



The effects of contemporary redlining on the mental health of Black residents

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ABSTRACT

Understanding how structural racism, including institutionalized practices such as redlining, influence persistent inequities in health and neighborhood conditions is still emerging in urban health research. Such research often focuses on historical practices, giving the impression that such practices are a thing of the past. However, mortgage lending bias can be readily detected in contemporary datasets and is an active form of structural racism with implications for health and wellbeing. The objective of the current study was to test for associations among multiple measures of mental health and a measure of contemporary redlining. We linked a redlining index constructed using Home Mortgage Disclosure Act data (2007–2013) to 2021 health data for Black/African American participants in the Study of Active Neighborhoods in Detroit ($n = 220$ with address data). We used multilevel regression models to examine the relationship between redlining and a suite of mental health outcomes (perceived stress, anxiety, depressive symptoms, and satisfaction with life), accounting for covariates including racial composition of the neighborhood. We considered three mediating factors: perceived neighborhood cohesion, aesthetics, and discrimination. Although all participants lived in redlined neighborhoods compared to the complete Detroit Metropolitan area, participants with very low income, low levels of experienced discrimination, and lower perceptions of neighborhood aesthetics resided in highly redlined neighborhoods (score ≥ 5). We observed that higher resident-reported neighborhood aesthetics were found in neighborhoods with lower redlining scores and were associated with higher levels of satisfaction with life. We found that lower levels of redlining were significantly associated with higher levels of perceived discrimination, which was significantly, positively associated with anxiety, depressive symptoms, and perceived stress scores. Our findings highlight that contemporary redlining practices may influence the aesthetics of the built environment because these neighborhoods experience less investment, with implications for residents' satisfaction with life. However, areas with lower redlining may be areas where Black/African American people experience increased perceived discrimination.

1. Introduction

Structural, systemic and institutionalized racism are now well-recognized drivers of health inequities (Braveman et al., 2022; Namin et al., 2022). These forms of racism are often less visible or directly intentional than hate crimes and racist interpersonal acts against individuals. Yet they are deeply destructive and embedded forms of racism that plague systems, policies, practices and beliefs and attitudes

(Braveman et al., 2022) that ultimately privilege White people over people of color. While systemic racism encompasses whole systems, structural racism emphasizes specific structures (policies, institutional practices and norms) that are part of the system. Structural racism involves the ways in which racism is so deeply ingrained in daily life that it is sometimes not noticed by those not affected. Finer still, institutional racism often refers to racism within a particular institution (Braveman et al., 2022) and, regardless of intent, involves discrimination against

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people of color to create advantages for White people (Elias & Paradies, 2021). Here, we explore the role of racism within the institution of mortgage lending. But, we cast a broader net to explore how this form of racism leads to cascading forms of racism, in terms of investment in neighborhood infrastructure (shaping aesthetics) (Bloch & Phillips, 2022) and interpersonal interactions (discrimination or cohesion) (Beagan et al., 2022). Thus, we utilize the concept of structural racism to encompass the breadth of our exploration, starting with racism within mortgage lending institutions.

In the US, historical racism in the housing sector, including *redlining* (“the practice of denying a creditworthy applicant a loan for housing in a certain neighborhood even though the applicant may otherwise be eligible for the loan”), has increasingly been examined over the past decade in public health research (Consumer Compliance Handbook, 1968). Understanding how racism in housing, including practices such as redlining, influences persistent inequities in neighborhood conditions and health is an important, emerging area in urban health research. Such findings may inform efforts to reduce discrimination, improve neighborhood conditions and bolster health.

While attention to structural racism in housing is growing, much of the recent literature has focused on *historical* redlining, likely due in part to the digitization of the Home Owners’ Loan Corporation (HOLC) maps and related interest in the history of housing discrimination in the US since the 1930s. These historical maps show a concerted effort to segregate immigrant and non-White populations, particularly Black/African American populations, from White neighborhoods through mortgage lending practices. Budding research has separately shown that historically redlined neighborhoods have poorer built, social, or toxicant environments compared to other areas (Aaronson et al., 2021; Balazs & Ray, 2014; McClintock, 2015; Nardone et al., 2021; Schwartz et al., 2021), with concomitant effects on resident health (Collin et al., 2021; Krieger et al., 2020; Matoba et al., 2019; Nardone et al., 2020a, 2020b). For example, research shows that historically redlined areas shape today’s built environment disadvantages, including less neighborhood greenspace (Nardone et al., 2021), reduced access to healthy food (Shaker et al., 2022), and higher density of tobacco retailers (Schwartz et al., 2021), even after accounting for other socioeconomic indicators. Historical redlining has also been shown to influence the social environment, whereby decades later, effects on household income and poverty have been detected (Aaronson et al., 2021). From these studies, it appears that the pathways through which historical redlining influence contemporary health are primarily through disinvestment in the neighborhood infrastructure and strains on social and environmental conditions. Extant research suggests that historical redlining is associated with contemporary redlining practices and that this disinvestment accumulates over time (Lynch et al., 2021; Namin et al., 2022). Contemporary redlining is the modern-day denial of mortgage loans to specific applicants or to specific neighborhoods, at a level higher than expected across a given city. Neighborhoods with sustained disinvestment experience worse physical and mental health than neighborhoods with high investment over time. These findings illustrate how ongoing legacies of structural racism influence modern-day health – because practices are ongoing.

While the influence of historical redlining practices is important and should be further examined, limiting research to historical practices may give the impression that such practices are a thing of the past. Unfortunately, current mortgage lending bias, or contemporary redlining, can be readily detected in contemporary datasets and is an active and contemporary form of structural racism in housing, with implications for ongoing inequalities in neighborhood conditions, health, and wellbeing.

Several recent studies have used the Home Mortgage Disclosure Act (HMDA) database to examine the influence of contemporary mortgage lending bias on health outcomes (Beyer et al., 2016, 2021; Gee, 2008; Lynch et al., 2021; Mendez et al., 2011). HMDA data represent a census of mortgage applications by US census tract across the country, including details of the mortgage application. These data have been used

in various ways to measure bias in mortgage lending, including by property location (i.e., contemporary redlining).

However, few studies have leveraged these data or approaches to examine mental health outcomes or indirect pathways that may link current biases in mortgage lending to health outcomes. One study did, however, show that living in redlined neighborhoods was associated with higher reports of discrimination and also poorer mental health among Chinese American people, compared to those residing in other areas (Gee, 2008). Still, the complex processes by which mortgage bias may lead to health outcomes remains poorly understood. These relationships are typically complicated by the strong association between mortgage lending bias and racial and ethnic population composition at the neighborhood level (Berkovec et al., 1994). Moreover, living in a redlined neighborhood with varying racial composition can have potential both hazardous and protective effects. For example, a recent meta-analysis reported consistent protective ethnic density associations across countries and multiple racial/ethnic minority subgroups with mental health outcomes (Bécares et al., 2018), and at least one study has illustrated a buffering effect of ethnic density in the face of racism and discrimination (Bécares et al., 2009), all suggesting that social factors influence the spatial distribution of poor mental health in minoritized groups. Little research has explicitly examined the relationship between contemporary redlining on mental health, via the indirect effects of neighborhood built and social conditions.

Bias in mortgage lending produces stigma of places, whereby certain areas become symbolic places onto which meanings are allocated (Keene & Padilla, 2010). Neighborhoods thus involve spatial boundaries that may demarcate inequalities, but also may serve as a mechanism to reinforce inequality through discourses of denigration and through institutionally racist practices such as mortgage lending restriction in specific neighborhoods. Residents of such vilified spaces are often marked not only by the stigma of race and class, but also by a “blemish of place” that has real implications for the conditions of their neighborhoods. For example, in Detroit, Michigan, USA, young residents commonly reported derelict built environment conditions (e.g., abandoned houses) as both the physical conditions of their neighborhood but also as ‘decaying’ or ‘dirty’ stigmas of their neighborhoods (Graham et al., 2016). However, there are exceptions where spatial stigma can also be harnessed to take advantage of the underdog reputation, to benefit entrepreneurs (Cowden et al., 2022).

Stigma, more broadly, has been associated with poor mental health and limited preventative and healthcare-seeking behavior (Link & Phelan, 2006). Spatial stigma, explicitly, has been shown to be associated with lower life satisfaction (Kelaheer et al., 2010). The mechanisms through which spatial stigma influences health are thought to operate by social division (Wakefield & McMullan, 2005) and patterns of disinvestment in material infrastructure (Macintyre et al., 2002). Keene and Padilla identify three primary pathways through which spatial stigma may shape health: (1) limited access to material resources; (2) stress; and (3) processes related to identity formation and management (Keene & Padilla, 2014). From these pathways, the effects on health may be direct (stress) or indirect via the built or social conditions that are influenced by spatial stigma. Studies of mental health are a priority, not only because of the burden of mental illnesses themselves, but also because of well documented biological pathways that link poor mental health, especially anxiety, depression, and stress, to chronic disease outcomes such as cardiovascular disease, obesity and diabetes, asthma, some forms of cancer and other diseases. These links may account for racial and ethnic differences in physical health and life expectancy (Aronoff et al., 2022; Johnson, 2022; Kuzawa & Sweet, 2009).

One way to measure stigmatization of places would be to quantify differences in mortgage lending odds based on neighborhood. In this way, we obtain a relative metric for how likely an applicant desiring to purchase a property in a specific neighborhood will be in obtaining a mortgage, compared to applicants wishing to purchase properties from all neighborhoods across an area. The objectives of the current study

were to explore how the institutional racist practice of mortgage lending bias reflects stigmatization of places and has concomitant effects on two other forms of racism - investment in neighborhood infrastructure (shaping aesthetics) and social interactions in neighborhoods (discrimination or cohesion). We also examined the direct and indirect effects of these social constructs on a suite of mental health indicators. Specifically, we (1) test for associations among multiple measures of mental health and a measure of contemporary redlining, and (2) examine indirect effects via experiences of discrimination, and perceptions of neighborhood cohesion and aesthetics. A conceptual framework guiding the study is shown in Fig. 1.

2. Methods

2.1. Sample

This study involves a subset of Black/African American (B/AA) participants in a larger, longitudinal study [see 37 for more details]. We used the US census categories for race/ethnicity in this study. Sampling was conducted first at the neighborhood level ($n = 11$ high vacancy, low-income neighborhoods defined as 500m around a neighborhood park, for the parent study (Pearson et al., 2020)); then, all residents within the 500m buffer were recruited through postcards, tabling events, and door-to-door contact. Because the parent study is focused on physical activity and mobility in the neighborhood, recruitment was restricted to only one English-speaking adult male or female per household who was able to walk continuously for at least 15 min. Which person participated was at members of the household's discretion. In May–October 2021, participants were recruited and data were collected ($n = 220$ with address data). Relevant to the current study, participants completed a survey about demographics, perceptions of their neighborhood, perceived stress, anxiety and depressive symptoms, and satisfaction with life.

2.2. Mental health measures (outcomes)

Self-reported mental health measures included perceived stress and symptoms of anxiety and depression. The perceived stress scale (PSS) (Cohen et al., 1983) is comprised of 10 items (i.e., feeling nervous) measured on Likert-type scale (0 = low, 40 = max stress). Using methods from previous research (Solivan et al., 2015), we imputed missing items within the PSS by carrying forward the response from the previous item when similarly coded and fewer than four responses were missing. PSS ranging from 0 to 13 are considered low stress; 14–26 are considered moderate stress; and above 26 are considered high perceived stress. PSS

has been validated in many populations (Kaiser-Meyer-Olkin coefficient = 0.86) and showed relationships with anxiety and depression (Baik et al., 2019; Khalili et al., 2017). Anxiety and depressive symptoms were measured via NIH's Adult PROMIS-29 Profile v2.0 (Hays et al., 2018; Health measures, 2018). T-scores for anxiety and depressive symptoms were generated by comparing values to the online tool reference population, the 2000 general US census population (mean of 50, standard deviation of 10), whereby lower t-scores indicate more favorable outcomes. Satisfaction with life was measured using a validated scale which correlates moderately to highly with measures of subjective well-being and certain personality characteristics (Diener et al., 1985). The score ranges from 5 to 35, where scores above 24 are considered highly satisfied, scores 20–24 are considered average, and those below 20 are considered dissatisfied. These measures of anxiety and depressive symptoms have shown high internal consistency (Cronbach's $\alpha > 0.88$) (Tang et al., 2019).

2.3. Perceptions of neighborhood cohesion and aesthetics (indirect pathways)

Questions related to perceptions of neighborhood cohesion were compiled from previous research on trust in relation to social capital (Larsen et al., 2016). Agreement with statements ("People in this neighborhood can be trusted."; "This is a close-knit neighborhood."; "People around my neighborhood are willing to help their neighbors."; and "People in this neighborhood generally don't get along with each other.") were rated on a Likert-type scale from somewhat agree (1) to strongly disagree (5). The final statement was re-coded so that higher values indicated higher cohesion. The aesthetics statements were compiled from other research showing high internal consistency (Cronbach's $\alpha = 0.92$). These statements included: "There are trees along the streets in my neighborhood."; "There are many interesting things to look at while walking in my neighborhood."; "My neighborhood is generally free from litter."; "There are landscaped sights in my neighborhood (such as landscaping, views)."; and "There are attractive buildings/homes in my neighborhood." For each sub-scale (cohesion and aesthetics), we summed items to create a score (range 6–20) with higher values indicating more favorable perceptions.

2.4. Experiences of discrimination measures (indirect pathway)

We included five separate questions from the Everyday Discrimination Scale (Cronbach's $\alpha = 0.77$) (Sternthal et al., 2011), each involving a rank of the frequency of experiencing the following events in day-to-day life: 1) treated with less courtesy/respect than other people;

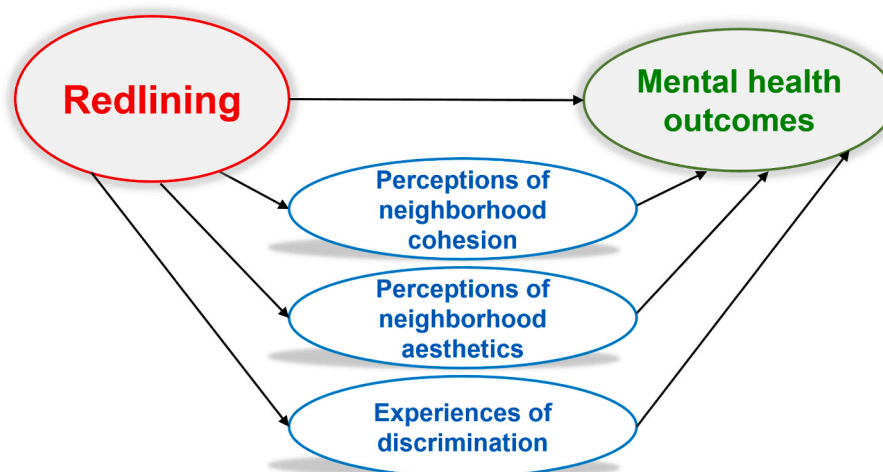


Fig. 1. Conceptual diagram for study objectives.

2) poorer service than others at restaurant/store; 3) people act afraid of you; 4) threatened/harassed; and 5) people act as if they think you are not smart. Ranks were assigned whereby 0 indicated never and 5 indicated almost every day. Values for each item were summed to create the Everyday Discrimination Scale (Short Version), with scores ranging from 0 to 25 (in our sample Cronbach's $\alpha = 0.88$).

In addition, all participants were asked, "What do you think is/are the main reason(s) for these experiences?" allowing multiple responses. "My ancestry or national origin" and "My race" were options. We used these responses to generate a new variable 'experienced racism' coded as a binary variable in which "1" indicated a positive response to either of these questions.

2.5. Measure of contemporary redlining (independent variable of interest)

We derived the independent variable of interest (redlining) from Home Mortgage Disclosure Act (HMDA) data. It measures the odds ratio of denial of a mortgage application based on the property location, comparing local properties with all properties within the Metropolitan Statistical Area (MSA), thus identifying neighborhoods within the MSA (Detroit) that are less likely to secure mortgages. The index was estimated using logistic regression modeling in an adaptive spatial filtering framework (Beyer et al., 2021). HMDA data from 2007 to 2013 were used. Continuous surfaces were estimated and summarized by census tract. Values > 1 indicate higher levels of denial of mortgage applications locally, when compared with the MSA as a whole; values < 1 indicate lower levels of denial than the MSA. This tract measure of contemporary redlining (for each census tract) was then assigned to each participant using their home address.

2.6. Statistical analyses

First, we calculated descriptive statistics for participants, stratified by high/low redlining values (using the median, OR = 5, as the threshold) (min = 2.5, 25th percentile = 3.5, mean = 6.3, sd = 3.5, median = 6.0, max = 24.2). To test for significant differences between the two groups, we used chi-squared tests and Welch two sample t-tests. To understand the associations between redlining and anxiety, depressive symptoms, and perceived stress scores, we fitted separate multilevel linear structural equation regression models for each outcome, and included age (continuous), female sex, income below \$10k, employed status, and percent B/AA population in the individual's census tract (as a measure of ethnic density) as potential confounders. We accounted for clustering within census tracts using cluster robust standard errors. We considered potential indirect effects of each of these primary relationships by three variables: perceptions of neighborhood social cohesion, perceptions of neighborhood aesthetics, and experiences of discrimination (total score). We used full information maximum likelihood (FIML) and assumed any missing data were missing at random. Standardized coefficients are presented.

All statistical techniques were performed using Stata v16 (Statacorp, College Station, TX, USA). Initially, we considered the use of tobit regression due to the conceptual censoring of the perceived stress scale (0 at the lower end and 40 at the upper end) (Austin et al., 2000), but decided against it as Stata does not allow covariance between the independent variables, reporting standardized coefficients, or accounting for missing data using FIML. Rather, we prioritized comparability across models in our analysis.

3. Results

All participants identified as B/AA race/ethnicity and lived in neighborhoods with high odds ratios of redlining within Detroit. The city as a whole showed great variation in redlining values across neighborhoods, with a range from 0.2 to over 20, and large areas with values from 1 to 5 (see map in Supplementary Materials Fig. S1). We also

see a clear pattern of higher redlining in the center of the city and lower redlining in suburban areas. Areas with the highest levels of redlining had between 1% and 100% B/AA residents, while areas with the lowest level of redlining had between 0.1% and 98%. Detroit as a whole had 79% B/AA population in 2019. When examining characteristics of participants by high/low redlining status, we found a significantly higher proportion of participants earning less than \$10k per year in highly redlined neighborhoods (Table 1). We found significantly higher perceived neighborhood aesthetics in low redlined neighborhoods ($p = 0.002$). Higher perceived neighborhood social cohesion in low redlined neighborhoods approached statistical significance ($p = 0.057$). Contrary to expectations, we found significantly higher levels of almost all measures of discrimination in low redlined areas. We did not observe significant differences in other demographic variables or in percent B/AA residents by neighborhood redlining status.

The majority of participants reported being current smokers (52%) and were overweight/obese (72%) (Table 2). On average, participants would be considered moderately stressed (Cohen et al., 1983). Participants also reported higher than average anxiety and depressive symptoms (USA mean = 50). Overall, satisfaction with life scores reflect an average level of satisfaction. When examining mental health characteristics, we observed no significant differences by neighborhood redlining status, although satisfaction with life was approaching statistical significance, whereby those in highly redlined neighborhoods had lower satisfaction with life ($p = 0.063$).

In evaluating regression modeling results, we found a significant ($p \leq 0.05$) indirect pathway from redlining through perceived discrimination to anxiety (Fig. 2), depressive symptoms, and perceived stress scores (shown in Supplementary Materials Figs. S2-S3). Specifically, in all three models, we observed that low redlining was significantly associated with higher levels of discrimination and that discrimination was significantly, positively associated with anxiety, depressive symptoms, and perceived stress scores. In all three cases, the largest effect on mental health outcomes was observed for discrimination in comparison to other variables in the models. For satisfaction with life, we found that

Table 1 Demographic characteristics for participants, stratified by high (>5 OR) or low (≤ 5 OR) neighborhood redlining.

	Low redlining n = 107	High redlining n = 113	Total n = 220	p-value
Ever had cancer, %	19.1	13.0	15.9	0.252
Income, % <\$10,000	42.5	59.0	51.4	0.030
Employed, %	28.2	23.4	25.7	0.427
Married/partnered, %	15.0	9.8	12.3	0.248
Own home, %	42.4	44.1	43.2	0.816
Sick in past two weeks, %	10.2	12.3	11.3	0.642
Age, mean (sd)	56.6 (13.3)	54.7 (14.0)	55.6 (13.7)	0.314
Number of kids, mean (sd)	0.2 (0.5)	0.4 (0.9)	0.3 (0.8)	0.065
Length of residence, mean (sd)	14.0 (16.3)	13.2 (15.1)	13.6 (15.7)	0.681
Experienced racism	42.7	38.2	40.3	0.509
Others felt threatened [§]	1.0 (1.6)	0.7 (1.3)	0.8 (1.4)	0.088
Others afraid of you [§]	1.2 (1.7)	1.0 (1.6)	1.1 (1.7)	0.267
Others think you are not smart [§]	1.7 (1.9)	1.3 (1.7)	1.5 (1.8)	0.040
You received poor service [§]	1.9 (1.9)	1.4 (1.7)	1.7 (1.8)	0.023
You received less respect [§]	2.3 (1.9)	1.6 (1.7)	2.0 (1.9)	0.004
Total discrimination score [‡]	5.4 (6.0)	3.6 (5.1)	4.5 (5.6)	0.040
Perceived neighborhood cohesion [¶]	14.3 (3.2)	13.6 (3.5)	13.9 (3.4)	0.057
Perceived neighborhood aesthetics [¶]	16.3 (5.4)	14.1 (4.8)	15.1 (5.2)	0.002
Percent Black/African American residents	84.3 (16.7)	81.7 (13.5)	82.9 (15.2)	0.214

Bold font: $p \leq 0.05$; § values range never (0) to always (5); ‡ values range 0-25; ¶ values range 6- 20.

Table 2
Health characteristics for participants, stratified by high/low neighborhood redlining.

	Low redlining n = 107	High redlining n = 113	Total n = 220	p-value
Current smokers, %	51.1	53.5	52.3	0.737
Overweight or obese, %	70.0	73.7	72.0	0.589
PSS score, mean (sd)	24.8 (6.3)	24.2 (5.8)	24.4 (6.0)	0.252
Anxiety, mean (sd)	56.3 (11.1)	54.5 (10.9)	55.4 (11.0)	0.113
Depression, mean (sd)	52.7 (11.0)	51.9 (9.9)	52.3 (10.4)	0.300
Satisfaction with life, mean (sd)	24.4 (7.0)	22.9 (5.6)	23.6 (6.4)	0.063

No significant differences at the $p \leq 0.05$ level.

high redlined areas were associated with lower aesthetics and that lower aesthetics were associated with lower satisfaction with life (Fig. 3). This was the largest effect in this model. In all four models, we did not observe significant ($p \leq 0.05$) direct effects of redlining on the outcomes, nor did we observe significant associations between the outcomes and percent B/AA residents. We also did not observe statistically significant evidence of indirect effects of redlining via neighborhood cohesion (although results approached statistical significance ($p \leq 0.10$) for anxiety and depressive symptoms, such that higher redlining was associated with lower cohesion, and lower cohesion was associated with higher anxiety and depression).

4. Discussion

In this study, we sought to examine associations between contemporary location-based mortgage lending bias, or contemporary redlining, and four key measures of mental health among B/AA participants in Detroit. We further sought to explore indirect effects via experiences of discrimination, social cohesion, and neighborhood aesthetics. While no direct relationship between redlining and mental health outcomes was found, we did identify several indirect relationships of interest.

First, we found a significant pathway from redlining through neighborhood aesthetics to life satisfaction, whereby areas with higher redlining were associated with poorer aesthetics and poorer aesthetics

were associated with lower life satisfaction. This finding mirrors qualitative work from Detroit showing that derelict built environment conditions were internalized by young residents, as ‘decaying’ or ‘dirty’ stigmas of their neighborhoods (Graham et al., 2016). Our finding is also echoed in quantitative work showing that spatial stigma was associated with lower life satisfaction (Kelaher et al., 2010) and findings that neighborhood aesthetics (specifically trees) were associated with a positive mental state (Liu et al., 2022). Further, crowd-sourced, geo-tagged ratings of “scenicness” were used in a national study concluding that residents in more scenic environments report better health, across urban, suburban, and rural areas (even after adjusting for multiple socioeconomic indicators) (Seresinhe et al., 2015).

Second, we found that B/AA individuals living in less redlined neighborhoods experienced more discrimination, though this relationship did not reach statistical significance in descriptive analyses. In regression models, we found that lower levels of redlining were associated with higher perceived discrimination and that higher discrimination was associated with higher anxiety, depression, and stress. While perhaps seemingly counterintuitive, these findings are supported by evidence from existing studies conducted in minoritized samples. For example, one longitudinal study in the USA found that African American and Hispanic youth who experienced upward socioeconomic mobility reported greater increases in discrimination compared those with stable socioeconomics (Colen et al., 2018). Differential experiences of discrimination, based perhaps on socioeconomic status in addition to, or more than race, explained a large proportion of the gap in self-rated health. Another study showed that the negative effects of discrimination on depressive symptoms were reduced among those adolescents who had had high levels of support from their parents and friends (Brody et al., 2006).

It is worth noting, as context to these findings, that all census tracts within the City of Detroit had an odds ratio of redlining greater than 1. This is because our redlining measure is a relative one and incorporates the relative likelihood of lending bias across all neighborhoods in the Detroit Metropolitan Statistical Area, which includes suburbs outside the city, where White flight and later affluent Black/African American people have relocated since the 1950s (Farley et al., 1978, 2000). However, the range of proportions of Black/African American residents in high redlining and low redlining areas was similar.

There are important strengths and weaknesses of this study. In terms

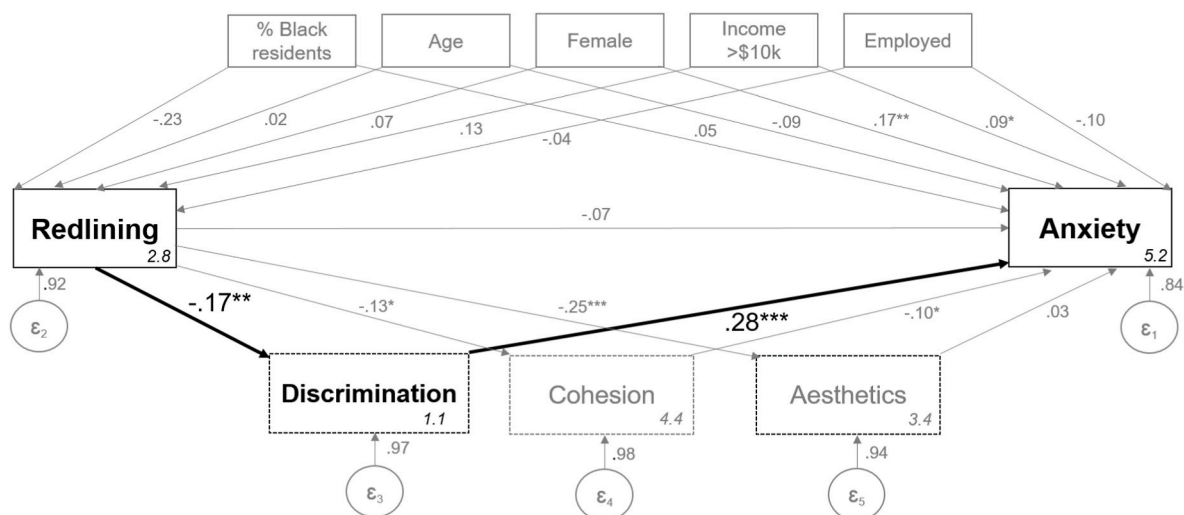


Fig. 2. Structural equation modeling direct and indirect effects of redlining on anxiety

* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.001$

Coefficient of determination = 0.156

NOTE: Mediators boxed by dashed line; confounders shown in grey; intercepts shown in italics; significant ≤ 0.05 indirect pathway shown by weighted arrows; covariances between confounders not shown in figure.

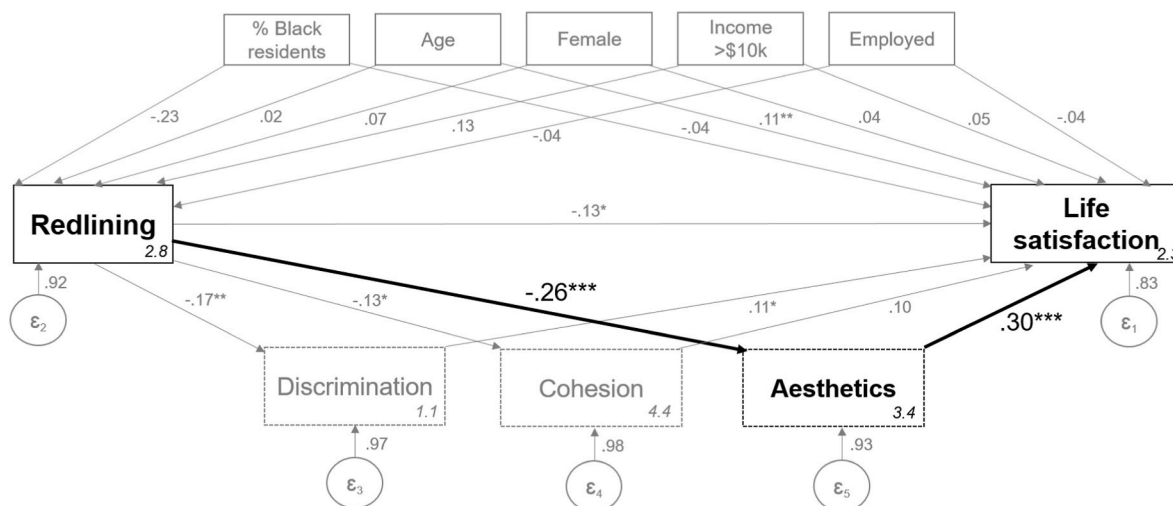


Fig. 3. Structural equation modeling direct and indirect effects of redlining on satisfaction with life

*p ≤ 0.10, **p ≤ 0.05, ***p ≤ 0.001

Coefficient of determination = 0.137

NOTE: Mediators boxed by dashed line; confounders shown in grey; intercepts shown in italics; significant ≤0.05 indirect pathway shown by weighted arrows; covariances between confounders not shown in figure.

of strengths, this sample of Black/African American participants provided a rich opportunity to explore how mortgage lending bias may affect mental health. Another strength of this study was our inclusion of indirect effects of redlining on health through the pathways of the neighborhood social and built environments. Finally, the consistency in findings across all three measures of poor mental health indicate that these findings warrant replication in other settings and among other minoritized populations. Weaknesses include a lack of diversity in terms of racial composition of neighborhood and participant income levels. Although outside the objectives of the current study, future studies with more heterogeneous samples may usefully examine disparities by race/ethnicity. Further, we did not directly evaluate potential income/class differences between our respondents and the neighborhoods in which they lived, which may provide insights into our finding that B/AA participants in lower redlining areas experienced increased discrimination. Future research, particularly qualitative work, may provide valuable information about residents' sense of belonging, neighborhood gentrification, or identities beyond race/ethnicity that influence how residents interact. Another limitation of our study was the lack of measurement of social support. In contrast to perceived neighborhood cohesion (measured in our study), social support may buffer negative effects and may involve individuals outside the neighborhood. It may be relevant for future research to explore whether areas with lower levels of redlining offer differing levels of social support for Black/African American people, either through church/religious activity or interpersonal relationships (Williams, 2018), which might buffer the effects of discrimination on mental health. While this sample of Black/African American participants can be seen as a major strength, it does not allow for comparisons across race/ethnicity groups.

5. Conclusion

Our findings highlight how redlining practices influence both the built environment and the ways in which people interact in neighborhoods. Specifically, our results suggest that areas with higher redlining may experience less investment in the built environment, which has implications for aesthetics and ultimately for residents' satisfaction with life. Likewise, areas with lower redlining may be areas where Black/African American people experience increased discrimination in terms of being treated with respect in their everyday lives, regardless of the racial composition of the neighborhood. Our study suggests that

mortgage lending bias, as a form of institutional racism, may have cascading effects on other forms of racism (interpersonal and disinvestment), with clear implications for mental health.

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Amber L. Pearson: Conceptualization, Data Curation, Investigation, Methodology, Project administration, Resources, Visualization, Writing - Original Draft, Writing - Review & Editing. **Yuhong Zhou:** Data Curation, Investigation, Methodology, Writing - Original Draft, Writing - Review & Editing. **Kirsten Beyer:** Conceptualization, Data Curation, Investigation, Methodology, Writing - Original Draft, Writing - Review & Editing. **Teresa H. Horton:** Investigation, Writing - Review & Editing. **Rachel T. Buxton:** Investigation, Writing - Review & Editing. **Karin A. Pfeiffer:** Investigation, Writing - Review & Editing.

Ethical statement

Human subjects approval.

The study was approved by Michigan State University's Institutional Review Board (IRB Approval #STUDY00000587; date 03/21/2019). Informed consent was obtained in writing from all participants.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2023.101462>.

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