-aged Black women in the Southeast US

Introduction

Racial disparities in cardiovascular disease (CVD) outcomes have persisted and widened over time (G. K. Singh et al., 2015), with recent studies highlighting concerning trends among young to middle-aged Black women (Kalinowski et al., 2019). Despite declines in CVD mortality among all race-gender groups since the 1960s and 1970s, declines have been slower among Black women compared to White women (Cooper et al., 2000), particularly among Black women 35 to 54 years old (Smilowitz et al., 2016). Within this age group, Black women have higher CVD mortality risk compared not only to White women, but also Black and White men (Smilowitz et al., 2016). Among those 35-44 years old, Black women have higher prevalence of CVD than Black men and White women and men (Jolly et al., 2010). However, research focusing on factors driving cardiovascular risk among young Black women is limited.

Additionally, among the population 35-44 years old, counties in which Black women have higher heart disease mortality than White men and women have almost doubled since the 1970s, with nearly half of counties in the US exhibiting this disparity (Vaughan et al., 2019). Evidence of young to middle-aged Black women experiencing worse cardiovascular health than men contradicts theories of greater biological protection for women relative to men against CVD, which is thought to be strongest at younger age (Pérez-López et al., 2010; Villablanca et al., 2010). These findings suggest the importance of exogenous factors, including social and environmental context in many counties, in overriding biological protectiveness against CVD among young to middle-aged Black women (Vaughan et al., 2019, p.). The increasing number of counties with Black women experiencing greater heart disease mortality than White men is driven by faster rates of decline in mortality rates among White men compared to Black women. Such population-level differences in rates of decline indicate the need to examine more upstream, population-level exposures which would explain inequitable access to health-promoting advancements and resources by race and place (Javed et al., 2022; Kramer et al., 2017).

Persistent and growing disparities in CVD by race and place reflect the consequences of persistent inequalities in social and environmental conditions by race and place related to a history of structural racism in the US, including residential segregation (Javed et al., 2022). Past and present processes (i.e., redlining) which have resulted in the systematic separation of racial groups by place have also resulted in the differential distribution of and exposure to health-relevant resources by race and place (Kershaw et al., 2015). Studies today show that for Black populations, living in majority Black neighborhoods is typically associated with worse health outcomes; in terms of CVD specifically, segregation has been found to be associated with greater risk for obesity, hypertension, and diabetes, as well as increased mortality from heart disease and stroke, beyond the effects of socioeconomic and traditional CVD risk factors (Kershaw & Albrecht, 2015). Black women may be particularly susceptible to the effects of residential segregation as studies have also found associations between segregation and CVD risk and outcomes among Black women where they have not found them among Black men (Barber, Hickson, Wang, et al., 2016; Kershaw et al., 2013).

Mechanisms relating residential segregation with health outcomes include differential investment and placement of services, such as access to healthy physical environments (i.e., food, walkability, green space) and preventive healthcare, educational and economic opportunity, social disorganization, concentrated poverty, and stress from exposure to psychosocial risk factors such as violence and discrimination (Greer et al., 2014; Williams & Collins, 2001). Underlying the residential segregation hypotheses is the conceptualization of residential neighborhoods as capturing a wide variety of the contextual areas, resources and exposures residents have access to, including locations where they engage in routine activities and interactions (Pinchak et al., 2021). However, recent studies highlight the concept of “spatial polygamy,” recognizing that individuals are generally mobile and exposed to multiple locations throughout their daily lives, with few routine activities (i.e., work, shopping, socializing) and little time spent within the boundaries of their neighborhood census tract (Pinchak et al., 2021; Tamura et al., 2018). Focusing on residential space in studies of segregation and health may only offer a partial, or even biased, assessment of the contextual spaces in which individuals spend time, potentially misclassifying their spatial exposures and the level of segregation an individual may experience (Wong & Shaw, 2011). A focus on residential neighborhoods assumes all residents within a neighborhood are exposed to the same level of segregation and same contextual environment, ignoring the variation in mobility and spatial exposures among individuals living in the same neighborhood (Wong & Shaw, 2011). Studies of segregation and health can provide a more holistic, comprehensive assessment of socio-geographical exposures and health related to race by considering activity spaces beyond the residential neighborhood.

Therefore, the current study seeks to further investigate the role of racial segregation on CVD health by examining associations between residential versus activity space segregation and ambulatory blood pressure (ABP) among young to middle-aged Black women. Hypertension is a major risk factor for CVD, with Black Americans among those having the highest prevalence of hypertension in the world, and racial disparities in hypertension prevalence are greater among women compared to men (Benjamin et al., 2019). While recent studies have demonstrated associations between residential segregation and hypertension (Gao et al., 2022; Kershaw et al., 2017a; Usher et al., 2018), these studies use blood pressure (BP) taken at study or clinic visits. ABP, on the other hand, takes several BP readings throughout the day and night for thorough description and quantification of BP outcomes, including daytime and nighttime systolic BP (SBP) and diastolic BP (SBP) (O'Brien et al., 2013). ABP is considered the gold standard method for diagnosis of hypertension, and is more predictive of poor CVD outcomes and mortality than clinic BP alone (W.-Y. Yang et al., 2019), particularly among women (Boggia et al., 2011). However, to our knowledge there are no studies which examine associations between residential or activity space segregation and ABP. Integrating spatial polygamy theory may be particularly insightful for studies of place and ABP as ABP outcomes may be reactive to environmental stimuli, daytime outcomes perhaps more related to spaces occupied during the day and nighttime outcomes perhaps more related to spaces occupied during the night. We hypothesize that residential and activity space segregation, individually and combined, will be associated with higher BP and greater risk for hypertension, and more specifically that activity space segregation will have more adverse effects on daytime BP (as individuals are more likely to occupy activity spaces during the day) and residential segregation will have more adverse effects on nighttime BP (as individuals are more likely to be home at night).

Methods

Study participants

Participants in the current analysis were from the Mechanisms Underlying the impact of Stress and Emotions on African-American Women's Health Study (MUSE). This cohort was made up of 422 self-identified Black/African-American women between 30-46 years old in the southeast US. The overarching goal of the MUSE study was to investigate the extent to which social and psychosocial exposures influence cardiovascular disease risk. The present study used baseline data from this cohort, collected from December 2016 to March 2018.

Consumer residential and voter registration lists were utilized to identify potential African-American women in the desired age range (30-45 years of age), selected for geographic variability in the Atlanta, Georgia metropolitan area (1-2 participants per census tract) and representing a wide range of socioeconomic backgrounds. Potential participants were then sent a flyer introducing the study, followed by a phone call. Inclusion criteria were self-identifying as a Black/African-American woman, being between 30-45 years old at the time of screening, and premenopausal with at least one ovary. Exclusion criteria included a history of clinical cardiovascular disease, being pregnant or lactating, any chronic illness known to influence atherosclerosis (e.g., HIV/AIDS, autoimmune or chronic inflammatory diseases such as lupus/rheumatoid arthritis, renal disease, liver disease), current treatment for psychiatric disorders, current illicit drug use (i.e., marijuana, cocaine), or alcohol abuse. Women who reported working overnight shifts were also excluded because of the known impact of shift-work on alterations in circadian rhythms which affect BP patterns.

Based on these inclusion and exclusion criteria, 831 individuals were eligible to participate in the study. Study staff contacted eligible participants and scheduled an in-person visit. A total of 422 eligible respondents, representing 201 unique census tracts, completed the in-person interview. All interviews were conducted in English by interviewers who identified as Black/African-American women. Of the 422 participants in the MUSE study, participants missing residential and activity space measures (n=8), outcomes (n=8), and covariates of interest in this study (n=7) were excluded, resulting in a remaining analytic sample of 399 participants.

Measures

Outcomes: Ambulatory Blood Pressure

ABP monitors (OnTrak model 90227; Spacelabs Healthcare) were used to obtain ABP readings over a 48-hour period. Participants were trained on proper application and removal techniques and instructed to remove the device only to shower or bathe. ABP monitoring was programmed to record systolic BP (SBP) and diastolic BP (DBP) every 30 minutes during the day (8 am to 10 pm) and every hour during the night. Upon completion, the ABP monitoring device was returned to study staff. Readings were downloaded with Sentinel Software, version 10.5, from Spacelabs Healthcare.

Forty-eight-hour ABP completion rates ranged from 9% to 150% (some participants wore the ABP cuff for a few hours into the next day), with 88% of women achieving a completion rate of at least 80%. From these readings we were able to create continuous outcomes as well as categorize continuous measurements into hypertension phenotypes. Continuous outcomes included the mean of all SBP and DBP outcomes for daytime and nighttime, resulting in four continuous outcomes: daytime SBP, nighttime SBP, daytime DBP, and nighttime DBP. Continuous daytime and nighttime BPs were categorized as daytime hypertension (daytime SBP ≥130 mmHg or daytime DBP ≥80 mmHg) and nighttime hypertension (nighttime SBP ≥110 mmHg or nighttime DBP ≥65 mmHg) based on suggested ABP cutpoints for women (Hermida et al., 2015).

Exposures: Residential and activity space segregation

Residential addresses were collected via self-report at baseline visit. Addresses were cleaned and geocoded in R, v4.1.1 (R Core Team, 2021). Of the 422 baseline addresses, less than 2% (n=8) of addresses were not geocoded – seven P.O. boxes and one address missing sufficient information to geocode.

Activity space locations were collected via a self-report questionnaire developed by Shareck and colleagues (Shareck et al., 2013), modified for use in this cohort (child school/daycare and leisure locations were added). This questionnaire allowed participants to report 0 to 10 activity space locations, including locations for studies (limited to one location), work (up to two locations), grocery shopping (up to two locations), physical activity (limited to one location), child school/daycare (limited to one location), child leisure activities (limited to one location), and other places they frequent (up to two locations). Participants were also able to report the amount of time (number of hours) spent at each activity space location in a typical week (for grocery shopping locations participants reported the number of times they went to this location in a typical week, assuming each visit was approximately equivalent to an hour). This questionnaire has demonstrated high convergent validity with activity space measures collected via global positioning system (GPS) tracking and prompted recall surveys (Shareck et al., 2013). Activity space addresses were cleaned and geocoded following the same procedures as residential addresses. Of the 1,771 activity space locations reported, 2.2% (n=39) were not geocoded for lack of sufficient address information to geocode.

Census tracts were used as proxies for neighborhood for residential and each activity space location. Using data from the US Census and 2018 5-year American Community Survey (ACS), segregation was defined as the percentage of Black residents in the census tract, or the racial composition of the census tract. Racial composition is a local corollary of the isolation index which is a weighted average of local racial compositions, describing in this case the extent to which the Black population is isolated from or exposed to other racial groups. Racial composition has been considered a crude measure of segregation (more specifically a measure of racial diversity) in that it does not fit the standard definition proposed by Massey and Denton which considers the spatial distribution of minority group members within the larger area (i.e., metropolitan statistical area [MSA], five-counties, city) (Kershaw & Albrecht, 2015; Massey & Denton, 1988). However, in this study, all participants were from the Atlanta metropolitan area and 99% of residential and 97-100% of activity space locations are within the same MSA (Atlanta – Sandy Springs – Alpharetta MSA). Therefore, the larger area often included in more explicit measures of segregation can be considered approximately uniform among all census tracts included in the study. For this reason, we considered the racial composition of census tracts an appropriate proxy of segregation in this study.

Each participant was assigned a residential, activity space, and combined residential and activity space segregation level, the three main exposures in this study, based on their residential and activity space information. For each participant, residential segregation was defined as the racial composition of the residential census tracts. Activity space segregation was defined as the time-weighted racial composition for each of the activity space location participants reported. The formula below depicts the calculation for this measure, where t_l represents the time spent at an activity space location and RC_l represents the racial composition of an activity space location. The summed product of the time spent at each location and the racial composition of each location was used to represent the overall activity space racial composition.

$$RC = \sum_{l} t_l \times RC_l$$

A combined residential and activity space segregation measure was defined as the median racial composition value of all residential and activity space locations.

Individual-Level Covariates

Covariates known to be associated with residential segregation and blood pressure as potential confounders or mediators were adjusted for in the analyses to isolate the effects of residential and activity space segregation on ABP outcomes. Individual-level sociodemographic information included self-reported age, educational attainment, employment status, partner status, income, and family size. Educational attainment was assessed as years of education and categorized in analyses as high school or less, some college, and college or more. Employment status was categorized as full-time, part-time, or unemployed, and partner status dichotomized as married/living with a partner or not. Household income was assessed with the following categories: <$35K, $35-<$50K, $50-<$75K, ≥$75K. Family size was included to contextualize household income, and was reported as the number of people currently living in the participant's household, including the participant.

Traditional CVD risk factors included body mass index (BMI) calculated as measured weight divided by the square of measured height (kg/m2), current smoking status (dichotomized: current smoker or not), antihypertensive medication use in the past 12 months, and minutes of intentional exercise each week (Bertoni et al., 2008). Severity of depression symptoms was self-reported using the Beck Depression Inventory (BDI), a 21-item, validated inventory widely used across populations (Beck, 1961).

Statistical Analyses

Choropleth maps depict the spatial distribution of participants by census tract in the Atlanta metropolitan area, and the racial composition of these census tracts. Descriptive statistics for the analytic sample were calculated by both high/low residential segregation and high/low activity space segregation (median cut-points were used to dichotomize high/low categories). The percentage of each activity location in the same census tract as residential locations was also calculated and presented in descriptive statistics.

We fit linear regression models to examine associations between residential and activity space segregation measures with continuous ABP measures (daytime SBP, daytime DBP, nighttime SBP, nighttime DBP). For each set of analyses, Model 1 was unadjusted. Model 2 was adjusted for age, Model 3 was further adjusted for sociodemographic factors (educational attainment, employment status, partner status, income, and family size), Model 4 was further adjusted for anti-hypertensive medication use, Model 5 was further adjusted for other traditional CVD risk factors (BMI, current smoking status, intentional exercise), and Model 6 was further adjusted for depression symptom severity.

In a separate series of models using the same sequence as above, we examined associations between residential and activity space segregation measures and dichotomous daytime and nighttime hypertension. As daytime and nighttime hypertension are highly prevalent in this cohort, odds ratios would overestimate the relative risk associated with our exposures due to violation of the rare event rate assumption (Zou, 2004). Therefore, we calculate prevalence ratios for dichotomous outcomes for better approximation of risk. In order to address convergence issues with using log-binomial models to calculate prevalence ratios, we use a modified Poisson approach using a Poisson distribution and a log link in generalized estimating equations for robust variance estimation (Yelland et al., 2011; Zou, 2004).

For each set of analyses, we conducted sensitivity analyses in which we excluded participants taking antihypertensive medications to examine how sensitive our results are to removing those with potentially controlled hypertension, as hypertension is the outcome of interest in this study. All analyses were conducted in R (R Core Team, 2021).

Results

Characteristics of sample

Choropleth maps depicting the spatial distribution of participants by census tract in the Atlanta metropolitan area, including the number of participants per census tract (Figure 1) and the racial composition of these census tracts (Figure 2) were developed. Participants in the analytic sample represented 199 census tracts mostly located in Fulton, DeKalb, and Clayton counties, more central to the metropolitan area, with over two-thirds of census tracts containing one or two participants and 41 census tracts containing three or more participants. Census tracts that the participants resided in also tended to have a higher proportion of Black residents.

Activity space locations overall tended to be more integrated than residential locations, residential spaces on average being 73% Black compared to the composite activity space on average being 61% Black. Table 1 shows descriptive characteristics of the analytic sample by high and low residential segregation groups. On average, across high/low residential and activity space segregation groups, participants were approximately the same age (≈38 years old), had similar family size (≈3 people in the household), and depression symptom severity (≈6 out of 21). Those in more segregated residential tracts were less likely to be married or living with a partner (High Segregation: 28%, Low Segregation: 46%), less likely to have a college degree (High Segregation: 38%, Low Segregation: 57%), less likely to be full-time employed (High Segregation: 59%, Low Segregation: 70%), or have an income >75K (High Segregation: 22%, Low Segregation: 39%). Those in more segregated residential tracts were more likely to have used antihypertensive medication in the past 12 months (High Segregation: 18%, Low Segregation: 15%), be current smokers (High Segregation: 15%, Low Segregation: 5%), and though those in more highly segregated residential tracts engaged in approximately 5 more minutes of intentional exercise each week compared to those in less segregated residential tracts, they had a slightly higher average BMI (High Segregation: 33.2, Low Segregation: 32.1).

As shown in Table 2, high/low activity space segregation patterns were similar to those seen for residential segregation, though differences were less pronounced, particularly for differences in those married/partnered (High Segregation: 39%, Low Segregation: 35%), having a college degree (High Segregation: 44%, Low Segregation: 52%), having income >75K (High Segregation: 28%, Low Segregation: 34%), current smokers (High Segregation: 11%, Low Segregation: 10%), average BMI (High Segregation: 32.9, Low Segregation: 32.3), and minutes of intentional exercise each week (High Segregation: 50.0, Low Segregation: 47.4). Those in more segregated residential spaces also had more segregated activity spaces overall (High Segregation: 62% Black, Low Segregation: 47% Black), and those in more segregated activity space also lived in more segregated residential space (High Segregation: 80% Black, Low Segregation: 67% Black).

In terms of ABP outcomes, daytime and nighttime average SBP and DBP measures were slightly higher among those in more segregated spaces, however these differences were less pronounced in the activity versus residential spaces. There were more pronounced differences across segregation levels for dichotomous ABP outcomes, approximately 39-40% of participants in more highly segregated residential and activity spaces having daytime hypertension compared to 33% in less segregated spaces, and 67-68% of participants in more highly segregated spaces having nighttime hypertension compared to 63-64% in less segregated spaces.

The number (and percentage) of each activity space location also located in residential tracts are provided in the Supplement (Supplement Table 1). Briefly, very few activity space locations were in the same census tracts as residential locations. Less than 5% of studies, work, physical activity, child leisure activity, and other places participants spent time occurred in residential census tracts. Grocery shopping (High Segregation: 8%, Low Segregation: 16%) and child's school/daycare locations (High Segregation: 11%, Low Segregation: 15%) were more likely to be in residential tracts, those in less segregated residential tracts more likely to do these activities in their census tracts.

Analytic results

Table 3 shows results for associations between residential and activity space segregation and average daytime SBP and DBP. We model a 20% increase in the proportion of Black residents in residential and activity spaces, which was approximately a standard deviation increase. After adjusting for sociodemographic and traditional CVD risk factors, including depression symptom severity (Model 6), a 20% increase in the proportion of Black residents in residential tracts was associated with a 0.48 mmHg (Confidence Interval [CI]: -1.54, 0.57) lower daytime SBP and a 0.33 mmHg (CI: -1.10, 0.45) lower daytime DBP. On the other hand, a 20% increase in the proportion of Black residents in activity space tracts was associated with a 0.40 mmHg (CI: -0.51, 1.31) higher daytime SBP and 0.25 mmHg (CI: -0.42, 0.92) higher daytime DBP. When we combine residential and activity space locations, a 20% increase in the proportion of Black residents across residential and activity space locations was associated with a 0.58 mmHg (CI: -0.38, 1.52) higher daytime SBP and a 0.26 mmHg (CI: -0.44, 0.97) higher daytime DBP. Effect sizes were overall larger for associations with daytime SBP than DBP.

Table 4 shows results for associations between residential and activity space segregation and average nighttime SBP and DBP. In Model 6, we see that a 20% increase in the proportion of Black residents in residential tracts was associated with a 0.21 mmHg (CI: -1.19, 0.76) lower nighttime SBP, but a 0.15 mmHg (CI: -0.58, 0.89) higher nighttime DBP. A 20% increase in the proportion of Black residents in activity space tracts was associated with a 0.33 mmHg (CI: -0.52, 1.18) lower nighttime SBP and 0.40

mmHg (CI: -0.24, 1.04) higher nighttime DBP, and when we combine residential and activity space a 20% increase in the proportion of Black residents across these spaces was associated with a 0.39 mmHg (CI: -0.50, 1.27) and 0.34 mmHg (CI: -0.33, 1.01) higher nighttime SBP and DBP, respectively. Unlike for daytime, effect sizes were similar for nighttime SBP and DBP associations.

Table 5 shows prevalence ratios for associations between residential and activity space segregation and dichotomous daytime and nighttime hypertension categories. In Model 6, a 20% increase in the proportion of Black residents in residential tracts was associated with 2% higher risk (PR: 1.02 [CI: 0.90, 1.15]) of having daytime hypertension as well as nighttime hypertension (PR: 1.02 [CI: 0.95, 1.09]). However, a 20% increase in the proportion of Black residents in activity space tracts was associated with a 12% higher risk (PR: 1.12 [1.01, 1.24]) of having daytime hypertension, and when we add residential space there was a 13% increased risk (PR: 1.13 [CI:1.02, 1.26]) of having daytime hypertension. On the other hand, a 20% increase in the proportion of Black residents in activity space tracts or combined residential and activity space tracts was associated with a 3% higher risk (activity space – PR: 1.03 [CI: 0.97, 1.09], residential and activity space – PR: 1.03 [CI: 0.97, 1.10]) for nighttime hypertension.

Sensitivity Analyses

Results for sensitivity analyses excluding participants taking antihypertensive medications in the past 12 months are included in the supplement (Supplement Tables 2-4). Effect sizes were in the same direction for all results when excluding those with potentially controlled hypertension. However, effect sizes were generally smaller for continuous outcomes (other than nighttime SBP) and larger for daytime hypertension results – a 20% increase in the proportion of Black residents in residential, activity space, and combined residential and activity spaces associated with 8% (PR: 1.08 [CI: 0.92, 1.28]), 14% (PR: 1.14 [CI: 1.00, 1.29]), and 18% (PR: 1.18 [CI: 1.02, 1.36]) higher risk for daytime hypertension, respectively.

Results for nighttime hypertension were comparable when including or excluding those taking antihypertensive medications.

Discussion

The current study sought to explore beyond a focus on residential space in studies of segregation and health, and compare results for residential and activity space segregation on ABP outcomes among young to middle-aged Black women. In our sample of Black women in the Atlanta metropolitan area, we found that women who occupied more highly segregated residential and activity spaces were also more likely to experience lower socioeconomic status in terms of education, employment, and household income (despite having a similar number of people within the household), and more likely to have worse cardiovascular risk in terms of current smoking status, BMI (despite more exercise), and having clinic hypertension as indicated by taking antihypertensive medications. In models adjusted for sociodemographic and traditional CVD risk factors including depression, we found that residential segregation tended to be associated with lower (or better) daytime SBP and DBP, and nighttime SBP, but higher (or worse) nighttime DBP, while activity space and combined residential and activity space segregation tended to be associated with higher daytime and nighttime SBP and DBP. However, confidence intervals (CIs) for all results with continuous outcomes contained values in the opposite direction of effect sizes. Also, effects sizes for continuous outcomes were small, no segregation measure associated with more than a 1 mmHg change in BP, which were likely not clinically meaningful changes (Guzman et al., 2014; Hess et al., 2016). Effects of residential segregation on daytime hypertension risk (mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg) were near null, but higher activity space segregation was associated with a 12% higher risk of daytime hypertension, which slightly increased to 13% after also including residential space with activity space. Effects of residential and/or activity space segregation on nighttime hypertension risk (mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg) were near null.

Unlike the current study, previous studies of segregation and hypertension (as well as other CVD-related outcomes) among Black populations have focused on residential space only and found the negative consequences of segregated residential space on hypertension (Kershaw & Albrecht, 2015). A 2011 study by Kershaw and colleagues, among the earliest to examine residential segregation and hypertension, found greater racial disparities in hypertension in more segregated neighborhoods (Kershaw et al., 2011). A recent 2022 study by Gao and colleagues found that Black residents living in more segregated neighborhoods were more likely to develop incident hypertension (Gao et al., 2022). Results for our sample may differ in that we focus on Black women, and specifically young to middle-aged Black women in the southeast US. The Kershaw and Goa studies include participants from multiple areas in the US, do not examine differences by gender, and the average age of participants in their cohorts are 10 to 20 years older than in our cohort. Another smaller area study of residential segregation among US- and foreign-born Black populations in New York City found no association between residential segregation and hypertension among US-born Black populations (White et al., 2011). Not only was the composition of our sample different from those finding effects of residential segregation, but our measures of hypertension were novel in this research area. This was the first study to examine residential segregation and hypertension that does not use clinic BP (average of BP measures taken in a clinic visit). Instead, we use outcomes from 48-hour ABP monitoring, which allowed us to take the average of several measures of BP throughout the day to more thoroughly measure BP and define daytime and nighttime hypertension status. Clinic hypertension only offers a momentary assessment of BP which may not reflect BP outside of the clinic, may not specifically describe an individual's BP and hypertension patterns, and may not be as predictive of CVD risk as ABP outcomes (O'Brien et al., 2013).

However, we did find that when we more specifically capture the locations where Black women do their routine activities, the composite segregation level of these activity spaces, weighted by time, is associated with risk for daytime hypertension. And this association becomes stronger when we include residential space to holistically capture the variety of spaces to which individuals are exposed, particularly in analyses excluding participants taking antihypertensive medications. Underlying the residential segregation hypothesis is that residential spaces contain the social and environmental contexts residents are exposed to and interact with, including a wide variety of their routine activity locations. However, in this sample, very few activities took place in residential census tracts, and even fewer for those in more segregated residential tracts (High Segregation: 0-10% of activity locations; Low Segregation: 0-16%). The potential for this discrepancy between residential and activity locations has been described before (Pinchak et al., 2021; Tan et al., 2020), prompting studies to begin expanding examinations of built environment (Tamura et al., 2018) and segregation (Wong & Shaw, 2011) to consider self-reported and GPS-tracked activity locations, yet few studies have examined health outcomes and no studies have examined activity space segregation levels and hypertension. In this study, we found that activity space locations are overall more integrated than residential locations, as described in previous studies (Wong & Shaw, 2011), indicating that those in more segregated residential spaces tend to do their activities in more integrated spaces, but the context of these activity locations may have more of an impact on daytime hypertension. It is likely that people spend more of their daytime hours in activity space locations, particularly in this cohort that excluded shift workers, and our results may be reflecting daytime BP levels reacting to social and environmental stimuli associated with the context of daytime activity space locations (O'Brien et al., 2013). Integrating activity space locations may more accurately describe the context of the food, grocery, and physical activity environments participants are actually exposed to and have shown implications for CVD risk factors (Drewnowski et al., 2020; Javed et al., 2022), overcoming the "residential trap" of restricting information on exposures to residential spaces (Tamura et al., 2018). Incorporating activity spaces also allows for more thorough description of the variability in levels of segregation individuals within the same residential areas are exposed to, which may be particularly informative in smaller area studies.

There are important limitations to this study which should be noted. This was a cross-sectional study, and therefore we cannot make assumptions on temporality or causality in the associations between segregation and BP. It could be that those with worse BP from other causes are more likely to move into more segregated residential spaces and do their activities in more segregated areas. Relatedly, there are likely earlier life-course experiences of social and environmental inequalities that are not captured in this study that have accumulated and partially explain worse BP outcomes among those in more segregated spaces in this study. A recent study by Reddy and colleagues found that subclinical risk for CVD was associated with living in more segregated spaces in young adulthood regardless of the type of neighborhood they lived in later in life, indicating that the accumulation of the effects of segregated space on health outcomes begins earlier in life (Reddy et al., 2022). Another limitation of this study was using census tracts as proxies for neighborhoods, which may not accurately capture the boundaries of space an individual was exposed to or perceived as their neighborhood (Pinchak et al., 2021). However, census tract boundaries are drawn to capture relatively homogenous populations in terms of economic status and living conditions, and are also used by government agencies to determine resource allocation, making this a policy relevant area measure for studies of place and health (Krieger et al., 2005). Additionally, as described in the methods, racial composition is often considered a poor proxy of residential segregation in that it does not capture the racial context of the larger area (i.e., a census tract that is 50% Black in an MSA that is 70% Black is not comparable in segregation level to a census tract that is 50% Black in an MSA that is 5% Black). However, in this study, nearly all residential and activity space locations are in the same MSA. Finally, we have a relatively small analytic sample size in this study, and may not have the power to detect effects.

There were also important strengths to this study. This study focuses on young to middle-aged Black women, a population with concerning recent trends in CVD outcomes and mortality that has resulted in a call to action to explore factors related to CVD risk in this understudied population (Kalinowski et al., 2019). Moreover, this study focuses on Black women in the southeast US, where low cardiovascular health tends to cluster (Zheng et al., 2021). While results of this study may not be generalizable to young to middle-aged Black women in other areas, it is also important for research to focus on relevant factors in the context of the southeast US. Additionally, we capture much more information about spatial exposures and BP outcomes by going beyond the residential area and clinic BP to examine the complexity and heterogeneity of spatial exposures and daytime and nighttime BP reactivity.

Conclusions

In this study of young to middle-aged Black women in the southeast US, we found that activity space segregation, alone and incorporating residential space, was associated with risk for daytime hypertension as measured via 48-hour ABP monitoring. Residential segregation alone was not associated with ABP outcomes. While segregation and health studies have thus far focused on residential space, ignoring places where individuals conduct their activities may miss important, health-relevant socio-contextual information. While policy implications of the segregation literature have focused on residential space and housing (Javed et al., 2022), this study implies the importance of the context of non-home locations and improving employment opportunities across segregated spaces to reduce adverse effects on daytime hypertension. Future studies should continue to examine neighborhood and individual-level factors which promote resilience to the adverse effects of segregation on CVD risk.

Chapter 3. Spatial segregation, neighborhood social environment, and ambulatory blood pressure among young and middle-aged Black women in the Southeast US

Introduction

While cardiovascular disease remains the leading cause of death among men and women in the US, there have been substantial declines in CVD mortality rates in the last several decades (Benjamin et al., 2019). However, the benefits of the prevention and treatment advancements which led to these declines have not diffused equitably along racial and ethnic boundaries, as racial disparities in CVD outcomes and mortality have persisted and widened (G. K. Singh et al., 2015), and Black adults are more than twice as likely to die of CVD compared to White adults (Javed et al., 2022). Recent studies have highlighted young and middle-aged Black women as a particularly high-risk group for CVD outcomes and mortality (Jolly et al., 2010; Kalinowski et al., 2019; Smilowitz et al., 2016), evidenced in part by a doubling of US counties in which Black women have higher heart disease mortality than White men, specifically among the population 35-44 years old (Vaughan et al., 2019). This county-level shift has been driven by faster rates of decline in heart disease mortality among White men compared to Black women, overriding the relative biological protectiveness women have against CVD compared to men at younger age (Pérez-López et al., 2010; Villablanca et al., 2010). These findings of persistent and growing disparities reflect inequalities in social environments (G. K. Singh et al., 2015), including the social and environmental context in many counties (Vaughan et al., 2019), which must be studied to highlight factors adversely affecting CVD risk among young and middle-aged Black women, as well as highlight opportunities to ameliorate risk in this understudied population.

There have been calls to action – including Presidential Advisory from the American Heart Association – to examine factors related to the deeply entrenched history of structural racism in the US as the fundamental driver of racial disparities in CVD risk and outcomes (Churchwell et al., 2020; Havranek et al., 2015; Javed et al., 2022). Among the processes through which structural racism has created and reinforced differential socioeconomic and environmental conditions by race, and therefore differential health experiences and outcomes by race, is residential segregation. Racial residential segregation refers to the process of separating racial groups into disparate residential contexts, not only to protect White populations from exposure to Black populations, but to restrict Black populations to the least desirable areas, producing and maintaining the unequal distribution of socioeconomic and other health-relevant resources which has resulted in the unequal distribution of health outcomes by race that persist today (Williams & Collins, 2001). In studies of health outcomes, the residential segregation hypothesis posits that the social process of residential segregation has contributed to worse health outcomes among Black communities compared to White communities through several mechanisms, including: differential investment in and placement of services, such as access to healthy physical environments (i.e., food, walkability, green space, clean air) and preventive healthcare; differential access to socioeconomic resources, such as educational and economic opportunities and concentrated poverty; and differential exposure to psychosocial risk factors, such as perceived neighborhood disorder (i.e., noise, crowding, and trouble with neighbors), discrimination, and other general stressors (Collins & Williams, 1999; Greer et al., 2014; Kramer & Hogue, 2009; Williams & Collins, 2001; Woo et al., 2019). Several studies examining the residential segregation hypothesis have found residential segregation to be associated with worse CVD risk among Black communities, including greater risk for obesity, hypertension, and diabetes, as well as increased mortality from heart disease and stroke, beyond the effects of socioeconomic and traditional CVD risk factors (Kershaw & Albrecht, 2015).

While the racial residential segregation hypothesis asserts greater exposure to psychosocial risk factors and stress in concentrated minority communities which results in worse health outcomes among residents (Basile Ibrahim et al., 2021), an alternative hypothesis, known as the ethnic density hypothesis, highlights the potential availability of health-promoting psychosocial resources associated with living in concentrated minority communities (Bécares et al., 2012; Viruell-Fuentes et al., 2012). The ethnic density hypothesis proposes the presence of protective and buffering factors, including social cohesion/capital, social support, and sense of community and belongingness, which may be enhanced among minority populations when living in concentrated communities composed of those with whom they racially/ethnically identify (Bécares et al., 2009, 2012). Studies examining ethnic density have often investigated and found protective effects among Latino, Asian, and other non-Black minority and immigrant populations living in ethnic enclaves/communities in the US (Bécares et al., 2012; T.-C. Yang et al., 2017), despite the presence of material deprivation in many of these communities (Osypuk et al., 2009). However, studies examining ethnic density among US Black and African-American populations have predominantly found the detrimental effects of living in majority Black areas (Bécares et al., 2012), providing further evidence supporting the relevance of the residential segregation hypothesis (and anti-Black racism specifically). This difference in effects of ethnic density between Black and non-Black minority populations is likely related to documented differences in segregation processes between these groups: while Black Americans have been constrained into segregated spaces characterized by area-level deprivation as a result of centuries of racist processes and policies, non-Black racial and ethnic minorities and immigrants are more likely to strategically self-segregate as a means of building social and financial capital, close-knit social and community support, and protection from discriminatory experiences among community members with whom they share language, culture, and norms (T.-C. Yang et al., 2017). Though studies have found protective effects of ethnic density for mental health outcomes among Black communities, including depression and anxiety (Shaw et al., 2012), few studies have found these effects for physical health outcomes.

While the far reaching effects of structural racism and residential segregation may be overriding the potential positive effects of living in concentrated Black communities on physical health outcomes, select studies have found the potential for the positive buffering and moderating effects of psychosocial resources on CVD risk factors in concentrated Black neighborhoods (Leak-Johnson et al., 2021; R. Singh et al., 2021). Two recent studies found that better social environment, characterized as higher perceived aesthetic quality, safety, and social cohesion of neighborhoods, modified associations between historic and contemporary measures of segregation and CVD risk (Gao et al., 2022; Mujahid et al., 2021). Specifically, while Black residents living in historically redlined (more “hazardous”) areas had lower odds of ideal cardiovascular health, as social environment improved this association weakened (Mujahid et al., 2021); and while Black residents living in more segregated census tracts had a greater hazard of incident hypertension, as social environment improved this hazard decreased and was more comparable to associations found among Black residents living in less segregated census tracts (Gao et al., 2022). These recent studies point to protective and buffering effects of psychosocial resources in majority Black communities, and prompts further examination of the potential for the protective aspects of ethnic density to override the negative effects of residential segregation.

The current study seeks to examine aspects of the social environment, including neighborhood social cohesion and activities with neighbors, as psychosocial resources that might buffer the adverse associations between segregation and CVD risk, specifically elevated blood pressure (BP), in a cohort of young and middle-aged Black women. The primary outcome is BP, measured via ambulatory blood pressure (ABP). Elevated BP is a critically important outcome to examine in the current cohort because Black Americans have the highest prevalence of hypertension in the world, a major risk factor for poor CVD outcomes (Benjamin et al., 2019). While Gao and colleagues recently found negative associations between residential segregation and hypertension which were modified by neighborhood social environment (Gao et al., 2022), this study further informs these relationships by using novel measures of hypertension and segregation. Unlike conventional clinic blood pressure (BP) used to diagnose hypertension, ABP takes several BP readings throughout the day and night for thorough description and quantification of BP outcomes, including daytime and nighttime systolic BP (SBP) and diastolic BP (SBP), making it the gold standard for diagnosis of hypertension (O'Brien et al., 2013). Additionally, ABP is more predictive of cardiovascular events and mortality than clinic BP alone (W.-Y. Yang et al., 2019), particularly among women (Boggia et al., 2011).

Furthermore, in addition to examining moderation of residential segregation effects, our study integrates activity space locations into a holistic measure of segregation across spaces to which individuals are exposed and with which they interact. This approach acknowledges theory recognizing "spatial polygamy" in studies of place and health, or the concept that individuals spend little time and do few of their routine activities (i.e., work, shopping, socializing) and interactions within residential boundaries, and therefore the context of residential space alone may only offer a partial, or even biased, assessment of the context of spaces which have implications for health (Pinchak et al., 2021; Tamura et al., 2018; Wong & Shaw, 2011). We hypothesize that positive neighborhood social environment will have protective effects on daytime and nighttime BP outcomes, and will buffer adverse effects of residential and combined residential and activity space segregation on ABP outcomes.

Methods

Study participants

Participants in the current analysis were from the Mechanisms Underlying the impact of Stress and Emotions on African-American Women's Health Study (MUSE). This cohort was made up of 422 self-identified Black/African-American women between 30-46 years old in the southeast US. The overarching goal of the MUSE study was to investigate the extent to which social and psychosocial exposures influence cardiovascular disease risk. The present study used baseline data from this cohort, collected from December 2016 to March 2018.

Consumer residential and voter registration lists were utilized to identify Black women in the target age range (30-45 years of age), selected for geographic variability in the Atlanta, Georgia metropolitan area (1-2 participants per census tract) and representing a wide range of socioeconomic backgrounds. Potential participants were then sent a flyer introducing the study, followed by a phone call. Inclusion criteria were self-identifying as a Black/African-American woman, being between 30-45 years old at the time of screening, and premenopausal with at least one ovary. Exclusion criteria included a history of clinical cardiovascular disease, being pregnant or lactating, any chronic illness known to influence atherosclerosis (e.g., HIV/AIDS, autoimmune or chronic inflammatory diseases such as lupus/rheumatoid arthritis, renal disease, liver disease), current treatment for psychiatric disorders, current illicit drug use (i.e., marijuana, cocaine), or alcohol abuse. Women who reported working overnight shifts were also excluded because of the known impact of shift-work on alterations in circadian rhythms which affect BP patterns.

Based on these inclusion and exclusion criteria, 831 individuals were eligible to participate in the study. Study staff contacted eligible participants and scheduled an in-person visit. A total of 422 eligible respondents, representing 201 unique census tracts, completed the in-person interview. All interviews were conducted in English by interviewers who identified as Black/African-American women. For these analyses, participants missing measures of interest, including social cohesion and activities with neighbors measures (n=10), residential and activity space measures (n=8), outcomes (n=8), and covariates of interest in this study (n=7), were also excluded, resulting in a remaining analytic sample of 389 participants.

Measures

Outcomes: Ambulatory Blood Pressure

ABP monitors (OnTrak model 90227; Spacelabs Healthcare) were used to obtain ABP readings over a 48-hour period. Participants were trained on proper application and removal techniques and instructed to remove the device only to shower or bathe. ABP monitoring was programmed to record systolic BP (SBP) and diastolic BP (DBP) every 30 minutes during the day (8 am to 10 pm) and every hour during the night. Upon completion, the ABP monitoring device was returned to study staff. Readings were downloaded with Sentinel Software, version 10.5, from Spacelabs Healthcare.

Forty-eight-hour ABP completion rates ranged from 9% to 150% (some participants wore the ABP cuff for a few hours into the next day), with 88% of women achieving a completion rate of at least 80%. From these readings we were able to create continuous outcomes as well as categorize continuous measurements into hypertension phenotypes. Continuous outcomes included the mean of all SBP and DBP outcomes for daytime and nighttime, resulting in four continuous outcomes: daytime SBP, nighttime SBP, daytime DBP, and nighttime DBP. Continuous daytime and nighttime BPs were categorized as daytime hypertension (daytime SBP ≥130 mmHg or daytime DBP ≥80 mmHg) and nighttime hypertension (nighttime SBP ≥110 mmHg or nighttime DBP ≥65 mmHg) based on suggested ABP cutpoints for women (Hermida et al., 2015).

Exposures: Neighborhood Social Environment

Aspects of the neighborhood social environment examined in this study included social cohesion and activities with neighbors. These constructs were measured via the Neighborhood Health Questionnaire, a self-report tool created to ascertain information on neighborhood-level dimensions relevant to CVD (Mujahid et al., 2007). Participants were asked to refer to the area within about a 20-minute walk, or about a mile from their home. Neighborhood social cohesion was measured with a 5-point Likert scale on level of agreement with the following four statements: *People around here are willing to help their neighbors; People in my neighborhood generally get along with each other; People in my neighborhood can be trusted; People in my neighborhood share the same values.* A summary neighborhood social cohesion score was estimated for each participant by taking the average across the four items, possible scores ranging from 0-4, higher scores indicating higher neighborhood social cohesion. Only participants with responses to all items were assigned a scale score.

Activities with neighbors was measured with a 4-point Likert scale on level of frequency (“never,” “rarely,” “sometimes,” “often”) of the following five activities: *About how often do you and people in your neighborhood do favors for each other?; When a neighbor is not at home or on vacation, how often do you and other neighbors watch over their property?; How often do you and other people in the neighborhood ask each other advice about personal things such as child rearing or job openings?; How often do you and people in your neighborhood have parties or other get-togethers where other people in the neighborhood are invited?; How often do you and other people in your neighborhood visit in each other’s homes or speak with each other on the street?* A summary of activities with neighbors score was estimated for each participant by taking the average across the five items, possible scores ranging from 0-3, higher scores indicating more activities with neighbors. Only participants with responses to all items were assigned a scale score. Dimensions of the Neighborhood Health Questionnaire have shown high internal consistency and test-retest reliability across census tract-defined neighborhoods (Mujahid et al., 2007).

Exposures: Residential and activity space segregation

Residential addresses were collected via self-report at baseline visit. Addresses were cleaned and geocoded. Of the 422 baseline addresses, less than 2% (n=8) of addresses were not geocoded – seven P.O. boxes and one address missing sufficient information to geocode.

Activity space locations were collected via a self-report questionnaire developed by Shareck and colleagues (Shareck et al., 2013), modified for use in this cohort (child school/daycare and leisure locations were added). This questionnaire allowed participants to report 0 to 10 activity space locations, including locations for studies (one), work (two), grocery shopping (two), physical activity (one), child school/daycare (one), child leisure activities (one), and other places they frequent (two). This questionnaire has demonstrated high convergent validity with activity space measures collected via global positioning system (GPS) tracking and prompted recall surveys (Shareck et al., 2013). Activity space addresses were cleaned and geocoded following the same procedures as residential addresses. Of the 1,771 activity space locations reported, 2.2% (n=39) were not geocoded for lack of sufficient address information to geocode.

Census tracts were used as proxies for neighborhood for residential and each activity space location. Using data from the US Census and 2018 5-year American Community Survey (ACS), segregation was defined as the percentage of Black residents in the census tract, or the racial composition of the census tract. Racial composition is a local corollary of the isolation index which is a weighted average of local racial compositions, describing in this case the extent to which the Black population is isolated from or exposed to other racial groups. Racial composition has been considered a crude measure of segregation (more specifically a measure of racial diversity) in that it does not fit the standard definition proposed by Massey and Denton which considers the spatial distribution of minority group members within the larger area (i.e., metropolitan statistical area [MSA], five-counties, city) (Kershaw & Albrecht, 2015; Massey & Denton, 1988). However, in this study, all participants were from the Atlanta metropolitan area and 99% of residential and 97-100% of activity space locations are within the same MSA (Atlanta – Sandy Springs – Alpharetta MSA). Therefore, the larger area often included in more explicit measures of segregation can be considered approximately uniform among all census tracts included in the study. For this reason, we considered the racial composition of census tracts an appropriate proxy of racial isolation segregation in this study, which we will refer to as segregation throughout this study.

A summary residential segregation and combined residential and activity space segregation level was estimated for each participant. Residential segregation was defined as the racial composition of the residential census tract. A combined residential and activity space segregation measure was defined as the median racial composition value among residential and all activity space locations.

Individual-Level Covariates

Covariates known to be associated with residential segregation and hypertension risk were adjusted for in analyses in order to isolate the effects of residential and activity space segregation on ABP outcomes. Individual-level sociodemographic information included self-reported age, educational attainment, employment status, partner status, income, and family size. Educational attainment was assessed as years of education and categorized in analyses as high school or less, some college, and college or more. Employment status was categorized as full-time, part-time, or unemployed, and partner status dichotomized as married/living with a partner or not. Household income was assessed with the following categories: <$35K, $35-<$50K, $50-<$75K, ≥$75K. Family size was included to contextualize the household income, and was reported as the number of people currently living in the participant's household, including the participant.

Traditional CVD risk factors included body mass index (BMI) calculated as measured weight divided by the square of measured height (kg/m2), current smoking status (dichotomized: current smoker or not), antihypertensive medication use in the past 12 months, and minutes of intentional exercise each week (Bertoni et al., 2008). Severity of depression symptoms was self-reported using the Beck Depression Inventory (BDI), a 21-item, validated inventory widely used across populations (Beck, 1961).

Statistical Analyses

Descriptive statistics for the analytic sample were calculated by both high/low social cohesion and activities with neighbors scores. Median cutpoints were used to dichotomize high/low categories to maintain approximately equal sample sizes by group.

We fit linear regression models to examine associations between average neighborhood social cohesion and, separately, activities with neighbors scores and continuous ABP measures (daytime SBP, daytime DBP, nighttime SBP, nighttime DBP). For each set of analyses, Model 1 was unadjusted. Model 2 was adjusted for age, Model 3 was further adjusted for sociodemographic factors (educational attainment, employment status, partner status, income, and family size), Model 4 was further adjusted for other traditional CVD risk factors (BMI, current smoking status, intentional exercise), Model 5 was further adjusted for antihypertensive medication use, and Model 6 was further adjusted for depression symptom severity.

In a separate series of models using the same sequence as above, we examined associations between average social cohesion and activities with neighbors scores and dichotomous daytime and nighttime hypertension. As daytime and nighttime hypertension are highly prevalent in this cohort, odds ratios would overestimate the relative risk associated with our exposures due to violation of the rare event rate assumption (Zou, 2004). Therefore, we calculated prevalence ratios for dichotomous outcomes for better approximation of risk. In order to address convergence issues with using log-binomial models to calculate prevalence ratios, we use a modified Poisson approach using Poisson regression with robust variance to estimate prevalence ratios (Yelland et al., 2011; Zou, 2004).

Furthermore, we examine interaction between each of the neighborhood social environment variables (social cohesion and activities with neighbors) and each of the segregation measures (residential segregation and combined residential and activity space segregation). To assess interaction on the additive scale, we include interaction terms in linear models with continuous outcomes, and we calculate the Relative Excess Risk due to Interaction (RERI) using logistic models for dichotomous outcomes. The RERI was calculated by including interaction terms in logistic models and substituting resulting regression coefficients in the formula: $RERI = e^{\widehat{\beta_1}+\widehat{\beta_2}+\widehat{\beta_3}} - e^{\widehat{\beta_1}} - e^{\widehat{\beta_2}} + 1$, where β_1

represents the regression coefficient for the neighborhood social context variable, β_2 represents the regression coefficient for the segregation variable, and β_3 represents the regression coefficient for the interaction term between these two exposures. We used bootstrapping methods to estimate 95% confidence intervals (CIs) for RERI values. Where statistically significant interaction was indicated ($p < 0.05$), we created stratified tables for associations between the segregation measure and ABP outcomes by the high/low groups of the neighborhood context variable.

For each set of analyses, we conducted sensitivity analyses in which we excluded participants taking antihypertensive medications to examine how sensitive our results are to removing those with potentially controlled hypertension, as hypertension is the outcome of interest in this study. All analyses were conducted in R (R Core Team, 2021).

Results

Characteristics of the sample

The average social cohesion score in this sample was 2.6 (range: 0-4), representing neutral (=2) to agree (=3) responses to statements indicating the presence of neighborhood social cohesion. Table 6 shows characteristics of the analytic sample by high and low neighborhood social cohesion groups based on median cutpoints (median = 2.75). Those reporting higher neighborhood social cohesion were slightly older (High Cohesion: 38.8, Low Cohesion: 37.0), more likely to be married or living with a partner (High Cohesion: 47%, Low Cohesion: 27%), more likely to have a college degree (High Cohesion: 55%, Low Cohesion 40%), more likely to be full-time employed (High Cohesion: 67%, Low Cohesion: 62%), and have an income >75K (High Cohesion: 41%, Low Cohesion: 21%), despite having a similar average family size as those reporting lower social cohesion (≈3 people in the household). Those reporting higher social cohesion were less likely to have used antihypertensive medication in the past 12 months (High Cohesion: 15%, Low Cohesion: 18%), be current smokers (High Cohesion: 8%, Low Cohesion: 13%), and though those reporting higher neighborhood social cohesion engaged in approximately 7 fewer minutes of intentional exercise each week compared to those reporting less social cohesion, they had a slightly lower average BMI (High Cohesion: 32.1, Low Cohesion: 33.3). Notably, those reporting higher neighborhood social cohesion reported lower depression symptom severity as indicated by BDI scores (High Cohesion: 4.6, Low Cohesion: 7.3).

The average activities with neighbors score in this sample was 1.5 (range: 0-3), representing rarely (=1) to sometimes (=2) responses to questions indicating frequency of participating in activities with neighbors. Table 7 shows characteristics of the analytic sample by high and low activities with neighbors groups based on median cutpoints (median=1.4). Those reporting more activities with neighbors were slightly older (High Activities: 38.6, Low Activities: 37.2), more likely to be married or living with a partner (High Activities: 41%, Low Activities: 35%), more likely to have a college degree (High Activities: 55%, Low Activities: 40%), and have an income >75K (High Activities: 41%, Low Activities: 21%) despite having a similar average family size as those reporting fewer activities with neighbors (≈3 people in the household). Unlike patterns seen for those reporting more social cohesion, those reporting more activities with neighbors were less likely to be full-time employed (High Activities: 62%, Low Activities: 68%), more likely to have used antihypertensive medication in the past 12 months (High Activities: 20%, Low Activities: 13%), be current smokers (High Activities: 13%, Low Activities: 7%), and had similar average BMI as those reporting fewer activities with neighbors (High Activities: 32.5, Low Activities: 32.9) despite engaged in approximately 14 more minutes of intentional exercise each week compared to those reporting fewer activities with neighbors. Again, those who reported more activities with neighbors reported lower depression symptom severity as indicated by BDI scores (High Activities: 5.5, Low Activities: 6.3), though this difference was less pronounced than that those seen between high/low social cohesion groups.

Those reporting higher social cohesion on average lived in residential census tracts that were less segregated, indicated by a lower proportion of Black residents (High Cohesion: 69%, Low Cohesion:

78%), and when including activity spaces occupied more integrated spaces with a similar overall residential and activity space racial composition as those reporting lower social cohesion (High Cohesion: 54%, Low Cohesion: 55%). The high social cohesion group had slightly lower daytime and nighttime SBP and DBP, and were slightly less likely to have daytime (High Cohesion: 36%, Low Cohesion: 38%) and nighttime (High Cohesion: 65%, Low Cohesion: 67%) hypertension. In contrast, those reporting more activities with neighbors occupied slightly more segregated residential and overall residential and activity spaces than those reporting less activities with neighbors, and had higher daytime and nighttime SBP and DBP and were more likely to have daytime hypertension (HA: 41%, LA: 32%), despite having a similar prevalence of nighttime hypertension (≈66%) as those reporting fewer activities with neighbors.

Main effects of neighborhood social context

Table 8 shows results for associations between neighborhood social cohesion and ABP outcomes. We model a 1-point increase in the average neighborhood social cohesion score, representing moving to a response level indicating higher social cohesion. While in unadjusted models higher neighborhood social cohesion was associated with lower daytime SBP (β=-0.85 [95% CI: -2.53, 0.84) and DBP (β=-0.20 [95% CI: -1.42, 1.01), after adjusting for sociodemographic and traditional CVD risk factors, including depression symptom severity (Model 6), a 1-point increase in average neighborhood social cohesion score was associated with a 0.03 mmHg lower average daytime SBP (CI: -1.71, 1.65) and a 0.40 mmHg higher average daytime DBP (CI: -0.84, 1.64). For nighttime outcomes, in adjusted models (Model 6), a 1-point increase in average social cohesion was associated with a 1.15 mmHg lower nighttime SBP (CI: -2.67, 0.38), and a 0.73 mmHg higher nighttime DBP (CI: -1.91, 0.45). Also included in Table 3 are prevalence ratios for associations between social cohesion and dichotomous daytime and nighttime hypertension outcomes. In unadjusted models, a 1-point increase in average social cohesion score was associated with a 2% higher risk (PR: 1.02 [CI: 0.84, 1.23]) for daytime hypertension and a 4% lower risk (PR: 0.96 [CI: 0.88, 1.05]) for nighttime hypertension, the effect size increasing to 11% higher risk (PR: 1.11 [CI: 0.93, 1.32]) for daytime hypertension in Model 6, but remaining relatively unchanged for nighttime hypertension after adjustment.

Table 9 shows results for associations between activities with neighbors and ABP outcomes, again modeling a 1-point increase in the average activities with neighbors score, or more activities with neighbors. In unadjusted models, a 1-point increase in activities with neighbors score was associated with higher daytime SBP (β=0.77 [95% CI: -0.85, 2.40) and DBP (β=0.42 [95% CI: -0.75, 1.60). After adjustment (Model 6), these associations were attenuated but still positive, more activities with neighbors associated with a 0.52 mmHg higher daytime SBP (CI: -1.04, 2.09) and a 0.21 mmHg higher daytime DBP (CI: -0.95, 1.37). Activities with neighbors was associated with a 0.12 mmHg higher nighttime SBP (CI: -1.31, 1.56), but a 0.21 mmHg lower nighttime DBP (CI: -1.32, 0.89). A 1-point increase in activities with neighbors score was associated with a 20% higher (PR: 1.20 [CI: 1.00, 1.43]) risk for daytime hypertension and a 3% lower (PR: 0.97 [CI: 0.88, 1.07]) risk for nighttime hypertension.

Interaction assessment

Based on interaction terms in linear models, significant interaction was found between activities with neighbors and residential segregation for all continuous outcomes (daytime and nighttime SBP and DBP). Stratified tables showing effects of residential segregation by high and low activities with neighbors groups (based on median cutpoints) were created to depict these interactions and are included in the Supplement (Supplementary Tables 5-6). Adjusted results (Model 6) show that among those reporting more activities with neighbors, higher residential segregation (modeled as a 20% increase in the proportion of Black residents in the residential census tract), was associated with a 0.37 mmHg higher daytime SBP (β=0.37 [95% CI: -0.35, 1.09) , a 0.24 mmHg higher daytime DBP (β=0.24 [95% CI: -0.28, 0.76), a 0.41 higher nighttime SBP (β=0.41 [95% CI: -0.24, 1.06), and a 0.44 mmHg higher nighttime DBP (β=0.44 [95% CI: -0.06, 0.94). On the other hand, among those reporting fewer activities with neighbors, higher residential segregation was associated with a 1.08 mmHg lower daytime SBP (β=-1.08 [95% CI: -1.91, -0.26), a 0.70 mmHg lower daytime DBP (β=-0.70 [95% CI: -1.32, -0.08), a 0.76 lower nighttime SBP (β=-0.76 [95% CI: -1.52, 0.01), and a 0.39 mmHg lower nighttime DBP (β=-0.39 [95% CI: -0.98, 0.20).

No statistically significant interaction was found between neighborhood social cohesion and segregation measures on ABP outcomes.

Sensitivity Analyses

We replicated these analyses restricted to participants who were not taking antihypertensive medications within the past 12 months, with a remaining sample size of 326 participants. Those taking antihypertensives had lower socioeconomic status based on all individual-level indicators, as well as worse health status based on CVD risk factors and ABP outcomes. In particular, the average BMI among those taking antihypertensive medications was 38.7 kg/m^2 compared to 31.5 kg/m^2 among those not taking antihypertensive medications. Also, those taking antihypertensive medications were more likely to smoke, did approximately 15 minutes less intentional exercise each week, and had higher depression symptom severity. Importantly, daytime and nighttime ABP outcomes were much worse among those taking antihypertensive medications. Average daytime BP was 131 mmHg/84.1 mmHg, and daytime hypertension prevalence 68%, among those taking antihypertensive medications, compared to 119 mmHg/76.3 mmHg and 30% daytime hypertension prevalence among those not taking antihypertensive medications. Similarly, average nighttime BP was 121 mmHg/74.8 mmHg, and nighttime hypertension prevalence 94%, among those taking antihypertensive medications, compared to 109 mmHg/67.2 mmHg 60% nighttime hypertension prevalence among those not taking antihypertensive medications.

Tables 7 and 8 in the Supplement shows study results among those not taking antihypertensive medications in the past 12 months. In Model 5 adjusted for sociodemographics and traditional CVD risk factors, including depression (comparable to Model 6 in our main analyses), patterns seen for effects of social cohesion on ABP outcomes persisted when excluding those taking antihypertensives, though positive effect sizes on daytime hypertension outcomes were slightly larger and negative associations with continuous nighttime SBP and DBP were slightly weaker. Notably, a 1-point increase in social cohesion score was associated with a 17% higher risk for daytime hypertension (PR: 1.17 [CI: 0.91, 1.50]) among those not taking antihypertensive medication (compared to a 7% increase found when including those taking antihypertensive medication). Results for nighttime hypertension were comparable when included and excluding those taking antihypertensive medications.

When excluding those taking antihypertensive medications, effect sizes for associations between activities with neighbors and ABP outcomes were smaller, and for daytime DBP and nighttime SBP, crossed over to negative associations. The 20% higher risk for daytime hypertension associated with an increase in activities with neighbors score became a 15% higher risk (PR: 1.15 [CI: 0.93, 1.43]) when excluding those taking antihypertensive medications. Results for nighttime hypertension were again comparable when included and excluding those taking antihypertensive medications.

The same patterns of interaction were found when including and excluding participants taking antihypertensive medications, interaction found between activities with neighbors and residential segregation for continuous outcomes. Patterns of associations in stratified analyses when excluding those taking antihypertensive medications were similar to those found when including those taking antihypertensive medications.

Discussion

The ethnic density hypothesis posits that segregation, that is living in neighborhoods with a high proportion of residents of the same ethnic background, may enhance social cohesion and social support, and provide a sense of community and belongingness. These factors in turn, can have protective and buffering effects against the negative mental and physical health consequences of chronic stressors and area deprivation associated with living in segregated communities (Bécares et al., 2012; Gao et al., 2022). The current study therefore examined social cohesion and activities with neighbors as protective psychosocial resources, indicating close-knit communities in which neighbors interact and through which support and resources can flow, on ABP outcomes, as well as the moderating effects of these resources on associations between segregation and health, among young and middle-aged Black women in the southeast US. We found some protective associations between neighborhood social cohesion and continuous nighttime SBP and DBP in models adjusting for sociodemographic and traditional CVD risk factors. A 1-point increase in average neighborhood social cohesion score was associated with a 1.15 mmHg lower nighttime SBP and a 0.73 mmHg lower nighttime DBP, though these differences in BP are small, and likely not clinically meaningful (Guzman et al., 2014; Hess et al., 2016). In contrast to the results for continuous outcomes, and contrary to prevailing hypotheses, a 1-point increase in average neighborhood social cohesion score was associated with an 11% higher risk for daytime hypertension. However, confidence intervals for all adjusted associations between neighborhood social cohesion and BP outcomes were wide and included values in the opposite direction of the main effects. Similarly, activities with neighbors was examined as another resource indicative of a positive neighborhood social environment that might be protective against CVD risk. However, again in contrast to prevailing hypotheses, in our cohort of Black women more activities with neighbors was associated with higher daytime SBP and DBP, and a 20% higher risk for daytime hypertension which persisted in adjusted models. Associations between activities with neighbors and nighttime outcomes were near null.

We further examined neighborhood social cohesion and activities with neighbors as potential moderators of associations between segregation and ABP outcomes. However, the adverse effects of segregation were worse among those reporting a more activities with neighbors. Among those reporting more activities with neighbors, higher residential segregation was associated with higher daytime and nighttime SBP and DBP; among those reporting fewer activities with neighbors higher residential segregation was associated with lower daytime and nighttime SBP and DBP. However, effect sizes for adverse associations among those reporting more activities with neighbors were again small and likely not clinically meaningful. These findings indicate that the adverse factors associated with living in segregated Black neighborhoods may override the potential protective effects of close-knit, ethnically dense Black communities (Bécares et al., 2012; Shaw et al., 2012).

In sensitivity analyses, we excluded those taking antihypertensive medications in the past 12 months from analyses, as these participants were taking BP lowering medications and our main outcome is BP. Patterns of effects largely remained the same when excluding those taking antihypertensive medications.

To our knowledge, this is the first study to examine associations between the neighborhood social environment and ABP outcomes, and the first to examine moderation of associations between residential, as well as activity space, segregation and ABP outcomes by the neighborhood social environment. Recent studies have also examined effects of health-promoting features of the neighborhood social environment in order to highlight factors which may be protective and promote resilience among Black populations and communities. Driven by evidence of heterogeneity in CVD risk across census tracts within the Atlanta metropolitan area (Kim et al., 2019), Islam and colleagues examined neighborhood characteristics among a cohort of Black men and women in Atlanta and found neighborhood social cohesion and activities with neighbors, also measured via the Neighborhood Health Questionnaire, were associated with ideal cardiovascular health, mainly in terms of diet, exercise and BMI, and particularly among Black women (Islam et al., 2022). In a separate cohort also from the Atlanta metropolitan area, social cohesion was associated with lower levels of interleukin-6, an inflammatory biomarker indicative of CVD risk, again with associations particularly strong among Black women

(Neergheen et al., 2019). Additionally, recent studies have examined moderating effects of the neighborhood social environment on associations between residential segregation and hypertension, and found that while segregation still had a negative impact on hypertension, better social environment (which included social cohesion but not activities with neighbors) buffered these effects, resulting in a less pronounced impact of segregation on hypertension (Gao et al., 2022; Mujahid et al., 2021).

Despite finding modest protective associations between social cohesion and nighttime SBP, we found social cohesion was associated with an elevated risk of daytime hypertension, and activities with neighbors was associated with an even stronger elevated risk of daytime hypertension; and that higher segregation, or higher black ethnic density, was more protective for continuous BP outcomes among those reporting fewer activities with neighbors. These findings are contrary to prevailing hypotheses and recent study findings from the same region. In this cohort, those reporting more activities with neighbors were those who were more likely to have been diagnosed with and on medication for hypertension, and when excluding those taking antihypertensive medications, were still those with much higher prevalence of daytime hypertension. Thus, it is possible that these women might have accumulated CVD risk over time, prior to their enrollment in this study. For example, a study by Geronimus and colleagues examining race and sex differences in age trajectories for hypertension found that by age 40, Black women had the highest hypertension rates and the steepest rise in prevalence since age 15 compared to White women and Black and White men (Geronimus et al., 2007). Compared to those engaging in less activities with neighbors, it is possible that those engaging in more in our cohort may have accumulated more harmful exposures and stressors over time. Geronimus and colleagues noted the need to examine risk factors, including psychosocial stressors, at younger ages, which may have accumulated and contributed to differential risk at baseline among those Black women engaging in more compared to less activities with neighbors in this cohort. For instance, it’s possible that those who engaged in more activities with neighbors and also were in more highly segregated neighborhoods have interacted with those neighbors, and therefore those neighborhoods, longer. Segregation has remained persistently high in part because residential mobility into more integrated spaces for Black Americans has been constrained by the discriminatory practices and socioeconomic inequalities which have persistently driven the creation and reinforcement of racial residential segregation (Bruch & Swait, 2019). Therefore, those Black women engaging in more activities with neighbors may have accumulated the effects of living in more segregated spaces over time, including those related to the adverse physical, socioeconomic and psychosocial environments characteristic of more segregated spaces. For instance, studies have shown air pollution levels in metropolitan areas were highest in more segregated Black neighborhoods (Woo et al., 2019), and that long-term exposure to ambient air pollution was cardiotoxic and related to increased risk for many CVD-related conditions and outcomes, including hypertension (Bont et al., 2022). While we did not have data on the length of time lived in current neighborhoods, or previous neighborhood information, data from the Coronary Artery Risk Development in Young Adults (CARIDA) Study found that residence in segregated neighborhoods from ages 18-30 had effects on CVD risk at ages 33-45 (Reddy et al., 2022); while moving from segregated to integrated neighborhoods led to reductions in blood pressure over time (Kershaw et al., 2017b). Thus, there is evidence that long-term exposure to segregated spaces may have cumulative effects on CVD risk.

While studies have found health protective effects of social cohesion among Black populations, results have been mixed (Islam et al., 2022). Social cohesion in Black communities has been identified as a potential double-edged sword in that while it may offer more support and reciprocity among those within a social network or neighborhood, it also may also contribute to more demands on those supplying those resources. In other words, more cohesion may represent a mechanism through which individuals and community residents “get by,” but this social insurance may be associated with a high cost, psychologically or even financially, on individuals and community members providing resources

(Kawachi & Berkman, 2014). For instance, studies document that Black women may be particularly more likely to engage with their neighborhood networks and engage in duties typically assigned to family members, including providing transportation, childcare, financial assistance and emotional support (Campbell & Lee, 1992; Kessler & McLeod, 1984). While social cohesion may indicate supportive social networks, in this cohort, stressful events happening to those in one's network were associated with elevated daytime SBP and DBP, which may be amplified when one's network includes others experiencing more social or area disadvantage.

It is also important to consider that we found adverse effects on dichotomous daytime hypertension outcomes in particular, defined as mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg. We did not find strong effects on continuous daytime measures, but perhaps because many people in the cohort were near the daytime DBP threshold for daytime hypertension, the slightly higher daytime DBP associated with higher social cohesion and more activities with neighbors was enough to increase risk for crossing daytime hypertension thresholds. Why neighborhood social environment had more adverse effects on daytime hypertension risk was also a novel finding as this study was the first to examine these exposures with ABP outcomes. Daytime BP may be particularly reactive to environmental stimuli throughout the day (O'Brien et al., 2013), in this study daytime being defined as 8am to 10pm. Overall, residential spaces tended to be more segregated and activity spaces more integrated among those reporting both higher and lower social cohesion, and daytime hours were from 8am to 10pm. As we found in aim 1, participants engage in most of their routine activities outside of residential census tracts, and therefore daytime BP may be more influence by the sociocontexutal environments of the spaces where individuals spend their daytime hours. In aim 1, we did find activity space segregation levels in particular to have positive associations with daytime hypertension risk. Therefore, we could also speculate that, according to an ethnic density hypothesis, when individuals are away from their ethnically dense residential tracts during the day, the psychosocial benefits associated with those ethnically dense residential spaces do not have protective effects outside of that space. This may be further evidenced by the null, or slightly protective effects we see between neighborhood social environment and nighttime outcomes. Minimally protective associations were found between neighborhood social cohesion and nighttime SBP, nighttime SBP in particular found to be a strong predictor of cardiovascular events and mortality (Hansen et al., 2011). Or, more in line with the residential segregation hypothesis, the activities which happen in more cohesive neighborhoods mostly happen during these daytime hours as well, and, as discussed above, the associations with daytime hypertension reflect the potential for social and neighborhood disadvantage to override the protective effects of these factors.

There are important limitations to this study which should be noted. This was a cross-sectional study, and therefore we cannot make assumptions on temporality or causality in the associations between current neighborhood social environment and BP, or moderating effects of social environment on associations between segregation and BP. It could be that those reporting more social cohesion or more activities with neighbors are those with earlier life stressors associated with more reliance on these community relationships, or they have lived in segregated spaces and accumulated risks associated with those spaces longer. Future studies should examine cumulative and chronic stressors in these populations and examine how earlier lifecourse context, including childhood home, school, and other activity locations, impacts ABP outcomes and these findings. Additionally, while social cohesion and activities with neighbors are measured via a reliable scale and there was evidence of the protective and buffering effects of these psychosocial resources, we may not have captured aspects of the social environment which may better represent protective resources among those living in more highly segregated areas. It is possible that more socioeconomic resources in these communities are needed for community bonds to be more beneficial to physical health outcomes. It should be noted that those reporting higher social cohesion and more activities with neighbors also had lower depression symptom severity, particularly among those with more social cohesion, but these mental health benefits did not translate to strong physical health benefits. Moreover, reviews of the ethnic density literature have called for more adequate adjustment for area deprivation measures related to the impacts of segregation, which may hinder identification of ethnic density effects (Bécares et al., 2012), which should explored in future research examining the neighborhood social environment among Black populations and communities. Also, as described in the methods, racial composition is often considered a poor proxy of residential segregation in that it does not capture the racial context of the larger area, however, in this study, nearly all residential and activity space locations are in the same MSA, and this local measure of isolation fits the definition of ethnic density as the proportion of ethnic minority residents in an area (Bécares et al., 2012) which we are exploring in this study. Finally, we have a relatively small analytic sample size in this study, and may not have the power to detect effects.

There were also important strengths to this study. This study focuses on young to middle-aged Black women, a population with concerning recent trends in CVD outcomes and mortality that has resulted in a call to action to explore factors related to CVD risk in this understudied population, as well as factors which may be protective and buffer the excess risk in this population (Kalinowski et al., 2019). Moreover, this study focuses on Black women in the southeast US, where low cardiovascular health tends to cluster (Zheng et al., 2021). Studies finding a moderating effect of neighborhood social environment on adverse segregation effects were multisite and may not fully capture relationships between these exposures and effects within this high-risk population within this high-risk geography. While results of this study may not be generalizable to young and middle-aged Black women in other areas, it is also important for research to focus on relevant factors in the context of the southeast US. Additionally, by examining ABP rather than conventional clinic hypertension, we were able to better describe effects of neighborhood social environment on gold standard and more CVD predictive aspects of BP.

Conclusions

In this study of young to middle-aged Black women in the southeast US, we found that higher neighborhood social cohesion was associated with minimally lower nighttime BP, SBP in particular, but among those with higher neighborhood social cohesion, there were more adverse effects of segregation on daytime hypertension risk. Activities with neighbors was associated with elevated risk for daytime hypertension as well. Among those reporting more activities with neighbors, there were more adverse effects of segregation on continuous BP outcomes, but these effects sizes were small. These results suggest the potential for the material, environmental and psychosocial risks associated with residential segregation to override the potential psychosocial resources available in ethnically dense spaces. Investments in segregated spaces to combat the relative deprivation of Black neighborhoods may be necessary to strengthen the protective and buffering effects of better neighborhood social environments in Black neighborhoods. As residential segregation has continued to persist, future research should continue to identify neighborhood and individual-level resilience factors which may highlight mechanisms to decrease CVD risk, particularly among young and middle-aged Black women who are currently experiencing concerning trends in CVD risk.

Chapter 4. Spatial segregation, racial identity, and ambulatory blood pressure among young and middle-aged Black women in the Southeast US

Introduction

Racial disparities in cardiovascular disease (CVD) outcomes have persisted and widened over time (G. K. Singh et al., 2015), with recent studies highlighting concerning trends among young and middle-aged Black women (Kalinowski et al., 2019; Smilowitz et al., 2016). Black women 35-44 years old not only have higher CVD prevalence than White women and Black and White men of that age (Jolly et al., 2010), but since 1988 there have been a doubling of counties with Black women having higher heart disease mortality than White men (Vaughan et al., 2019). This increasing disparity is due to faster rates of decline in CVD outcomes and mortality among White men compared to Black women in many counties (Smilowitz et al., 2016; Vaughan et al., 2019), despite women having more biological protectiveness against CVD at young age compared to men (Pérez-López et al., 2010; Villablanca et al., 2010). These population-level differences in rates of decline indicate the need to examine population-level exposures which would explain inequitable access to health-promoting advancements and resources by race and place (Javed et al., 2022; Kramer et al., 2017), as well as factors which may be protective or buffer adverse exposures among young and middle-aged Black women.

Many studies examining contextual factors related to place which contribute to racial disparities in health examine residential segregation as a fundamental determinant of unequal socioenvironmental contexts, and therefore health experiences, by race (Kershaw & Albrecht, 2015; Kramer & Hogue, 2009; Williams & Collins, 2001). Residential segregation, or the systematic separation of racial groups into different residential contexts, was born out of practices and policies intended to protect White populations from exposure to Black populations, and restrict Black populations to the least desirable areas, allowing for the creation of disparate socioeconomic and health-relevant contexts among Black and White populations which has been reinforced over time and largely persists today (Mujahid et al., 2021; Williams & Collins, 2001). In studies of health outcomes, the residential segregation hypothesis posits that residential segregation has contributed to worse health outcomes among Black communities compared to White communities through: differential investment in and placement of services, such as access to healthy physical environments (i.e., food, walkability, green space) and preventive healthcare; differential access to socioeconomic resources, such as educational and economic opportunities and concentrated poverty; and differential exposure to psychosocial risk factors, such as perceived neighborhood disorder (i.e., noise, crowding, and trouble with neighbors), discrimination, and other general stressors (Collins & Williams, 1999; Greer et al., 2014; Kramer & Hogue, 2009; Williams & Collins, 2001). Several studies have found residential segregation to be associated with worse CVD risk among Black communities, including greater risk for obesity, hypertension, and diabetes, as well as increased mortality from heart disease and stroke, beyond the effects of socioeconomic and traditional CVD risk factors (Kershaw & Albrecht, 2015).

However, closing racial disparity gaps and improving cardiovascular health outcomes among Black populations also requires examination of health-promoting factors and those which may buffer the disproportionate burden of adverse exposures experienced by Black populations and communities. While the racial residential segregation hypothesis places emphasis on the health-harming factors associated with living in minority communities, including greater exposure to psychosocial risk factors and stress (Basile Ibrahim et al., 2021), an alternative hypothesis, known as the ethnic density hypothesis, highlights the potential availability of health-promoting psychosocial resources associated with living in concentrated minority communities (Bécares et al., 2012; Viruell-Fuentes et al., 2012). The ethnic density hypothesis proposes the presence of protective and buffering factors, including social cohesion/capital, social support, and sense of community and belongingness, which may be enhanced among minority populations when living in concentrated communities composed of those with whom they racially/ethnically identify (Bécares et al., 2009, 2012). Studies examining ethnic density have often investigated and found protective effects among Latino, Asian, and other non-Black minority and immigrant populations living in ethnic enclaves/communities in the US (Bécares et al., 2012; T.-C. Yang et al., 2017), though benefits vary for enclave residents by such individual-level factors as gender, nativity, and acculturation status (Chang et al., 2010; Kershaw & Albrecht, 2015; Li et al., 2013). Studies examining ethnic density among Black populations have predominantly found the detrimental effects of living in majority Black areas (Bécares et al., 2012), however, studies of isolated Black communities often treat Black populations as a single group with homogenous risk, not accounting for heterogeneity across a range of social factors beyond gender and age to further elucidate subgroups which may benefit from the psychosocial resources associated with living in ethnically dense communities (Kershaw & Albrecht, 2015).

The difference in effects of ethnic density between Black and non-Black minority populations is likely a function of different segregation processes between these groups. Decades of research has documented that Black Americans have been constrained into segregated spaces characterized by area-level deprivation as a result of centuries of racist practices and policies (Williams & Collins, 2001). Non-Black racial and ethnic minorities and immigrants, on the other hand, have been found to be more likely to strategically self-segregate to be within community among those with whom they share ethnic identity and cultural norms, facilitating the creation of close-knit communities characterized by social support and capital, and insulated from the discrimination associated with interracial contact, which are factors highlighted as resources promoting health in ethnic enclaves (T.-C. Yang et al., 2017). Racial/ethnic identity, or sense of collective identity based on sharing cultural and racial/ethnic heritage (Demo & Hughes, 1990), may therefore be an important aspect of the creation and protectiveness of ethnic enclaves.

Among Black populations, strong racial identity has been posited to be a psychosocial resource, contributing to a sense of closeness and attachment to Black populations which promotes meaningful roles and purpose in families and communities, and allows healthy psychological adjustment despite the stressors associated with being Black in the US (Ida & Christie-Mizell, 2012). While studies of racial identity were born out of observations that Black Americans may internalize the racist sentiments of larger society and have negative feelings about their racial identity and group (i.e., Black children choosing White dolls instead of Black dolls) (Neblett et al., 2004), much of the research examining racial identity has demonstrated the buffering effects of more positive racial identity against the adverse effects of stress related to perceived prejudice and discrimination on mental health outcomes (Neblett et al., 2004). For instance, studies have found that Black Americans who hold their race more central to their identity, and feel more belonging and positive feelings toward other Black people, are more likely to attribute unfair treatment to racial discrimination (Sellers & Shelton, 2003); however, due to positive feelings about their racial identity and their racial group, and racial discrimination being consistent with their world view and expectations, are better equipped to cope with experiences of discrimination (Neblett et al., 2004; Sellers & Shelton, 2003). Thus, studies have found that positive racial identity among Black populations is directly associated with better mental health outcomes, including better psychological well-being and less depression, and buffers effects of adverse psychosocial exposures, such as discrimination, on mental health outcomes (Caldwell et al., 2002; Huguley et al., 2019; Ida & Christie-Mizell, 2012; Neblett et al., 2004). Few studies have examined racial identity in Black populations with physical health outcomes. Yet, there is some evidence that dimensions of racial identity are associated with self-reported heart disease, though findings are mixed (Christie-Mizell et al., 2010; Dagadu & Christie-Mizell, 2014). Other studies have found that dimensions of racial identity moderated associations between discrimination and autonomic responses (Neblett & Roberts, 2013) and allostatic load (Thomas Tobin et al., 2021) among Black adults.

The current study seeks to examine racial identity as an individual-level psychosocial resource that might buffer the adverse associations between segregation and CVD risk, specifically elevated blood pressure (BP), in a cohort of young and middle-aged Black women. Specifically, we will examine three dimensions of racial identity: 1) centrality – the importance of one's racial/ethnic group membership to one's self-concept; 2) private regard – one's feelings about their own racial/ethnic group; and 3) public regard – beliefs about how those of other racial and ethnic groups in society perceive one's racial/ethnic group (Huguley et al., 2019). The primary outcome is BP, measured via ABP. Elevated BP is a critically important outcome to examine in the current cohort because Black Americans have the highest prevalence of hypertension in the world, a major risk factor for poor CVD outcomes (Benjamin et al., 2019). Unlike conventional clinic blood pressure (BP) used to diagnose hypertension, ABP takes several BP readings throughout the day and night for thorough description and quantification of BP outcomes, including daytime and nighttime systolic BP (SBP) and diastolic BP (SBP), making it the gold standard for diagnosis of hypertension (O'Brien et al., 2013). Additionally, ABP is more predictive of cardiovascular events and mortality than clinic BP alone (W.-Y. Yang et al., 2019), particularly among women (Boggia et al., 2011). We will examine not only the direct effects of dimensions of racial identity on ABP outcomes, but whether effects of segregation on ABP are moderated by racial identity. Racial identity is in part shaped by racial composition of community fostering a sense of group identity (Demo & Hughes, 1990), and those who have strong positive racial identity may experience more positive self-concept, sense of well-being, belonging and community in Black neighborhoods, and perhaps self-select into Black neighborhoods, which translate to better psychological and physiological health outcomes (Christie-Mizell et al., 2010). Based on the literature related to racial identity and mental and physical health outcomes among Black populations, we hypothesize that higher centrality and private regard, and lower public regard (indicative of racial discrimination being consistent with one's world view and expectations), will have protective effects on ABP outcomes, and buffer the effects of segregation on ABP outcomes.

Methods

Study participants

Participants in the current analysis were from the Mechanisms Underlying the impact of Stress and Emotions on African-American Women's Health Study (MUSE). This cohort was made up of 422 self-identified Black/African-American women between 30-46 years old in the southeast US. The overarching goal of the MUSE study was to investigate the extent to which social and psychosocial exposures influence cardiovascular disease risk. The present study used baseline data from this cohort, collected from December 2016 to March 2019.

Consumer residential and voter registration lists were utilized to identify potential African-American women in the target age range (30-45 years of age), selected for geographic variability in the Atlanta, Georgia metropolitan area (1-2 participants per census tract) and representing a wide range of socioeconomic backgrounds. Potential participants were then sent a flyer introducing the study, followed by a phone call. Inclusion criteria were self-identifying as a Black/African-American woman, being between 30-45 years old at the time of screening, and premenopausal with at least one ovary. Exclusion criteria included a history of clinical cardiovascular disease, being pregnant or lactating, any chronic illness known to influence atherosclerosis (e.g., HIV/AIDS, autoimmune or chronic inflammatory diseases such as lupus/rheumatoid arthritis, renal disease, liver disease), current treatment for psychiatric disorders, current illicit drug use (i.e., marijuana, cocaine), or alcohol abuse. Women who reported working overnight shifts were also excluded because of the known impact of shift-work on alterations in circadian rhythms which affect BP patterns.

Based on these inclusion and exclusion criteria, 831 individuals were eligible to participate in the study. Study staff contacted eligible participants and scheduled an in-person visit. A total of 422 eligible respondents, representing 201 unique census tracts, completed the in-person interview. All interviews were conducted in English by interviewers who identified as Black/African-American women. For these analyses, participants missing measures of interest, including measures for dimensions of racial identity (n=11), residential and activity space measures (n=8), outcomes (n=8), and covariates of interest in this study (n=7), were also excluded, resulting in a remaining analytic sample of 389 participants.

Measures

Outcomes: Ambulatory Blood Pressure

ABP monitors (OnTrak model 90227; Spacelabs Healthcare) were used to obtain ABP readings over a 48-hour period. Participants were trained on proper application and removal techniques and instructed to remove the device only to shower or bathe. ABP monitoring was programmed to record systolic BP (SBP) and diastolic BP (DBP) every 30 minutes during the day (8 am to 10 pm) and every hour during the night. Upon completion, the ABP monitoring device was returned to study staff. Readings were downloaded with Sentinel Software, version 10.5, from Spacelabs Healthcare.

Forty-eight-hour ABP completion rates ranged from 9% to 150% (some participants wore the ABP cuff for a few hours into the next day), with 88% of women achieving a completion rate of at least 80%. From these readings we were able to create continuous outcomes as well as categorize continuous measurements into hypertension phenotypes. Continuous outcomes included the mean of all SBP and DBP outcomes for daytime and nighttime, resulting in four continuous outcomes: daytime SBP, nighttime SBP, daytime DBP, and nighttime DBP. Continuous daytime and nighttime BPs were categorized as daytime hypertension (daytime SBP ≥130 mmHg or daytime DBP ≥80 mmHg) and nighttime hypertension (nighttime SBP ≥110 mmHg or nighttime DBP ≥65 mmHg) based on suggested ABP cutpoints for women (Hermida et al., 2015).

Exposures: Racial Identity

Dimensions of racial identity included in this study were centrality, private regard, and public regard, assessed via a modified version of the Multidimensional Inventory for Black Identity (MIBI) (Sellers et al., 1998). The MIBI is a self-report tool, this modified version including 11-items, measuring level of agreement with statements related to dimensions of racial identity on a 7-point Likert scale (*1=Strongly Disagree, 7=Strongly Agree*). Centrality, the importance of membership within a racial group to one's self-concept, was measured by level of agreement with the following four statements: *In general, being Black is an important part of my self-image; I have a strong sense of belonging to Black people; I have a strong attachment to other Black people; Being Black is an important reflection of who I am.* Private regard, one's feelings about their own racial/ethnic group, was measured by level of agreement with the following three statements: *I feel good about Black people; I am happy that I am Black; I am proud to be Black.* Public regard, beliefs about how those of other racial/ethnic groups in society perceive one's racial/ethnic group, was measured by level of agreement with the following four statements: *Overall, Blacks are considered good by others; In general, others respect Black people; In general, other groups view Blacks in a positive manner; Society views Black people as an asset.* Scores for each dimension were estimated by taking the average across the items for that dimension, possible scores ranging from 1-7, higher scores indicating race being more central to one's self-concept (high centrality), positive feelings about being Black and other Black people (high private regard), or believing that other racial/ethnic groups view Black people positively (high public regard). Only participants with responses to all items were assigned a scale score. Dimensions of MIBI have demonstrated high internal consistency and construct validity with scales measuring related constructs (Sellers et al., 1997).

Exposures: Residential and activity space segregation

Residential addresses were collected via self-report at baseline visit. Addresses were cleaned and geocoded in R, v4.1.1 (R Core Team, 2021). Of the 422 baseline addresses, less than 2% (n=8) of addresses were not geocoded – seven P.O. boxes and one address missing sufficient information to geocode.

Activity space locations were collected via a self-report questionnaire developed by Shareck and colleagues (Shareck et al., 2013), modified for use in this cohort (child school/daycare and leisure locations were added). This questionnaire allowed participants to report 0 to 10 activity space locations, including locations for studies (one), work (two), grocery shopping (two), physical activity (one), child school/daycare (one), child leisure activities (one), and other places they frequent (two). This questionnaire has demonstrated high convergent validity with activity space measures collected via global positioning system (GPS) tracking and prompted recall surveys (Shareck et al., 2013). Activity space addresses were cleaned and geocoded following the same procedures as residential addresses. Of the 1,771 activity space locations reported, 2.2% (n=39) were not geocoded for lack of sufficient address information to geocode.

Census tracts were used as proxies for neighborhood for residential and each activity space location. Using data from the US Census and 2018 5-year American Community Survey (ACS), segregation was defined as the percentage of Black residents in the census tract, or the racial composition of the census tract. Racial composition is a local corollary of the isolation index which is a weighted average of local racial compositions, describing in this case the extent to which the Black population is isolated from or exposed to other racial groups. Racial composition has been considered a crude measure of segregation (more specifically a measure of racial diversity) in that it does not fit the standard definition proposed by Massey and Denton which considers the spatial distribution of minority group members within the larger area (i.e., metropolitan statistical area [MSA], five-counties, city) (Kershaw & Albrecht, 2015; Massey & Denton, 1988). However, in this study, all participants were from the Atlanta metropolitan area and 99% of residential and 97-100% of activity space locations are within the same MSA (Atlanta – Sandy Springs – Alpharetta MSA). Therefore, the larger area often included in more explicit measures of segregation can be considered approximately uniform among all census tracts included in the study. For this reason, we considered the racial composition of census tracts an appropriate proxy of racial isolation segregation in this study, which we will refer to as segregation throughout this study.

A summary residential segregation and combined residential and activity space segregation level was estimated for each participant. Residential segregation was defined as the racial composition of the residential census tract. A combined residential and activity space segregation measure was defined as the median racial composition value among residential and all activity space locations.

Individual-Level Covariates

Covariates known to be associated with associated with residential segregation and blood pressure as potential confounders or mediators were adjusted for in analyses in order to isolate the effects of residential and activity space segregation on ABP outcomes. Individual-level sociodemographic information included self-reported age, educational attainment, employment status, partner status, income, and family size. Educational attainment was assessed as years of education and categorized in analyses as high school or less, some college, and college or more. Employment status was categorized as full-time, part-time, or unemployed, and partner status dichotomized as married/living with a partner or not. Household income was assessed with the following categories: <$35K, $35-<$50K, $50-<$75K, ≥$75K. Family size was included to contextualize the household income, and was reported as the number of people currently living in the participant's household, including the participant.

Traditional CVD risk factors included body mass index (BMI) calculated as measured weight divided by the square of measured height (kg/m2), current smoking status (dichotomized: current smoker or not), antihypertensive medication use in the past 12 months, and minutes of intentional exercise each week (Bertoni et al., 2008). Severity of depression symptoms was self-reported using the

Beck Depression Inventory (BDI), a 21-item, validated inventory widely used across populations (Beck, 1961).

Statistical Analyses

Descriptive statistics for the analytic sample were calculated by high/low centrality, private regard, and public regard scores. Based on distributions of scores, high centrality and private regard were defined as those reporting average responses of 6-7 (*Agree to Strongly Agree*) while low centrality and private regard was average scores 1-<6 (*Strongly Disagree to Somewhat Agree*); high public regard was defined as those reporting average responses of 4-7 (*Neither Agree Nor Disagree to Strongly Agree*) while low public regard was average scores 1-<4 (*Strongly Disagree to Somewhat Disagree*).

We fit linear regression models to examine associations between average scores for centrality, private regard, and public regard and continuous ABP measures (daytime SBP, daytime DBP, nighttime SBP, nighttime DBP). For each set of analyses, Model 1 was unadjusted. Model 2 was adjusted for age, Model 3 was further adjusted for sociodemographic factors (educational attainment, employment status, partner status, income, and family size), Model 4 was further adjusted for other traditional CVD risk factors (BMI, current smoking status, intentional exercise), Model 5 was further adjusted for antihypertensive medication use, and Model 6 was further adjusted for depression symptom severity.

In a separate series of models using the same sequence as above, we examined associations between average centrality, private regard, and public regard scores and dichotomous daytime and nighttime hypertension. As daytime and nighttime hypertension are highly prevalent in this cohort, odds ratios would overestimate the relative risk associated with our exposures due to violation of the rare event rate assumption (Zou, 2004). Therefore, we calculated prevalence ratios for dichotomous outcomes for better approximation of risk. In order to address convergence issues with using log-binomial models to calculate prevalence ratios, we use a modified Poisson approach using Poisson regression with robust variance to estimate prevalence ratios (Yelland et al., 2011; Zou, 2004).

Furthermore, we examine interaction between each of the racial identity dimensions (centrality, private regard, and public regard) and each of the segregation measures (residential segregation and combined residential and activity space segregation). To assess interaction on the additive scale, we include interaction terms in linear models with continuous outcomes, and we calculate the Relative Excess Risk due to Interaction (RERI) using logistic models for dichotomous outcomes. The RERI was calculated by including interaction terms in logistic models and substituting resulting regression coefficients in the formula: $RERI = e^{\widehat{\beta_1}+\widehat{\beta_2}+\widehat{\beta_3}} - e^{\widehat{\beta_1}} - e^{\widehat{\beta_2}} + 1$, where β_1 represents the regression coefficient for the racial identity variable, β_2 represents the regression coefficient for the segregation variable, and β_3 represents the regression coefficient for the interaction term between these two exposures. We used bootstrapping methods to estimate 95% confidence intervals (CIs) for RERI values. Where statistically significant interaction was indicated ($p < 0.05$), we created stratified tables for associations between the segregation measure and ABP outcomes by the high/low groups of the racial identity variable.

For each set of analyses, we conducted sensitivity analyses in which we excluded participants taking antihypertensive medications to examine how sensitive our results are to removing those with potentially controlled hypertension, as hypertension is the outcome of interest in this study. All analyses were conducted in R (R Core Team, 2021).

Results

Characteristics of the sample

Overall, centrality and private regard were high in this study, the average score for centrality 6.2 (SD: 1.0; range: 1.0, 7.0) and the average score for private regard 6.4 (SD: 0.8; range: 1.0, 7.0). Public regard was more normally distributed in this cohort, with an average score of 3.8 (SD: 1.5; range: 1.0, 7.0). Table 10 shows participant characteristics by high/low centrality groups. Those high in centrality were slightly more likely to be married (High Centrality: 39%, Low Centrality: 35%), more likely to have a college degree (High Centrality: 51%, LC Low Centrality 42%), be employed full-time (High Centrality: 67%, Low Centrality: 62%), and have a household income >75K (High Centrality: 33%, Low Centrality: 27%). While those high in centrality were more likely to be taking antihypertensive medications (High Centrality: 18%, Low Centrality: 14%), they were less likely to be current smokers (High Centrality: 8%, Low Centrality: 12%), exercised approximately 6 more minutes each week, and had lower depression symptom severity based on BDI scores (High Centrality: 5.7, Low Centrality: 6.4). Those reporting higher centrality had daytime and nighttime SBP and DBP equal to that of those reporting low centrality, and had lower prevalence of nighttime hypertension (High Centrality: 62%, Low Centrality: 70%), but had slightly higher prevalence of daytime hypertension (High Centrality: 37%, Low Centrality: 34%).

Table 11 shows participant characteristics by high/low private regard groups. Similar to patterns seen for high versus low centrality, those reporting higher private regard were higher in individual and census tract-level socioeconomic status measures, as they were more likely to be married (High Private Regard: 39%, Low Private Regard: 32%), have a college degree (High Private: 49%, Low Private Regard: 46%), work full-time (High Private: 66%, Low Private Regard: 62%), and have an income >75K (High Private: 31%, Low Private Regard: 30%), though they occupied slightly more segregated residential and activity spaces. However, many of these differences between high and low private regard groups were less pronounced than those seen between high and low centrality groups. As seen with centrality, those with high private regard were more likely to be taking antihypertensive medications in the past 12 months (High Private: 18%, Low Private Regard: 14%), but less likely to be current smokers (High Private: 8%, Low Private Regard: 14%). Those reporting high public regard also had lower depression symptom severity (High Private: 5.5, Low Private Regard: 7.2) as well as lower daytime and nighttime SBP and DBP and lower prevalence of nighttime hypertension (High Private: 62%, Low Private Regard: 71%), differences slightly larger than those seen between high and low centrality groups, but unlike with centrality, there was approximately equal prevalence of daytime hypertension among those reporting higher and lower private regard (≈36%).

On the other hand, patterns were different for high/low public regard groups (Table 12). While also in more segregated residential and activity spaces, those reporting higher public regard were less likely to be married (High Public: 34%, Low Public: 40%), less likely to have a college degree (High Public: 42%, Low Public: 52%), less likely to have an income >75K (High Public: 24%, Low Public: 36%), and were more likely to be current smokers (High Public: 11%, Low Public: 9%), and had higher average BMI (High Public: 33.6, Low Public: 31.9), but had lower depression symptom severity (High Public: 5.5, Low Public: 6.3). Daytime and nighttime SBP and DBP, and daytime hypertension prevalence, were similar between high and low public regard groups, but those reporting higher public regard had higher prevalence of nighttime hypertension (High Public: 68%, Low Public: 62%).

Main effects of racial centrality, private regard and public regard

Table 13 shows results for associations between centrality and ABP outcomes. We model a 1-point increase in the average centrality score, representing moving to a response level indicating higher centrality. Higher centrality was associated with lower daytime and nighttime SBP, but higher daytime and nighttime DBP. After adjusting for sociodemographic and traditional CVD risk factors, including depression symptom severity (Model 6), a 1-point increase in the average centrality score was associated with a 0.61 mmHg decrease in average daytime SBP (confidence interval [CI]: -1.77, 0.55) and a 0.77 mmHg decrease in nighttime SBP (CI: -1.84, 0.31), but a 0.45 mmHg increase in average daytime DBP (CI: -0.41, 1.30) and a 0.23 mmHg increase in average nighttime DBP (-0.59, 1.05). Higher centrality was associated with a 14% increased risk for daytime hypertension (prevalence ratio [PR]: 1.14; CI: 0.98, 1.32), and a 2% decreased risk for nighttime hypertension (CI: 0.91, 1.05).

Table 14 shows results for associations between private regard and ABP outcomes, again modeling a 1-point increase in the average private regard score, or higher private regard. Higher private regard was associated with lower daytime and nighttime SBP and DBP. In adjusted model 6, higher private regard was associated with a 1.16 mmHg decrease in average daytime SBP (CI: -2.58, 0.27) and a 1.37 mmHg decrease in nighttime SBP (CI: -2.69, -0.05), and a 0.21 mmHg decrease in average daytime DBP (CI: -1.27, 0.85) and a 0.56 mmHg decrease in average nighttime DBP (-1.57, 0.45). Higher private regard was associated with a 3% increased risk for daytime hypertension (PR: 1.03; CI: 0.88, 1.21), and a 4% decreased risk for nighttime hypertension (CI: 0.88, 1.05).

Table 15 shows results for associations between public regard and ABP outcomes, again modeling a 1-point increase in the average public regard score, or higher public regard. Higher public regard was associated with slightly lower daytime and nighttime SBP and less than a 0.1 mmHg change in daytime and nighttime DBP. In adjusted model 6, higher public regard was associated with a 0.22 mmHg decrease in average daytime SBP (CI: -1.01, 0.57) and a 0.21 mmHg decrease in nighttime SBP (CI: -0.94, 0.53), as well as a 0.08 mmHg increase in average daytime DBP (CI: -0.50, 0.66) and a 0.05 mmHg decrease in average nighttime DBP (-0.63, 0.52). Higher public regard was associated with a 2% increased risk for daytime hypertension (PR: 1.02; CI: 0.94, 1.12), and a 3% increased risk for nighttime hypertension (CI: 0.98, 1.08).

Interaction assessment

We did not find evidence of significant statistical interaction between dimensions of racial centrality and segregation measures in this cohort.

Sensitivity Analyses

We replicated these analyses restricted to participants who were not taking antihypertensive medications within the past 12 months, with a remaining sample size of 324 participants. Those taking antihypertensives had lower socioeconomic status based on all individual-level indicators, as well as worse health status based on CVD risk factors and ABP outcomes. In particular, the average BMI among those taking antihypertensive medications was 38.7 kg/m² compared to 31.5 kg/m² among those not taking antihypertensive medications. Also, those taking antihypertensive medications were more likely to be smokers, did approximately 15 minutes less intentional exercise, and had higher depression symptom severity. They also scored slightly higher on centrality and private and public regard.

After excluding those taking antihypertensive medications, patterns of associations remained (see Supplementary Tables 9-11). Effect sizes for continuous outcomes were often slightly attenuated, however effect sizes for daytime hypertension were increased for centrality and private regard in particular. In models adjusting for sociodemographics and traditional CVD risk factors, a 1-point increase in the centrality score was associated with a 14% increased risk for daytime hypertension (PR: 1.14; CI: 0.98, 1.32) when including those taking antihypertensive medications, and a 27% increase in daytime hypertension risk (PR: 1.27, CI: 1.03, 1.56) when excluding those taking antihypertensive medications. Similarly, a 1-point increase in the private regard score was associated with a 3% increased risk for daytime hypertension (PR: 1.03; CI: 0.88, 1.21) when including those taking antihypertensive medications, and a 11% increase in daytime hypertension risk (PR: 1.11, CI: 0.89, 1.38) when excluding those taking antihypertensive medications.

Discussion

The current study examined effects of racial identity on ABP outcomes, as well as the moderating effects of racial identity on associations between segregation and health, among young and middle-aged Black women in the southeast US. The goal of this research was to examine positive racial identity as a potential buffer of the adverse association between residential segregation and ABP.

Consistent with our hypothesis, we found that higher centrality, defined as Black identity being more central to one's self-concept and feeling more attachment and belonging with Black people, was associated with slightly lower daytime and nighttime SBP, and slightly higher daytime and nighttime DBP. But these effect sizes were small, especially for DBP, and likely not clinically meaningful (Guzman et al., 2014; Hess et al., 2016). However, counter to our hypothesis, higher centrality was associated with a 14% higher risk for daytime hypertension. Higher private regard, or more positive feelings about being Black, was associated in the expected direction with slightly lower levels of continuous BP measures, particularly a 1.16 mmHg lower daytime SBP and a 1.37 mmHg lower nighttime SBP. Finally, higher public regard, or more positive feelings about how other racial/ethnic groups view Black people, was also in the expected direction, and associated with minimally lower levels of daytime and nighttime SBP. However, effect sizes for all associations were near null. We did not find evidence of moderation of associations between segregation measures and ABP outcomes by racial identity dimensions in this cohort. We also did not find a change in this pattern of results after conducting sensitivity analyses excluding those taking antihypertensive medications in the past 12 months.

The vast majority of studies examining racial identity have examined protective effects of positive racial identity on mental health outcomes, particularly its ability to buffer the adverse effects of racial discrimination on mental health outcomes (Sellers & Shelton, 2003). It is hypothesized that Black Americans with higher centrality and public regard are buffered from the adverse mental health effects of racial discrimination. Those with higher centrality feel more attachment and belonging with their racial group and those with higher private regard feel more positively about their racial group, and therefore have a greater capacity to find support to cope with racist experiences within their communities and more easily reject harmful messages related to racism (Neblett et al., 2004; Sellers & Shelton, 2003), resulting in better mental health outcomes. There is empirical evidence supporting these theories, including buffering of negative effects of daily racial hassles on stress, depressive symptoms and anxiety among those who hold being Black as a central component of their racial identity (Neblett et al., 2004), and strong protective effects of more positive feelings toward Black populations, or higher private regard, on psychological adjustment outcomes (Burrow & Ong, 2010). Results for public regard have been more mixed, some studies showing more protective associations with mental health outcomes among those with lower public regard, or those who believe that other groups have negative opinions about Black Americans, potentially because experiences of racial discrimination are more consistent with their world view and expectations, and thus less psychologically taxing to cope with (Sellers & Shelton, 2003); other studies demonstrate lower public regard is associated with greater stress levels (Huguley et al., 2019). As mental health outcomes have implications for physical health outcomes, particularly depression and CVD (Zhang et al., 2022), we expected to see similar patterns of protective health effects on ABP outcomes. However, we only found minimally protective effects of higher private regard on daytime and nighttime SBP. We also did not find strong protective associations between centrality or public regard and ABP outcomes.

This was the first study to our knowledge to examine associations between racial identity dimensions and ABP outcomes. It is unclear why racial identity dimensions were not protective against elevated BP among the Black women in our cohort, and in fact centrality in particular appeared to be harmful. Those with higher centrality in this study had higher individual-level socioeconomic status, and were living in census tracts which were characterized by higher socioeconomic status relative to those reporting lower centrality. Consequently, these associations are not driven by individual or neighborhood-level deprivation.

It is hypothesized that although those with higher centrality and private regard, and lower public regard, are better equipped to cope with experiences of discrimination, they also are more likely to attribute unfair treatment to racial discrimination, which is in part how they are able to hone these coping skills (Sellers & Shelton, 2003). Neblett and colleagues demonstrated this higher perceived discrimination among those reporting higher centrality (Neblett et al., 2004). In a subsequent study, Neblett and colleagues investigated this hypothesis by examining moderating effects of racial identity measures on autonomic nervous system reactivity in the context of discriminatory events, and found that individuals with higher racial centrality and private regard had greater sympathetic activation in response to discriminatory events (Neblett & Roberts, 2013). While this increased frequency of appraisals may make one better prepared to deal with these experiences and build coping skills, this perceived threat may still be engaged with a fight-or-flight response, indicated by the sympathetic branch of the nervous system (SNS) being activated, and this increased exposure to physiological stress can result in biological “wear and tear” which contributes to adverse health outcomes, including cardiovascular disease (Geronimus, 1992).

The baseline data used in these analyses were collected from December 2016 – March 2019. This is a time in the wake of recent high-profile events, including the murders of Trayvon Martin in 2013 and Michael Brown in 2014, as well as the election of Donald Trump in 2016. This period of time is noted as one of increasing social unrest related to police and state-sanctioned violence against Black Americans (Curtis et al., 2021), and the election of Trump shedding new light on pre-existing negative attitudes toward racial and ethnic minorities (Williams, 2018). While there were mixed opinions in larger society on whether these events were motivated by interpersonal and structural racism, the heightened social unrest, protests, as well as the creation and growth of the Black Lives Matter movement during this time (Cohn & Quealy, 2020), indicate that many perceived heightened racial injustice, and studies show that Black Americans who felt more connected to their racial identity felt more unsafe and angry after the death of Trayvon Martin (Thomas & Blackmon, 2015). Therefore, the physiological risks associated with higher centrality at this time of heightened racial injustice and unrest, including SNS activation related to the appraisal of racism which can result in physiological dysregulation that affects CVD risk, may override the potential for protective and buffering effects of positive racial self-concept on health outcomes (Chae et al., 2021; Curtis et al., 2021). Though notably, those reporting higher centrality reported lower BDI scores, indicating lower depression symptom severity, despite evidence of adverse effects on physical health outcomes. As the MUSE study is a longitudinal cohort study, future studies should examine trends in the effects changing sociopolitical contexts with implications on population-level experiences of racism on ABP outcomes in this cohort.

It is also important to consider that we found adverse effects on dichotomous daytime hypertension outcomes in particular, defined as mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg. We did not find strong effects on continuous daytime measures, but perhaps because many people in the cohort were near the daytime DBP threshold for daytime hypertension, the slightly higher daytime DBP associated with higher centrality was enough to increase risk for crossing daytime hypertension thresholds. The higher racial centrality had more adverse effects on daytime hypertension risk was also a novel finding as this study was the first to examine this exposure with ABP outcomes. Daytime BP may be particularly reactive to environmental stimuli throughout the day (O'Brien et al., 2013), in this study daytime being defined as 8am to 10pm. Stressors which those reporting more centrality may be particularly vulnerable to may be more likely to happen in these daytime hours, which may be why we see adverse effects of higher racial centrality specific to daytime hypertension risk, but not nighttime. Modest protective associations were found between high private regard and nighttime SBP, nighttime SBP in particular found to be a strong predictor of cardiovascular events and mortality (Hansen et al., 2011).

There are important limitations to this study which should be noted. This was a cross-sectional study, and therefore we cannot make assumptions on temporality or causality in the associations between racial identity and BP. This study is also limited in that we could not further explore the potential for the larger sociopolitical environment to impact associations found for racial identity. For instance, we do not have measures of area-level exposure to racism, or attitudes or feelings about political climate. Additionally, centrality and private regard were relatively high in this cohort, so there was not as much variability in these estimates, but this is consistent with other studies (Thomas Tobin et al., 2021). Nonetheless, there may be greater selection of women with higher centrality into this study, as the MUSE study was advertised as the African American Women's Health Study. Moreover, this study took place in the context of Atlanta, a quickly growing city attracting Black migration, Black residents being pulled to the city for a variety of reasons, including the Black music, art, film, tech, and entrepreneurship presence, commonly for its reputation as "the Black mecca of the South" (Hobson, 2017). Therefore, this study may overall select for those with stronger, positive racial identity overall and not be representative of young and middle-aged Black women in Atlanta or the southeast US. Further exploration of ways in which area deprivation moderates positive racial identity should be explored in future research, as well as ways in which larger sociopolitical contexts may moderate racial identity effects. Finally, we have a relatively small analytic sample size in this study, and may not have the power to detect effects.

There were also important strengths to this study. This study focuses on young to middle-aged Black women, a population with concerning recent trends in CVD outcomes and mortality that has resulted in a call to action to explore factors related to CVD risk in this understudied population, as well as factors which may be protective and buffer the excess risk in this population (Kalinowski et al., 2019). Moreover, this study focuses on Black women in the southeast US, where low cardiovascular health tends to cluster (Zheng et al., 2021). While results of this study may not be generalizable to young and middle-aged Black women in other areas, it is also important for research to focus on relevant factors in the context of the southeast US. Also, we examine ABP, a novel outcome in racial identity research, which allows for more thorough description of racial centrality effects on the gold standard method for diagnosing hypertension.

Conclusions

In this study of young to middle-aged Black women in the southeast US, we found that higher private regard was associated with minimally lower levels of nighttime BP, SBP in particular, but higher centrality was associated with higher risk for daytime hypertension. These results suggest a greater sense of Black identity and belonging to Black community may be associated with higher risk for daytime hypertension. Future studies should continue to examine the mechanisms through which racial identity impacts mental and physical health outcomes. Furthermore, while we use baseline data in these analyses, future studies should examine patterns and relationships of the broader sociopolitical environment with racial identity and mental and physical health outcomes. Additionally, continuing to explore the racial/ethnic density hypothesis, future studies should continue to consider ways in which racial identity may moderate effects of segregation among Black communities, as segregation continues to persist and contribute to negative health outcomes among Black neighborhoods. In particular, racial identity may moderate the effects of neighborhood-level psychosocial resources in Black neighborhoods.

Chapter 5. Conclusions and Future Directions

Motivating this study are concerning trends in cardiovascular disease (CVD) development, prevalence, and mortality among young and middle-aged Black women (Kalinowski et al., 2019). As the number of counties in which White men have had faster rates of decline in CVD mortality than Black women have doubled since 1988 (Vaughan et al., 2019), it is important to examine factors which contribute to adverse outcomes and slow decline in this understudied population, as well as protective factors and those which may buffer the effects of adverse exposures. In this dissertation, we endeavored to expand the current conceptual models underlying place and health research in Black populations and neighborhoods, which investigate the adverse health effects associated with segregated residential spaces among Black populations. We integrated a “spatial polygamy” framework which has been relatively understudied in segregation research (Wong & Shaw, 2011), including the context of spaces where individuals spend most of their time and conduct their daily routines (Tamura et al., 2018). Additionally, we investigated the potential for protective and buffering effects of psychosocial resources associated with living in racially/ethnically-dense minority communities – an examination of the racial/ethnic density hypothesis which posits that health-promoting resources related to a sense of community and belongingness may be enhanced in minority communities (Bécares et al., 2012). Examinations of such neighborhood- and individual-level resilience factors are relatively understudied in racially/ethnically dense, or segregated, Black communities. We estimate effects of these exposures on ambulatory blood pressure (ABP) outcomes, a gold standard measure of blood pressure which allows 48-hour assessment of blood pressure (BP) throughout the day. In this final chapter, we summarize major findings from each of our three dissertation aims and discuss the overall contributions and implications of these findings within the segregation and ethnic density literature. We also describe the strengths and limitations, as well as future directions in research, associated with each dissertation aim.

Dissertation Aim 1

In Aim 1, we explored beyond a focus on residential space in studies of segregation and health, and compared results for residential and activity space segregation on ABP outcomes among young to middle-aged Black women. This inclusion of activity spaces allowed us to examine spaces where people do their daily routines beyond the residential area, and whether and how this was associated with daytime BP levels. We found that very few daily routines and activities, including work, grocery shopping, and physical activity, took place in residential tracts, and activity space segregation, or higher Black racial/ethnic density across activity space locations, was associated with a 12% higher risk for daytime hypertension. With these dynamic measures of place and BP, we concluded that the socioenvironmental context related to segregation of activity locations may have more of an impact on daytime hypertension risk. These findings of adverse associations related to segregated activity space environments, including food, grocery, and physical activity environments (Drewnowski et al., 2020; Javed et al., 2022), provide evidence for the segregation hypothesis beyond residential space. Interestingly, and contrary to prior studies, we did not find associations between residential (e.g. non-activity space) segregation and adverse BP outcomes.

We did not find support for the racial/ethnic density hypothesis for either residential or activity space segregation, as both were associated with null or worse ABP outcomes. However national studies have found that segregation across cities has remained persistently high (Bruch & Swait, 2019), requiring that future studies and policy target the individual- and area-level socioeconomic deprivation and inequalities associated with segregated space which contribute to adverse outcomes among Black populations. Future studies should examine other opportunities to highlight protective resources that may buffer the adverse individual- and area-level deprivation that might be associated with segregated spaces, particularly psychosocial resources which may be enhanced when living in racially/ethnically dense neighborhoods.

Limitations of this aim, as well as the other aims, include the cross-sectional nature of the study, as previous studies have shown the potential for exposure to segregation at younger age to affect later life health outcomes (Reddy et al., 2022). As Black women develop CVD earlier than other race-gender groups, having the steepest rise in hypertension prevalence between ages 15 to 40 (Geronimus et al., 2007), future studies should examine whether earlier life segregation, including childhood home, school, and other activity locations, may have impacts on later life ABP outcomes, or if there may be accumulation of these effects across the lifecourse. Another limitation was using census tracts as proxies for neighborhoods, which may not accurately capture the boundaries of space an individual was exposed to or perceived as their neighborhood (Pinchak et al., 2021). While, there are benefits associated with using these administrative boundaries (Krieger et al., 2005), future studies should examine the potential for changes in the associations we found using different neighborhood boundaries, including buffers around locations and self-reported boundaries. Another limitation of this study is the small sample size, which limited our ability to examine potential effects of clustering, as about 10% of the sample were in census tracts containing 3 or more participants.

There are important strengths of this aim, as well as the others, including a focus on young to middle-aged Black women, an understudied population with concerning trends in CVD risk, and specifically in the southeast US where low cardiovascular health tends to cluster (Zheng et al., 2021). Additionally, we capture much more information about spatial exposures and BP outcomes by going beyond the residential area and clinic BP to examine the complexity and heterogeneity of spatial exposures and daytime and nighttime BP reactivity.

Dissertation Aim 2

Heterogeneity in CVD risk among Black populations across census tracts in the Atlanta-metropolitan area has previously been described, indicating the presence of more resilient communities and the need to examine factors related to community-level resilience. The racial/ethnic density hypothesis posits that living in neighborhoods with a high proportion of residents of the same racial/ethnic background may enhance social cohesion and social support, and provide a sense of community and belongingness that can have protective and buffering effects against the negative mental and physical health consequences of chronic stressors and area deprivation associated with living in segregated communities. In aim 2, we examined social cohesion and activities with neighbors as psychosocial resources, potentially having protective associations with ABP outcomes, or moderating associations between segregation and ABP outcomes.

Though higher neighborhood social cohesion was associated with a slightly lower nighttime SBP, contrary to prevailing hypotheses, higher neighborhood social cohesion was associated with an elevated risk for daytime hypertension, and activities with neighbors had an even stronger adverse association with daytime hypertension risk. Furthermore, residential segregation, or racial/ethnic density, was associated with higher daytime and nighttime SBP and DBP among those reporting more activities with neighbors, but lower daytime and nighttime SBP and DBP among those reporting fewer activities with neighbors, though these effects were small. These results suggest the potential for the material, environmental and psychosocial risks associated with residential segregation to override the potential psychosocial resources available in racially/ethnically dense spaces. Investments in segregated spaces to combat the relative deprivation of Black neighborhoods may be necessary to strengthen the protective and buffering effects of better neighborhood social environments in Black neighborhoods.

Limitations and strengths for this aim includes those described in Aim 1. Those reporting higher neighborhood social cohesion and more activities with neighbors may also be those who have spent more time in their neighborhoods, and future studies should investigate whether accumulated time in segregated spaces may moderate the effects of neighborhood social environments. Furthermore, qualitative and community-based studies should shed further light on the protective and adverse aspects of social cohesion and activities with neighbors among Black populations and neighborhoods, which may better inform study tools to be used in when investigating population-level effects of neighborhood social environment and ethnic density in quantitative analyses.

Dissertation Aim 3

Positive racial/ethnic density effects may be less prevalent among studies of Black populations verses other racial/ethnic and immigrant groups because these groups have experienced different segregation process in the US: whereas centuries of racist practices and policies have persistently confined Black populations to the least desirable areas that separate them from the amenities and health-promoting resources given to White populations, non-Black racial and ethnic minority populations are more likely to strategically self-segregate to be within community among those with whom they share ethnic identity and cultural norms, facilitating the creation of close-knit communities characterized by social support and capital, and insulated from the discrimination associated with interracial contact (T.-C. Yang et al., 2017). Racial/ethnic identity, or sense of collective identity based on sharing cultural and racial/ethnic heritage (Demo & Hughes, 1990), may therefore be an important aspect of the creation and protectiveness of ethnic enclaves. In aim 3, we examined three dimensions of positive racial identity, psychosocial resources which have demonstrated positive associations with mental health outcomes, as potentially having protective associations with ABP outcomes, or moderating associations between segregation and ABP outcomes. We found higher private regard, or more positive feelings about being Black, was associated with slightly lower levels of continuous daytime and nighttime SBP measures. Contrary to our hypotheses, we found that higher centrality, defined as Black identity being more central to one's self-concept and feeling more attachment and belonging with Black people, was associated with a higher risk for daytime hypertension.

Future studies should continue to examine the mechanisms through which racial identity impacts mental and physical health outcomes. While those reporting higher centrality had lower depression symptom severity on average, this did not translate into a physical health benefit in this cohort. Previous studies have hypothesized and demonstrated that those with higher centrality are better able to cope with stressors related to race, but are also more likely to attribute events to racial discrimination (Neblett et al., 2004), activating a stress response which may have negative effects on hypertension risk (Geronimus, 1992; Neblett & Roberts, 2013). However, there are still few studies which have examined associations between racial identity and physiological outcomes. The data for this study was collected from December 2016 – March 2019, a time of growing social unrest related to racist events in the US, including the rise of the Black Lives Matter Movement. Those with higher centrality may have experienced relatively more psychosocial risks associated with high centrality in this time (Thomas & Blackmon, 2015), versus the potential psychosocial benefits of high centrality. While we use baseline data in these analyses, future studies should examine patterns and relationships of the broader sociopolitical environment with racial identity and mental and physical health outcomes.

Limitations and strengths for this aim includes those described in Aim 1. An additional strength of this study is that it is one of few to examine racial identity with a gold standard measure of a physical health outcomes, and examines a potential factor related to individual-level heterogeneity in risk among Black populations and communities beyond gender or age.

At present, young and middle-aged Black women are experiencing concerning trends in CVD prevalence and mortality, requiring research into health-harming and health-protective factors impacting this population. Our findings contribute to studies of Black communities and health outcomes by highlighting the potential health implications of the sociocontextual spaces where individuals conduct their activities and interact beyond the residential space. We hoped to inform prevention efforts by identifying neighborhood- and individual-level factors which may be related to resilience among Black populations and neighborhoods. However, we found only minimal evidence of protective effects, and evidence of health harming effects of hypothesized psychosocial resources. Our findings suggest that the adverse conditions associated with being Black in the US and/or living in segregated Black neighborhoods may override protective features related to living in racially/ethnically dense communities in the southeast US. Future studies should continue disentangling and understanding these relationships, and continue examining the potential for protective factors in persistently segregated Black neighborhoods. These studies may highlight future interventions for promoting resilience among Black communities and individuals.

Tables

Table 1. Characteristics of analytic sample by high/low residential segregation groups.

	High Residential Segregation (77.8% - 98.5% Black)	***Low Residential Segregation (3.4% - <77.8% Black)***
Covariates		
Age, years (mean, SD)	37.7 (4.24)	38.0 (4.27)
Married/Partnered (n, %)	55 (27.9%)	93 (46.0%)
College Degree (n, %)	75 (38.1%)	115 (56.9%)
Full-time employed (n, %)	116 (58.9%)	142 (70.3%)
Income >75K (n, %)	44 (22.3%)	79 (39.1%)
Family Size (mean, SD)	3.4 (1.83)	3.8 (1.67)
Antihypertensive Medication User (n, %)	36 (18.3%)	30 (14.9%)
Current Smoker (n, %)	30 (15.2%)	10 (5.0%)
Body Mass Index (mean, SD)	33.2 (7.86)	32.1 (8.16)
Intentional Exercise (minutes/week, mean, SD)	51.6 (67.8)	45.9 (80.2)
Beck Depression Inventory Score (mean, SD)	6.0 (7.16)	5.9 (6.53)
Exposures		
Residential Segregation, % Black (mean, SD)	0.92 (0.046)	0.55 (0.178)
Activity Space Segregation, % Black (mean, SD)	0.62 (0.272)	0.47 (0.223)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	122 (12.1)	121 (12.4)
Daytime Diastolic Blood Pressure (mean, SD)	77.8 (8.66)	77.2 (8.95)
Nighttime Systolic Blood Pressure (mean, SD)	112 (11.6)	110 (11.4)
Nighttime Diastolic Blood Pressure (mean, SD)	69.0 (8.58)	67.8 (8.20)
Daytime Hypertension (n, %)	78 (39.6%)	66 (32.7%)
Nighttime Hypertension (n, %)	135 (68.5%)	127 (62.9%)

Table 2. Characteristics of analytic sample by high/low activity space segregation groups.

	High Activity Space Segregation (56.0% - 97.7% Black)	***Low Activity Space Segregation (3.0% - <56.0% Black)***
Covariates		
Age, years (mean, SD)	38.0 (4.15)	37.7 (4.36)
Married/Partnered (n, %)	78 (39.2%)	70 (35.0%)
College Degree (n, %)	87 (43.7%)	103 (51.5%)
Full-time employed (n, %)	111 (55.8%)	147 (73.5%)
Income >75K (n, %)	55 (27.6%)	68 (34.0%)
Family Size (mean, SD)	3.8 (1.87)	3.4 (1.62)
Antihypertensive Medication User (n, %)	36 (18.1%)	30 (15.0%)
Current Smoker (n, %)	21 (10.6%)	19 (9.5%)
Body Mass Index (mean, SD)	32.9 (7.82)	32.3 (8.22)
Intentional Exercise (minutes/week, mean, SD)	50.0 (58.6)	47.4 (87.4)
Beck Depression Inventory Score (mean, SD)	5.8 (6.99)	6.1 (6.70)
Exposures		
Residential Segregation, % Black (mean, SD)	0.80 (0.188)	0.67 (0.249)
Activity Space Segregation, % Black (mean, SD)	0.77 (0.117)	0.32 (0.139)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	122 (12.5)	121 (12.1)
Daytime Diastolic Blood Pressure (mean, SD)	77.5 (9.29)	77.4 (8.31)
Nighttime Systolic Blood Pressure (mean, SD)	112 (12.0)	111 (11.0)
Nighttime Diastolic Blood Pressure (mean, SD)	68.7 (8.72)	68.1 (8.09)
Daytime Hypertension (n, %)	77 (38.7%)	67 (33.5%)
Nighttime Hypertension (n, %)	133 (66.8%)	129 (64.5%)

Table 3. Adjusted Associations between Residential and Activity Space Segregation (per 20% Increase in Proportion of Black Residents) and Daytime Systolic and Diastolic Blood Pressure in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Systolic Blood Pressure			**Daytime Diastolic Blood Pressure**		
	Residential % Black	***Activity Space % Black***	***Residential + Activity Space % Black***	***Residential % Black***	***Activity Space % Black***	***Residential + Activity Space % Black***
Model 1. Unadjusted	*0.04 (-1.02, 1.09)*	*0.38 (-0.56, 1.31)*	*0.81 (-0.17, 1.79)*	*-0.03 (-0.78, 0.73)*	*0.25 (-0.42, 0.92)*	*0.42 (-0.28, 1.13)*
Model 2. Adjusted for age	*0.20 (-0.86, 1.26)*	*0.39 (-0.54, 1.32)*	*0.79 (-0.18, 1.77)*	*0.05 (-0.71, 0.82)*	*0.25 (-0.42, 0.92)*	*0.42 (-0.29, 1.12)*
Model 3. Model 2 + sociodemographics[a]	*-0.35 (-1.45, 0.76)*	*0.30 (-0.67, 1.26)*	*0.58 (-0.43, 1.59)*	*-0.26 (-1.06, 0.54)*	*0.19 (-0.51, 0.89)*	*0.29 (-0.44, 1.02)*
Model 4. Model 3 + antihypertensive medication use	*-0.43 (-1.48, 0.62)*	*0.33 (-0.59, 1.24)*	*0.51 (-0.45, 1.47)*	*-0.31 (-1.08, 0.45)*	*0.21 (-0.46, 0.88)*	*0.24 (-0.46, 0.94)*
Model 5. Model 4 + traditional CVD risk factors[b]	*-0.55 (-1.60, 0.50)*	*0.35 (-0.57, 1.26)*	*0.51 (-0.44, 1.47)*	*-0.36 (-1.13, 0.41)*	*0.22 (-0.45, 0.89)*	*0.23 (-0.47, 0.93)*
Model 6. Model 5 + depression symptom severity[c]	*-0.48 (-1.54, 0.57)*	*0.40 (-0.51, 1.31)*	*0.58 (-0.38, 1.53)*	*-0.33 (-1.10, 0.45)*	*0.25 (-0.42, 0.92)*	*0.26 (-0.44, 0.97)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, antihypertensive medication use
[c]Beck Depression Inventory score
*p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI)

Table 4. Adjusted Associations between Residential and Activity Space Segregation (per 20% Increase in Proportion of Black Residents) and Nighttime Systolic and Diastolic Blood Pressure in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Nighttime Systolic Blood Pressure			**Nighttime Diastolic Blood Pressure**		
	Residential % Black	***Activity Space % Black***	***Residential + Activity Space % Black***	***Residential % Black***	***Activity Space % Black***	***Residential + Activity Space % Black***
Model 1. Unadjusted	*0.30 (-0.69, 1.29)*	*0.39 (-0.49, 1.27)*	*0.64 (-0.29, 1.56)*	*0.40 (-0.33, 1.12)*	*0.42 (-0.22, 1.06)*	*0.50 (-0.18, 1.17)*
Model 2. Adjusted for age	*0.44 (-0.56, 1.44)*	*0.40 (-0.48, 1.27)*	*0.62 (-0.30, 1.55)*	*0.49 (-0.24, 1.21)*	*0.42 (-0.22, 1.06)*	*0.49 (-0.18, 1.16)*
Model 3. Model 2 + sociodemographics[a]	*-0.04 (-1.09, 1.00)*	*0.22 (-0.70, 1.13)*	*0.39 (-0.56, 1.35)*	*0.23 (-0.53, 1.00)*	*0.32 (-0.35, 0.99)*	*0.36 (-0.34, 1.06)*
Model 4. Model 3 + antihypertensive medication use	*-0.12 (-1.11, 0.86)*	*0.25 (-0.61, 1.11)*	*0.32 (-0.58, 1.23)*	*0.18 (-0.55, 0.91)*	*0.34 (-0.30, 0.98)*	*0.31 (-0.36, 0.98)*
Model 5. Model 4 + traditional CVD risk factors[b]	*-0.27 (-1.25, 0.71)*	*0.28 (-0.56, 1.13)*	*0.33 (-0.56, 1.22)*	*0.11 (-0.62, 0.85)*	*0.36 (-0.28, 1.00)*	*0.30 (-0.37, 0.97)*
Model 6. Model 5 + depression symptom severity[c]	*-0.21 (-1.19, 0.76)*	*0.33 (-0.52, 1.18)*	*0.39 (-0.50, 1.27)*	*0.15 (-0.58, 0.89)*	*0.40 (-0.24, 1.04)*	*0.34 (-0.33, 1.01)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, antihypertensive medication use
[c]Beck Depression Inventory score
*p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI)

Table 5. Adjusted Prevalence Ratios for Associations between Residential and Activity Space Segregation (per 20% Increase in Proportion of Black Residents) and Daytime and Nighttime Hypertension in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Hypertension (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)			**Nighttime Hypertension (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)**		
	Residential % Black	***Activity Space % Black***	***Residential + Activity Space % Black***	***Residential % Black***	***Activity Space % Black***	***Residential + Activity Space % Black***
Model 1. Unadjusted	*1.05 (0.94, 1.19)*	*1.12 (1.01, 1.24)**	*1.15 (1.03, 1.28)**	*1.03 (0.97, 1.10)*	*1.03 (0.98, 1.09)*	*1.04 (0.98, 1.11)*
Model 2. Adjusted for age	*1.06 (0.95, 1.20)*	*1.12 (1.01, 1.24)**	*1.14 (1.03, 1.28)**	*1.04 (0.97, 1.10)*	*1.03 (0.98, 1.09)*	*1.04 (0.98, 1.11)*
Model 3. Model 2 + sociodemographics[a]	*1.02 (0.90, 1.15)*	*1.11 (1.00, 1.23)*	*1.12 (1.00, 1.26)**	*1.02 (0.96, 1.09)*	*1.02 (0.97, 1.09)*	*1.03 (0.97, 1.10)*
Model 4. Model 3 + antihypertensive medication use	*1.01 (0.90, 1.14)*	*1.11 (1.01, 1.23)**	*1.12 (1.00, 1.25)**	*1.02 (0.96, 1.09)*	*1.03 (0.97, 1.09)*	*1.03 (0.97, 1.09)*
Model 5. Model 4 + traditional CVD risk factors[b]	*1.01 (0.90, 1.14)*	*1.12 (1.01, 1.24)**	*1.12 (1.00, 1.25)**	*1.02 (0.95, 1.09)*	*1.03 (0.97, 1.09)*	*1.03 (0.97, 1.09)*
Model 6. Model 5 + depression symptom severity[c]	*1.02 (0.90, 1.15)*	*1.12 (1.01, 1.24)**	*1.13 (1.01, 1.26)**	*1.02 (0.95, 1.09)*	*1.03 (0.97, 1.09)*	*1.03 (0.97, 1.10)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, antihypertensive medication use
[c]Beck Depression Inventory score
*p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 6. Characteristics of analytic sample by high/low neighborhood social cohesion groups.

	High Neighborhood Social Cohesion (Score = 2.75 - 4)	***Low Neighborhood Social Cohesion (Score = 0 - <2.75)***
Individual-Level Covariates		
Age, years (mean, SD)	38.8 (4.11)	37.0 (4.24)
Married/Partnered (n, %)	96 (47.3%)	50 (26.9%)
College Degree (n, %)	112 (55.2%)	75 (40.3%)
Full-time employed (n, %)	136 (67.0%)	116 (62.4%)
Income >75K (n, %)	84 (41.4%)	39 (21.0%)
Family Size (mean, SD)	3.7 (1.74)	3.5 (1.80)
Antihypertensive Medication User (n, %)	30 (14.8%)	33 (17.7%)
Current Smoker (n, %)	16 (7.9%)	24 (12.9%)
Body Mass Index (mean, SD)	32.1 (7.76)	33.3 (8.31)
Intentional Exercise (minutes/week, mean, SD)	45.8 (80.7)	52.4 (67.8)
Beck Depression Inventory Score (mean, SD)	4.6 (5.68)	7.3 (7.48)
Exposures		
Activities with Neighbors (mean, SD)	1.75 (0.687)	1.22 (0.732)
Residential Segregation, % Black (mean, SD)	0.69 (0.241)	0.78 (0.208)
Residential and Activity Space Segregation, % Black (mean, SD)	0.54 (0.254)	0.55 (0.265)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	121 (12.4)	122 (12.3)
Daytime Diastolic Blood Pressure (mean, SD)	77.4 (9.04)	77.7 (8.74)
Nighttime Systolic Blood Pressure (mean, SD)	110 (11.7)	112 (11.2)
Nighttime Diastolic Blood Pressure (mean, SD)	68.0 (8.40)	68.9 (8.54)
Daytime Hypertension (n, %)	72 (35.5%)	70 (37.6%)
Nighttime Hypertension (n, %)	131 (64.5%)	124 (66.7%)

Table 7. Characteristics of analytic sample by high/low activities with neighbors groups.

	High Activities with Neighbors (Score = 1.4 - 3)	***Low Activities with Neighbors (Score = 0 - <1.4)***
Individual-Level Covariates		
Age, years (mean, SD)	38.6 (4.07)	37.2 (4.34)
Married/Partnered (n, %)	79 (40.5%)	67 (34.5%)
College Degree (n, %)	98 (50.3%)	89 (45.9%)
Full-time employed (n, %)	121 (62.1%)	131 (67.5%)
Income >75K (n, %)	74 (37.9%)	49 (25.3%)
Family Size (mean, SD)	3.6 (1.76)	3.6 (1.77)
Antihypertensive Medication User (n, %)	38 (19.5%)	25 (12.9%)
Current Smoker (n, %)	26 (13.3%)	14 (7.2%)
Body Mass Index (mean, SD)	32.5 (7.99)	32.9 (8.10)
Intentional Exercise (minutes/week, mean, SD)	55.8 (66.6)	42.0 (81.8)
Beck Depression Inventory Score (mean, SD)	5.5 (6.34)	6.3 (7.08)
Exposures		
Neighborhood Social Cohesion (mean, SD)	2.78 (0.746)	2.40 (0.665)
Residential Segregation, % Black (mean, SD)	0.74 (0.247)	0.73 (0.213)
Residential and Activity Space Segregation, % Black (mean, SD	0.55 (0.261)	0.53 (0.258)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	122 (12.7)	120 (11.9)
Daytime Diastolic Blood Pressure (mean, SD)	78.2 (8.99)	76.9 (8.75)
Nighttime Systolic Blood Pressure (mean, SD)	112 (11.7)	110 (11.2)
Nighttime Diastolic Blood Pressure (mean, SD)	68.8 (8.69)	68.1 (8.25)
Daytime Hypertension (n, %)	80 (41.0%)	62 (32.0%)
Nighttime Hypertension (n, %)	128 (65.6%)	127 (65.5%)

Table 8. Adjusted Associations between Neighborhood Social Cohesion (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) Study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.85 (-2.53, 0.84)*	*-0.20 (-1.42, 1.01)*	1.02 (0.84, 1.23)	*-1.74 (-3.30, -0.19)**	*-1.12 (-2.28, 0.03)*	*0.96 (0.88, 1.05)*
Model 2. Adjusted for age	*-1.25 (-2.95, 0.46)*	*-0.38 (-1.62, 0.85)*	1.00 (0.83, 1.20)	*-2.12 (-3.69, -0.54)**	*-1.35 (-2.51, -0.18)**	*0.95 (0.87, 1.04)*
Model 3. Model 2 + sociodemographics[a]	*-0.62 (-2.36, 1.13)*	*0.001 (-1.27, 1.27)*	1.06 (0.88, 1.28)	*-1.63 (-3.25, -0.02)**	*-1.09 (-2.29, 0.12)*	*0.96 (0.87, 1.05)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.50 (-2.22, 1.23)*	*0.09 (-1.18, 1.37)*	1.06 (0.88, 1.28)	*-1.51 (-3.07, 0.06)*	*-0.99 (-2.19, 0.22)*	*0.96 (0.87, 1.06)*
Model 5. Model 4 + antihypertensive medication use	*-0.33 (-1.99, 1.32)*	*0.22 (-1.00, 1.44)*	1.07 (0.90, 1.27)	*-1.36 (-2.86, 0.15)*	*-0.88 (-2.03, 0.28)*	*0.97 (0.88, 1.07)*
Model 6. Model 5 + depression symptom severity[c]	*-0.03 (-1.71, 1.65)*	*0.40 (-0.84, 1.64)*	1.11 (0.93, 1.32)	*-1.15 (-2.67, 0.38)*	*-0.73 (-1.91, 0.45)*	*0.97 (0.88, 1.08)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ł Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 9. Adjusted Associations between Activities with Neighbors (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) Study

	Daytime Measures			Nighttime Measures		
	Systolic Blood Pressure ƚ	***Diastolic Blood Pressure ƚ***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure ƚ***	***Diastolic Blood Pressure ƚ***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*0.77 (-0.85, 2.40)*	*0.42 (-0.75, 1.60)*	1.17 (0.98, 1.40)	*0.33 (-1.19, 1.84)*	*-0.06 (-1.18, 1.06)*	*0.98 (0.89, 1.07)*
Model 2. Adjusted for age	*0.48 (-1.16, 2.12)*	*0.29 (-0.90, 1.48)*	1.16 (0.97, 1.38)	*0.07 (-1.46, 1.60)*	*-0.22 (-1.35, 0.91)*	*0.97 (0.88, 1.06)*
Model 3. Model 2 + sociodemographics[a]	*0.67 (-0.97, 2.31)*	*0.37 (-0.82, 1.57)*	1.17 (0.99, 1.40)	*0.24 (-1.29, 1.77)*	*-0.10 (-1.23, 1.04)*	*0.98 (0.89, 1.07)*
Model 4. Model 3 + traditional CVD risk factors[b]	*0.59 (-1.05, 2.22)*	*0.29 (-0.92, 1.51)*	1.19 (1.00, 1.42)*	*0.20 (-1.30, 1.69)*	*-0.15 (-1.30, 0.99)*	*0.98 (0.89, 1.07)*
Model 5. Model 4 + antihypertensive medication use	*0.39 (-1.18, 1.96)*	*0.14 (-1.02, 1.30)*	1.17 (0.98, 1.39)	*0.02 (-1.41, 1.45)*	*-0.29 (-1.39, 0.82)*	*0.97 (0.88, 1.06)*
Model 6. Model 5 + depression symptom severity[c]	*0.52 (-1.04, 2.09)*	*0.21 (-0.95, 1.37)*	1.20 (1.00, 1.43)*	*0.12 (-1.31, 1.56)*	*-0.21 (-1.32, 0.89)*	*0.97 (0.88, 1.07)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ƚ Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 10. Characteristics of analytic sample by high/low racial centrality groups.

	High Centrality (Agree/Strongly Agree)	***Low Centrality (Strongly Disagree-Somewhat Agree)***
Individual-Level Covariates		
Age, years (mean, SD)	38.1 (4.38)	37.4 (4.09)
Married/Partnered (n, %)	96 (38.6%)	49 (35.3%)
College Degree (n, %)	128 (51.4%)	58 (41.7%)
Full-time employed (n, %)	166 (66.7%)	86 (61.9%)
Income >75K (n, %)	82 (32.9%)	38 (27.3%)
Family Size (mean, SD)	3.70 (1.86)	3.40 (1.60)
Antihypertensive Medication User (n, %)	44 (17.7%)	20 (14.4%)
Current Smoker (n, %)	21 (8.4%)	17 (12.2%)
Body Mass Index (mean, SD)	32.8 (8.20)	32.2 (7.61)
Intentional Exercise (minutes/week, mean, SD)	51.2 (81.1)	45.6 (63.6)
Beck Depression Inventory Score (mean, SD)	5.71 (6.82)	6.44 (7.08)
Exposures		
Private Regard (mean, SD)	6.73 (0.414)	5.88 (1.04)
Public Regard (mean, SD)	3.79 (1.63)	3.70 (1.19)
Residential Segregation, % Black (mean, SD)	0.735 (0.224)	0.716 (0.241)
Activity Space Segregation, % Black (mean, SD)	0.556 (0.255)	0.518 (0.265)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	121 (12.1)	122 (12.7)
Daytime Diastolic Blood Pressure (mean, SD)	77.4 (8.66)	77.4 (9.17)
Nighttime Systolic Blood Pressure (mean, SD)	110 (11.3)	112 (12.0)
Nighttime Diastolic Blood Pressure (mean, SD)	68.1 (8.33)	68.5 (8.64)
Daytime Hypertension (n, %)	91 (36.5%)	47 (33.8%)
Nighttime Hypertension (n, %)	154 (61.8%)	97 (69.8%)

Table 11. Characteristics of analytic sample by high/low racial private regard groups.

	High Private Regard (Agree/Strongly Agree)	***Low Private Regard (Strongly Disagree-Somewhat Agree)***
Individual-Level Covariates		
Age, years (mean, SD)	38.0 (4.25)	37.5 (4.39)
Married/Partnered (n, %)	110 (39.3%)	35 (32.4%)
College Degree (n, %)	136 (48.6%)	50 (46.3%)
Full-time employed (n, %)	185 (66.1%)	67 (62.0%)
Income >75K (n, %)	88 (31.4%)	32 (29.6%)
Family Size (mean, SD)	3.71 (1.86)	3.29 (1.51)
Antihypertensive Medication User (n, %)	49 (17.5%)	15 (13.9%)
Current Smoker (n, %)	23 (8.2%)	15 (13.9%)
Body Mass Index (mean, SD)	32.7 (8.15)	32.2 (7.57)
Intentional Exercise (minutes/week, mean, SD)	49.2 (76.2)	49.1 (73.0)
Beck Depression Inventory Score (mean, SD)	5.50 (6.65)	7.19 (7.45)
Exposures		
Centrality (mean, SD)	6.53 (0.574)	5.26 (1.28)
Public Regard (mean, SD)	3.89 (1.57)	3.42 (1.19)
Residential Segregation, % Black (mean, SD)	0.731 (0.230)	0.720 (0.231)
Activity Space Segregation, % Black (mean, SD)	0.549 (0.258)	0.526 (0.260)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	120 (11.9)	123 (13.2)
Daytime Diastolic Blood Pressure (mean, SD)	77.1 (8.54)	78.0 (9.57)
Nighttime Systolic Blood Pressure (mean, SD)	110 (10.9)	113 (12.8)
Nighttime Diastolic Blood Pressure (mean, SD)	68.0 (8.30)	69.1 (8.77)
Daytime Hypertension (n, %)	100 (35.7%)	38 (35.2%)
Nighttime Hypertension (n, %)	174 (62.1%)	77 (71.3%)

Table 12. Characteristics of analytic sample by high/low racial public regard groups.

	High Private Regard (Somewhat Disagree - Strongly Agree)	***Low Private Regard (Strongly Disagree/ Disagree)***
Individual-Level Covariates		
Age, years (mean, SD)	37.8 (4.28)	37.9 (4.30)
Married/Partnered (n, %)	54 (33.5%)	91 (40.1%)
College Degree (n, %)	68 (42.2%)	118 (52.0%)
Full-time employed (n, %)	104 (64.6%)	148 (65.2%)
Income >75K (n, %)	39 (24.2%)	81 (35.7%)
Family Size (mean, SD)	3.75 (1.75)	3.48 (1.79)
Antihypertensive Medication User (n, %)	35 (21.7%)	29 (12.8%)
Current Smoker (n, %)	18 (11.2%)	20 (8.8%)
Body Mass Index (mean, SD)	33.6 (8.26)	31.9 (7.74)
Intentional Exercise (minutes/week, mean, SD)	56.9 (96.9)	43.7 (54.4)
Beck Depression Inventory Score (mean, SD)	5.48 (6.81)	6.32 (6.98)
Exposures		
Centrality (mean, SD)	6.33 (0.785)	6.06 (1.13)
Private Regard (mean, SD)	6.63 (0.528)	6.28 (0.938)
Residential Segregation, % Black (mean, SD)	0.766 (0.212)	0.701 (0.240)
Activity Space Segregation, % Black (mean, SD)	0.581 (0.262)	0.515 (0.254)
Outcomes		
Daytime Systolic Blood Pressure (mean, SD)	121 (11.4)	121 (13.0)
Daytime Diastolic Blood Pressure (mean, SD)	77.7 (8.61)	77.1 (9.00)
Nighttime Systolic Blood Pressure (mean, SD)	111 (10.5)	111 (12.3)
Nighttime Diastolic Blood Pressure (mean, SD)	68.0 (7.79)	68.4 (8.87)
Daytime Hypertension (n, %)	59 (36.6%)	79 (34.8%)
Nighttime Hypertension (n, %)	110 (68.3%)	141 (62.1%)

Table 13. Adjusted Associations between Centrality (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.40 (-1.62, 0.83)*	*0.52 (-0.36, 1.40)*	*1.14 (0.97, 1.32)*	*-0.62 (-1.76, 0.53)*	*0.32 (-0.52, 1.15)*	*0.99 (0.92, 1.07)*
Model 2. Adjusted for age	*-0.58 (-1.80, 0.65)*	*0.45 (-0.44, 1.33)*	*1.13 (0.96, 1.31)*	*-0.75 (-1.90, 0.40)*	*0.24 (-0.60, 1.09)*	*0.99 (0.92, 1.06)*
Model 3. Model 2 + sociodemographics[a]	*-0.44 (-1.67, 0.79)*	*0.55 (-0.34, 1.44)*	*1.15 (0.98, 1.35)*	*-0.64 (-1.80, 0.52)*	*0.29 (-0.56, 1.14)*	*0.98 (0.91, 1.06)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.49 (-1.69, 0.72)*	*0.54 (-0.35, 1.43)*	*1.15 (0.98, 1.35)*	*-0.65 (-1.77, 0.46)*	*0.31 (-0.54, 1.16)*	*0.99 (0.92, 1.06)*
Model 5. Model 4 + antihypertensive medication use	*-0.62 (-1.78, 0.54)*	*0.44 (-0.41, 1.30)*	*1.14 (0.98, 1.32)*	*-0.77 (-1.85, 0.30)*	*0.22 (-0.59, 1.04)*	*0.98 (0.91, 1.05)*
Model 6. Model 5 + depression symptom severity[c]	*-0.61 (-1.77, 0.55)*	*0.45 (-0.41, 1.30)*	*1.14 (0.98, 1.32)*	*-0.77 (-1.84, 0.31)*	*0.23 (-0.59, 1.05)*	*0.98 (0.91, 1.05)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ƚ Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 14. Adjusted Associations between Private Regard (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-1.08 (-2.59, 0.44)*	*-0.18 (-1.27, 0.91)*	*1.03 (0.87, 1.22)*	*-1.32 (-2.74, 0.10)*	*0.20 (-0.63, 1.02)*	*0.97 (0.89, 1.06)*
Model 2. Adjusted for age	*-1.17 (-2.68, 0.34)*	*-0.23 (-1.32, 0.86)*	*1.03 (0.87, 1.21)*	*-1.39 (-2.81, 0.02)*	*-0.47 (-1.51, 0.57)*	*1.03 (0.99, 1.08)*
Model 3. Model 2 + sociodemographics[a]	*-1.05 (-2.56, 0.47)*	*-0.14 (-1.23, 0.96)*	*1.04 (0.88, 1.23)*	*-1.29 (-2.71, 0.14)*	*-0.51 (-1.55, 0.53)*	*1.03 (0.98, 1.08)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-1.04 (-2.52, 0.45)*	*-0.10 (-1.20, 1.00)*	*1.04 (0.88, 1.23)*	*-1.27 (-2.64, 0.11)*	*-0.47 (-1.52, 0.58)*	*1.03 (0.98, 1.08)*
Model 5. Model 4 + antihypertensive medication use	*-1.23 (-2.66, 0.19)*	*-0.25 (-1.30, 0.80)*	*1.03 (0.88, 1.20)*	*-1.44 (-2.77, -0.12)*	*-0.43 (-1.47, 0.61)*	*1.02 (0.98, 1.08)*
Model 6. Model 5 + depression symptom severity[c]	*-1.16 (-2.58, 0.27)*	*-0.21 (-1.27, 0.85)*	*1.03 (0.88, 1.21)*	*-1.37 (-2.69, -0.05)*	*-0.56 (-1.57, 0.45)*	*0.96 (0.88, 1.05)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ƚ Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 15. Adjusted Associations between Public Regard (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.02 (-0.85, 0.81)*	*0.19 (-0.40, 0.78)*	*1.04 (0.95, 1.13)*	*-0.04 (-0.82, 0.74)*	*-0.52 (-1.54, 0.50)*	*1.03 (0.98, 1.08)*
Model 2. Adjusted for age	*0.03 (-0.79, 0.86)*	*0.22 (-0.38, 0.81)*	*1.04 (0.95, 1.14)*	*0.00 (-0.78, 0.77)*	*-0.56 (-1.58, 0.46)*	*1.03 (0.99, 1.08)*
Model 3. Model 2 + sociodemographics[a]	*-0.12 (-0.95, 0.72)*	*0.15 (-0.46, 0.75)*	*1.03 (0.94, 1.13)*	*-0.11 (-0.90, 0.68)*	*0.00 (-0.56, 0.57)*	*1.03 (0.98, 1.08)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.20 (-1.02, 0.62)*	*0.12 (-0.49, 0.72)*	*1.03 (0.94, 1.12)*	*-0.19 (-0.95, 0.57)*	*0.03 (-0.54, 0.60)*	*1.03 (0.98, 1.08)*
Model 5. Model 4 + antihypertensive medication use	*-0.31 (-1.09, 0.48)*	*0.03 (-0.55, 0.61)*	*1.02 (0.93, 1.11)*	*-0.29 (-1.02, 0.44)*	*-0.02 (-0.60, 0.56)*	*1.02 (0.98, 1.08)*
Model 6. Model 5 + depression symptom severity[c]	*-0.22 (-1.01, 0.57)*	*0.08 (-0.50, 0.66)*	*1.02 (0.94, 1.12)*	*-0.21 (-0.94, 0.53)*	*-0.05 (-0.63, 0.52)*	*1.03 (0.98, 1.08)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ɫ Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Figures

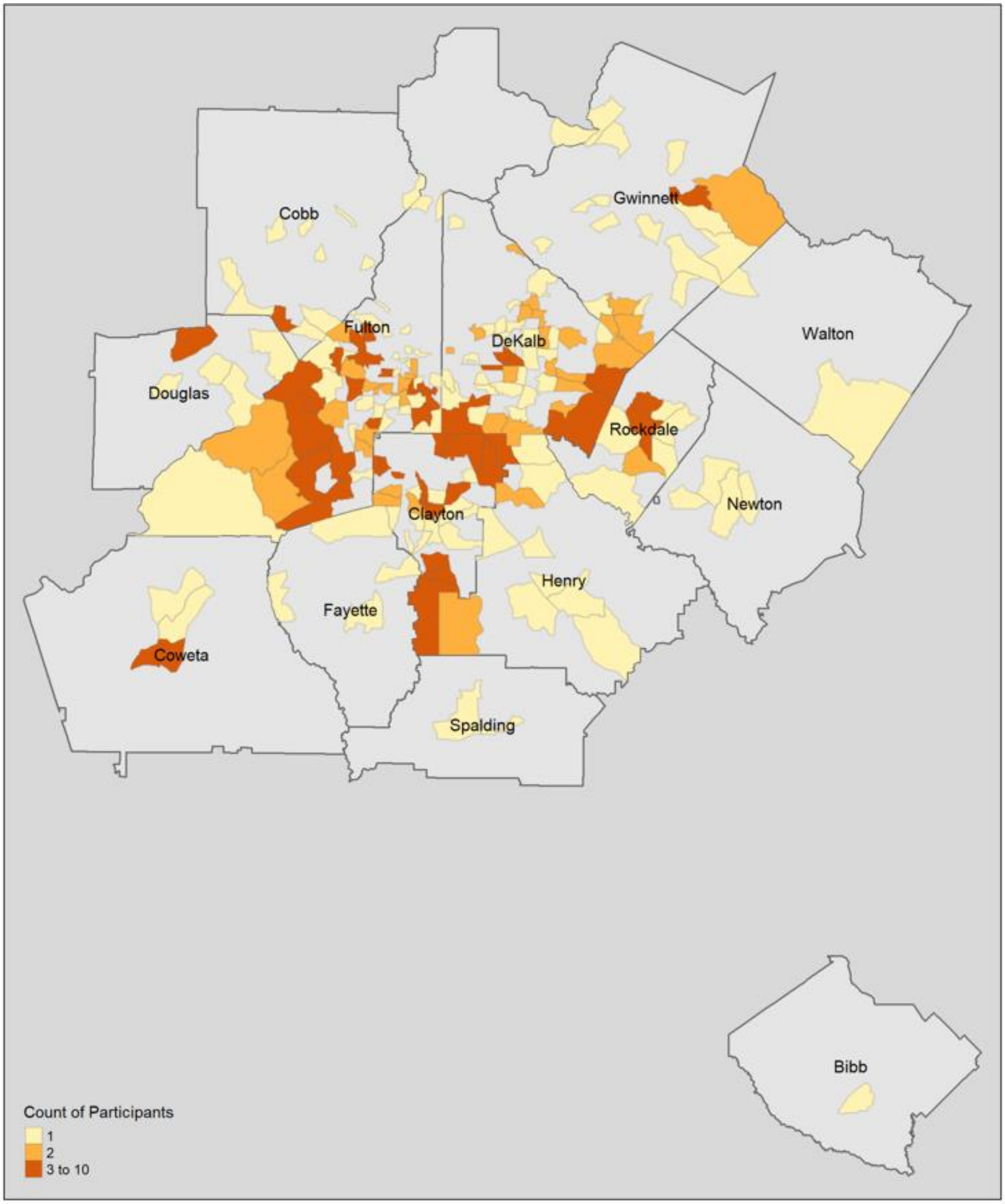

Figure 1. Counts of Mechanisms Underlying the impact of Stress and Emotions (MUSE) study participants across census tracts in the metro-Atlanta area by approximate tertiles.

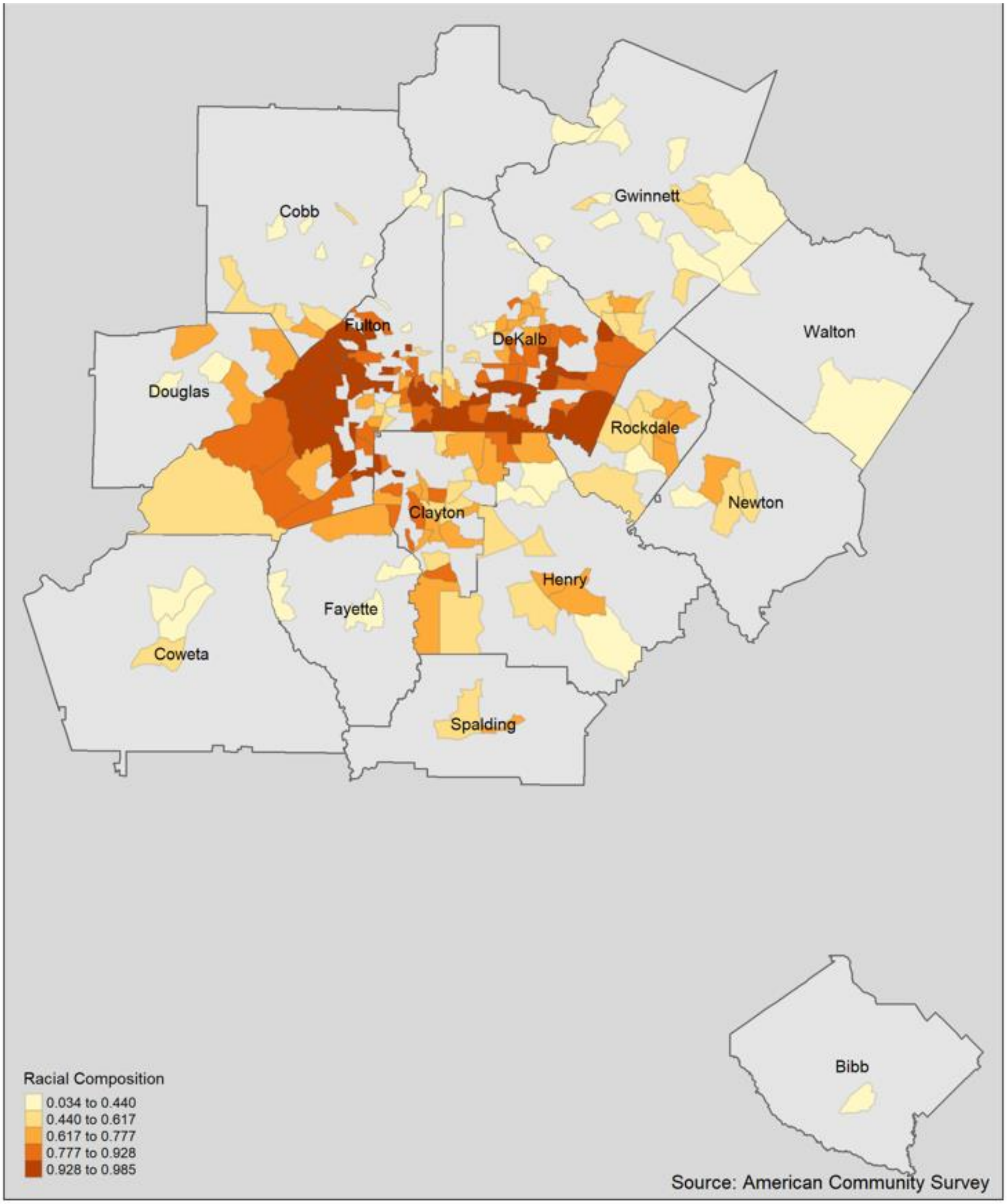

Figure 2. Racial Composition (% Black residents) across census tracts among participants of the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study participants by quintiles.

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Supplement

Supplementary Table 1. Characteristics of activity space locations by high/low residential segregation groups.

		Same Census Tract as Residential (n, %)	
	Number of locations	***High Residential Segregation (77.8% - 98.5% Black)***	***Low Residential Segregation (3.4% - <77.8% Black)***
Studies	*27*	0 (0.0%)	0 (0.0%)
Work (Primary)	*258*	2 (1.0%)	2 (1.0%)
Work (Secondary)	*26*	0 (0.0%)	0 (0.0%)
Grocery (Primary)	*411*	15 (7.6%)	33 (16.3%)
Grocery (Secondary)	*292*	3 (1.5%)	11 (5.4%)
Physical Activity	*105*	3 (1.5%)	4 (2.0%)
Child School/Daycare	*258*	21 (10.7%)	30 (14.9%)
Child Leisure Activity	*115*	5 (2.5%)	7 (3.5%)
Other #1	*189*	8 (4.1%)	6 (3.0%)
Other #2	*46*	0 (0%)	4 (2.0%)

Supplementary Table 2. Adjusted Associations between Residential and Activity Space Segregation (per 20% Increase in Proportion of Black Residents) and Daytime Systolic and Diastolic Blood Pressure in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study: *Among those not taking antihypertensive medications*

	Daytime Systolic Blood Pressure			**Daytime Diastolic Blood Pressure**		
	Residential % Black	***Activity Space % Black***	***Residential + Activity Space % Black***	***Residential % Black***	***Activity Space % Black***	***Residential + Activity Space % Black***
Model 1. Unadjusted	*0.28 (-0.77, 1.34)*	*0.17 (-0.77, 1.11)*	*0.52 (-0.46, 1.51)*	*0.11 (-0.66, 0.88)*	*0.17 (-0.51, 0.85)*	*0.29 (-0.43, 1.01)*
Model 2. Adjusted for age	*0.38 (-0.69, 1.45)*	*0.19 (-0.75, 1.13)*	*0.54 (-0.44, 1.53)*	*0.14 (-0.64, 0.92)*	*0.18 (-0.51, 0.86)*	*0.30 (-0.42, 1.02)*
Model 3. Model 2 + sociodemographics[a]	*-0.02 (-1.14, 1.10)*	*0.09 (-0.89, 1.07)*	*0.37 (-0.65, 1.39)*	*-0.05 (-0.87, 0.78)*	*0.13 (-0.59, 0.84)*	*0.23 (-0.52, 0.99)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.23 (-1.34, 0.89)*	*0.03 (-0.94, 1.00)*	*0.28 (-0.74, 1.29)*	*-0.11 (-0.94, 0.72)*	*0.12 (-0.60, 0.84)*	*0.21 (-0.55, 0.96)*
Model 5. Model 4 + depression symptom severity[c]	*-0.14 (-1.26, 0.97)*	*0.09 (-0.88, 1.06)*	*0.34 (-0.67, 1.35)*	*-0.06 (-0.89, 0.77)*	*0.15 (-0.57, 0.88)*	*0.24 (-0.51, 1.00)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
*p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI)

Supplementary Table 3. Adjusted Associations between Residential and Activity Space Segregation (per 20% Increase in Proportion of Black Residents) and Nighttime Systolic and Diastolic Blood Pressure in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study: *Among those not taking antihypertensive medications*

	Nighttime Systolic Blood Pressure			**Nighttime Diastolic Blood Pressure**		
	Residential % Black	***Activity Space % Black***	***Residential + Activity Space % Black***	***Residential % Black***	***Activity Space % Black***	***Residential + Activity Space % Black***
Model 1. Unadjusted	*0.38 (-0.60, 1.37)*	*0.34 (-0.53, 1.22)*	*0.55 (-0.37, 1.47)*	*0.44 (-0.30, 1.18)*	*0.40 (-0.26, 1.05)*	*0.48 (-0.21, 1.18)*
Model 2. Adjusted for age	*0.45 (-0.55, 1.46)*	*0.36 (-0.52, 1.24)*	*0.56 (-0.36, 1.49)*	*0.50 (-0.25, 1.25)*	*0.41 (-0.25, 1.07)*	*0.50 (-0.20, 1.19)*
Model 3. Model 2 + sociodemographics[a]	*0.13 (-0.92, 1.17)*	*0.27 (-0.65, 1.18)*	*0.42 (-0.54, 1.38)*	*0.33 (-0.45, 1.12)*	*0.39 (-0.30, 1.08)*	*0.45 (-0.27, 1.17)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.10 (-1.14, 0.93)*	*0.19 (-0.71, 1.08)*	*0.31 (-0.63, 1.25)*	*0.24 (-0.56, 1.03)*	*0.37 (-0.32, 1.06)*	*0.40 (-0.33, 1.12)*
Model 5. Model 4 + depression symptom severity[c]	*-0.03 (-1.07, 1.00)*	*0.24 (-0.66, 1.13)*	*0.36 (-0.58, 1.30)*	*0.29 (-0.50, 1.08)*	*0.41 (-0.28, 1.09)*	*0.43 (-0.29, 1.15)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
*p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI)

Supplementary Table 4. Adjusted Prevalence Ratios for Associations between Residential and Activity Space Segregation (per 20% Increase in Proportion of Black Residents) and Daytime and Nighttime Hypertension in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study: *Among those not taking antihypertensive medications*

	Daytime Hypertension (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)			**Nighttime Hypertension (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)**		
	Residential % Black	***Activity Space % Black***	***Residential + Activity Space % Black***	***Residential % Black***	***Activity Space % Black***	***Residential + Activity Space % Black***
Model 1. Unadjusted	*1.10 (0.95, 1.28)*	*1.14 (1.01, 1.29)**	*1.19 (1.04, 1.36)**	*1.03 (0.95, 1.11)*	*1.03 (0.96, 1.10)*	*1.05 (0.97, 1.12)*
Model 2. Adjusted for age	*1.11 (0.96, 1.29)*	*1.14 (1.01, 1.30)**	*1.19 (1.04, 1.36)**	*1.03 (0.95, 1.11)*	*1.03 (0.96, 1.10)*	*1.05 (0.97, 1.12)*
Model 3. Model 2 + sociodemographics[a]	*1.07 (0.91, 1.26)*	*1.13 (1.00, 1.29)*	*1.17 (1.02, 1.35)**	*1.02 (0.94, 1.11)*	*1.02 (0.95, 1.09)*	*1.04 (0.96, 1.12)*
Model 4. Model 3 + traditional CVD risk factors[b]	*1.07 (0.91, 1.26)*	*1.13 (1.00, 1.28)*	*1.17 (1.02, 1.35)**	*1.02 (0.94, 1.10)*	*1.02 (0.95, 1.09)*	*1.03 (0.96, 1.11)*
Model 5. Model 4 + depression symptom severity[c]	*1.08 (0.92, 1.28)*	*1.14 (1.00, 1.29)**	*1.18 (1.02, 1.36)**	*1.02 (0.94, 1.11)*	*1.02 (0.95, 1.09)*	*1.04 (0.96, 1.12)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
*p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Supplementary Table 5. Adjusted Associations between Residential Racial Composition (per 20% Increase) and Systolic Blood Pressure in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) Study Among High and Low Activities with Neighbors Groups

	Daytime Systolic Blood Pressure		**Nighttime Systolic Blood Pressure**	
	High Activities with Neighbors	***Low Activities with Neighbors***	***High Activities with Neighbors***	***Low Activities with Neighbors***
Model 1. Unadjusted	*0.55 (-0.18, 1.27)*	*-0.59 (-1.38, 0.20)*	*0.56 (-0.11, 1.23)*	*-0.25 (-1.00, 0.50)*
Model 2. Adjusted for age	*0.68 (-0.07, 1.43)*	*-0.56 (-1.35, 0.23)*	*0.68 (-0.01, 1.36)*	*-0.23 (-0.97, 0.52)*
Model 3. Model 2 + sociodemographics[a]	*0.50 (-0.27, 1.27)*	*-1.04 (-1.88, -0.19)*	*0.57 (-0.14, 1.29)*	*-0.66 (-1.46, 0.13)*
Model 4. Model 3 + traditional CVD risk factors[b]	*0.37 (-0.39, 1.12)*	*-1.14 (-1.98, -0.30)*	*0.41 (-0.27, 1.09)*	*-0.80 (-1.58, -0.02)*
Model 5. Model 4 + antihypertensive medication use	*0.35 (-0.37, 1.07)*	*-1.15 (-1.97, -0.33)*	*0.39 (-0.25, 1.04)*	*-0.81 (-1.57, -0.05)*
Model 6. Model 5 + depression symptom severity[c]	0.37 (-0.35, 1.09)	-1.08 (-1.91, -0.26)	0.41 (-0.24, 1.06)	-0.76 (-1.52, 0.01)

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI)

Supplementary Table 6. Adjusted Associations between Residential Racial Composition (per 20% Increase) and Diastolic Blood Pressure in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) Study Among High and Low Activities with Neighbors Groups

	Daytime Diastolic Blood Pressure		**Nighttime Diastolic Blood Pressure**	
	High Activities with Neighbors	***Low Activities with Neighbors***	***High Activities with Neighbors***	***Low Activities with Neighbors***
Model 1. Unadjusted	*0.39 (-0.13, 0.90)*	*-0.52 (-1.10, 0.06)*	*0.52 (0.03, 1.01)*	*-0.20 (-0.75, 0.35)*
Model 2. Adjusted for age	*0.48 (-0.05, 1.01)*	*-0.51 (-1.10, 0.07)*	*0.64 (0.13, 1.14)*	*-0.19 (-0.74, 0.36)*
Model 3. Model 2 + sociodemographics[a]	*0.33 (-0.21, 0.88)*	*-0.75 (-1.38, -0.12)*	*0.55 (0.02, 1.07)*	*-0.39 (-0.99, 0.21)*
Model 4. Model 3 + traditional CVD risk factors[b]	*0.25 (-0.30, 0.80)*	*-0.76 (-1.40, -0.12)*	*0.44 (-0.09, 0.96)*	*-0.43 (-1.03, 0.17)*
Model 5. Model 4 + antihypertensive medication use	*0.24 (-0.28, 0.76)*	*-0.76 (-1.38, -0.15)*	*0.43 (-0.07, 0.93)*	*-0.44 (-1.02, 0.15)*
Model 6. Model 5 + depression symptom severity[c]	0.24 (-0.28, 0.76)	-0.70 (-1.32, -0.08)	0.44 (-0.06, 0.94)	-0.39 (-0.98, 0.20)

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI)

Supplementary Table 7. Adjusted Associations between Neighborhood Social Cohesion (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) Study: *Among those not taking antihypertensive medication in the past 12 months*

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.58 (-2.29, 1.14)*	*0.10 (-1.16, 1.36)*	1.07 (0.85, 1.36)	*-1.33 (-2.89, 0.24)*	*-0.66 (-1.87, 0.55)*	*0.97 (0.86, 1.09)*
Model 2. Adjusted for age	*-0.77 (-2.52, 0.98)*	*0.05 (-1.23, 1.34)*	1.06 (0.83, 1.35)	*-1.51 (-3.10, 0.08)*	*-0.76 (-1.99, 0.47)*	*0.97 (0.86, 1.09)*
Model 3. Model 2 + sociodemographics[a]	*-0.21 (-2.02, 1.61)*	*0.33 (-1.01, 1.67)*	1.14 (0.90, 1.46)	*-1.17 (-2.83, 0.49)*	*-0.59 (-1.86, 0.69)*	*0.98 (0.86, 1.10)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.11 (-1.91, 1.69)*	*0.39 (-0.96, 1.74)*	1.14 (0.88, 1.46)	*-1.10 (-2.73, 0.54)*	*-0.53 (-1.81, 0.75)*	*0.98 (0.86, 1.11)*
Model 5. Model 5 + depression symptom severity[c]	*0.16 (-1.65, 1.97)*	*0.56 (-0.79, 1.92)*	1.17 (0.91, 1.50)	*-0.91 (-2.56, 0.73)*	*-0.39 (-1.68, 0.90)*	*0.98 (0.87, 1.12)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ɫ Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Supplementary Table 8. Adjusted Associations between Activities with Neighbors (per 1 point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) Study: *Among those not taking antihypertensive medication in the past 12 months*

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*0.25 (-1.40, 1.90)*	*-0.06 (-1.27, 1.15)*	1.11 (0.89, 1.39)	*-0.22 (-1.73, 1.30)*	*-0.52 (-1.68, 0.64)*	*0.96 (0.86, 1.08)*
Model 2. Adjusted for age	*0.11 (-1.57, 1.78)*	*-0.10 (-1.33, 1.13)*	1.10 (0.88, 1.38)	*-0.34 (-1.87, 1.20)*	*-0.60 (-1.78, 0.57)*	*0.96 (0.85, 1.08)*
Model 3. Model 2 + sociodemographics[a]	*0.20 (-1.48, 1.87)*	*-0.09 (-1.32, 1.15)*	1.11 (0.89, 1.38)	*-0.27 (-1.81, 1.27)*	*-0.54 (-1.72, 0.64)*	*0.96 (0.85, 1.08)*
Model 4. Model 3 + traditional CVD risk factors[b]	*0.13 (-1.56, 1.82)*	*-0.19 (-1.45, 1.07)*	1.14 (0.92, 1.42)	*-0.27 (-1.81, 1.26)*	*-0.61 (-1.80, 0.59)*	*0.96 (0.86, 1.09)*
Model 5. Model 5 + depression symptom severity[c]	*0.19 (-1.49, 1.87)*	*-0.15 (-1.41, 1.10)*	1.15 (0.93, 1.43)	*-0.23 (-1.76, 1.30)*	*-0.57 (-1.77, 0.62)*	*0.97 (0.86, 1.09)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ł Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Supplementary Table 9. Adjusted Associations between Centrality (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.25 (-1.46, 0.96)*	*0.67 (-0.21, 1.55)*	*1.24 (1.01, 1.52)*	*-0.34 (-1.47, 0.78)*	*0.46 (-0.39, 1.31)*	*0.99 (0.91, 1.08)*
Model 2. Adjusted for age	*-0.32 (-1.54, 0.90)*	*0.66 (-0.23, 1.54)*	*1.23 (1.01, 1.51)*	*-0.39 (-1.52, 0.75)*	*0.44 (-0.42, 1.30)*	*0.99 (0.91, 1.08)*
Model 3. Model 2 + sociodemographics[a]	*-0.20 (-1.42, 1.02)*	*0.73 (-0.17, 1.62)*	*1.26 (1.03, 1.55)*	*-0.29 (-1.44, 0.85)*	*0.47 (-0.40, 1.33)*	*0.99 (0.90, 1.08)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.21 (-1.42, 1.00)*	*0.71 (-0.19, 1.61)*	*1.27 (1.03, 1.56)*	*-0.27 (-1.40, 0.85)*	*0.48 (-0.38, 1.35)*	*0.99 (0.91, 1.08)*
Model 5. Model 5 + depression symptom severity[c]	*-0.19 (-1.39, 1.02)*	*0.72 (-0.17, 1.62)*	*1.27 (1.03, 1.56)*	*-0.25 (-1.37, 0.87)*	*0.50 (-0.37, 1.36)*	*0.99 (0.91, 1.08)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ł Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Supplementary Table 10. Adjusted Associations between Private Regard (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.80 (-2.28, 0.68)*	*0.07 (-1.01, 1.16)*	*1.09 (0.88, 1.34)*	*-0.92 (-2.30, 0.47)*	*-0.27 (-1.32, 0.78)*	*0.97 (0.87, 1.07)*
Model 2. Adjusted for age	*-0.85 (-2.34, 0.64)*	*0.06 (-1.03, 1.15)*	*1.08 (0.87, 1.34)*	*-0.95 (-2.33, 0.44)*	*-0.29 (-1.34, 0.76)*	*0.97 (0.87, 1.07)*
Model 3. Model 2 + sociodemographics[a]	*-0.74 (-2.23, 0.75)*	*0.14 (-0.96, 1.23)*	*1.10 (0.89, 1.35)*	*-0.85 (-2.25, 0.54)*	*-0.26 (-1.32, 0.80)*	*0.96 (0.87, 1.07)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.69 (-2.17, 0.79)*	*0.16 (-0.94, 1.26)*	*1.10 (0.89, 1.36)*	*-0.79 (-2.16, 0.58)*	*-0.22 (-1.28, 0.84)*	*0.97 (0.87, 1.07)*
Model 5. Model 5 + depression symptom severity[c]	*-0.57 (-2.05, 0.90)*	*0.22 (-0.88, 1.33)*	*1.11 (0.89, 1.38)*	*-0.69 (-2.06, 0.67)*	*-0.15 (-1.21, 0.90)*	*0.97 (0.87, 1.07)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ł Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Supplementary Table 11. Adjusted Associations between Public Regard (per 1-point Increase in Average Score) and Ambulatory Blood Pressure Outcomes in the Mechanisms Underlying the impact of Stress and Emotions (MUSE) study

	Daytime Measures			**Nighttime Measures**		
	Systolic Blood Pressure	***Diastolic Blood Pressure***	***Hypertension: (Mean daytime SBP ≥ 130 mmHg or DBP ≥ 80 mmHg)***	***Systolic Blood Pressure***	***Diastolic Blood Pressure***	***Hypertension: (Mean nighttime SBP ≥ 110 mmHg or DBP ≥ 65 mmHg)***
Model 1. Unadjusted	*-0.15 (-0.99, 0.68)*	*0.07 (-0.54, 0.68)*	*1.03 (0.92, 1.15)*	*-0.12 (-0.90, 0.66)*	*-0.12 (-0.71, 0.47)*	*1.02 (0.96, 1.08)*
Model 2. Adjusted for age	*-0.12 (-0.96, 0.72)*	*0.08 (-0.54, 0.69)*	*1.03 (0.92, 1.16)*	*-0.10 (-0.88, 0.68)*	*-0.11 (-0.70, 0.48)*	*1.02 (0.96, 1.08)*
Model 3. Model 2 + sociodemographics[a]	*-0.21 (-1.06, 0.64)*	*0.06 (-0.57, 0.69)*	*1.02 (0.91, 1.15)*	*-0.15 (-0.94, 0.65)*	*-0.10 (-0.70, 0.50)*	*1.02 (0.96, 1.08)*
Model 4. Model 3 + traditional CVD risk factors[b]	*-0.33 (-1.18, 0.52)*	*0.02 (-0.61, 0.65)*	*1.02 (0.91, 1.15)*	*-0.26 (-1.05, 0.52)*	*-0.14 (-0.75, 0.46)*	*1.01 (0.95, 1.08)*
Model 5. Model 5 + depression symptom severity[c]	*-0.24 (-1.09, 0.60)*	*0.07 (-0.56, 0.70)*	*1.03 (0.92, 1.16)*	*-0.19 (-0.97, 0.59)*	*-0.09 (-0.70, 0.51)*	*1.02 (0.96, 1.08)*

[a]Educational attainment, employment status, income, family size, partner status
[b]BMI, smoking status, physical activity
[c]Beck Depression Inventory score
* p-value < 0.05
ɫ Evidence of interaction with residential segregation
§ Evidence of interaction with residential + activity space segregation
Abbreviations: Cardiovascular Disease (CVD), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)