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Gentrification, Neighborhood Change, and Population Health: a Systematic Review

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Abstract Despite a proliferation of research on neighborhood effects on health, how neighborhood economic development, in the form of gentrification, affects health and well-being in the USA is poorly understood, and no systematic assessment of the potential health impacts has been conducted. Further, we know little about whether health impacts differ for residents of neighborhoods undergoing gentrification versus urban development, or other forms of neighborhood socioeconomic ascent. We followed current guidelines for systematic reviews and present data on the study characteristics of the 22 empirical articles that met our inclusion criteria and were published on associations between gentrification, and similar but differently termed processes (e.g., urban regeneration, urban development, neighborhood upgrading), and health published between 2000 and 2018. Our results show that impacts on health vary by outcome assessed, exposure measurement, the larger context-specific determinants of neighborhood change, and analysis decisions including which reference and treatment groups to examine. Studies of the health impacts of gentrification, urban development, and urban regeneration describe similar processes, and synthesis and comparison of their results helps bridge differing theoretical approaches to this emerging research. Our article helps to inform the debate on the impacts of gentrification and urban development for health and suggests that these neighborhood change processes likely have both detrimental and beneficial effects on health. Given the influence of place on health and the trend of increasing gentrification and urban development in many American cities, we discuss how future research can approach understanding and researching the impacts of these processes for population health.

Keywords Gentrification · Urban development · Health · Urban health · Systematic review · Neighborhood · Social determinants of health

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Introduction

Economically deprived neighborhoods are associated with elevated rates of disease risk [1] and higher rates of health challenges at the neighborhood and individual level [2, 3], as measured by outcomes including preterm birth [4], cardiovascular disease [5], and premature mortality [6]. A body of literature shows associations between underlying social and area-level factors and area-level health inequities [7, 8], and finds that

neighborhood conditions—and in particular racial residential segregation—are implicated in creating patterns of inequity across a multitude of social outcomes [9] and help to explain racial disparities in health outcomes between neighborhoods [10]. One understudied, but potentially relevant determinant of neighborhood-level health disparities, is gentrification.

The term gentrification was initially coined in the 1960s to describe the entrance of an urban "gentry" to, and subsequent transformation of, working-class areas of London [11]. Since then, the definition of gentrification, as well as its causes and consequences, has been widely debated among academics, activists, and the public [12–15]. We employ Smith's [16] definition of gentrification: "the process by which central urban neighborhoods that have undergone disinvestments and economic decline experience a reversal, reinvestment, and the in-migration of a well-off middle- and upper-middle-class population." Increases in housing prices and amenities, and distinct shifts in the demographic, residential, social, cultural, and political context of a neighborhood often accompany the entrance of higher socioeconomic status (SES) population [17]. These larger cultural and contextual shifts distinguish gentrification from other forms of neighborhood socioeconomic ascent such as redevelopment or public reinvestment, though these types of changes may catalyze gentrification. Despite the debates on gentrification, there is general agreement that gentrification has become more prevalent in the past two decades [18].

Gentrification has attracted academics' and the public's attention since the 1970s, with scholars and activists arguing for the importance of gentrification in shifting the economic trajectories and demographics of urban neighborhoods [19, 20]. In the 1970s to 1980s, after decades of population decline and socioeconomic disinvestment, many urban, previously low-income neighborhoods began to experience reversals in SES, catalyzing a wave of research on the causes and consequences of gentrification [21]. These early patterns of "urban renewal" or "revitalization" were characterized by the redevelopment of dilapidated housing in a limited number of often predominantly white central city neighborhoods [22]. In contrast to previous decades, twenty-first-century gentrification has become faster and more widespread, creating more extreme neighborhood change in a greater number of neighborhoods [23–25] and impacting many low-income communities of color. The gentrification-related changes in the past two decades include the following: accelerated compositional shifts towards higher SES residents [25–27]; increases in the white, young college-educated population; and expansion of gentrification processes into historically Black neighborhoods [28]. By 2010, more than half of all large US cities had at least one gentrifying neighborhood [23]. Despite the increases in the SES of some urban neighborhoods, historical patterns of neighborhood disadvantage continue, with the average downtown neighborhood continuing to have lower SES than the metro area as a whole [27].

Gentrification increases are one trend in a recent process of US metropolitan reorganization. In the past two decades, higher-income populations have moved back to cities, more often to historically low-income communities of color than in previous decades, and less economically advantaged populations have moved or are being pushed out to suburbs [29]. These changes have begun to invert the geographic patterns of residential segregation that predominated since World War II [18, 30]. Due to systematic housing discrimination and racist policies that limited home purchasing options for non-white populations, many US metropolitan areas racially isolate low-income urban neighborhoods in central cities and largely prohibited non-whites from higher-income suburbs [31]. However, since 2000, these patterns have degraded, so much so that by 2014, three million more low-income individuals lived in the suburbs than in urban areas [32], and patterns of concentrated poverty experienced by communities of color in cities have started to replicate in the suburbs [29], putting some suburbs at risk of subsequent gentrification. While recent gentrification and increasing suburban poverty have begun reorganizing geographic distributions of neighborhood and metropolitan area inequity, the health implications of these changes have been understudied. In this article, we explicitly draw on ecosocial theory [33] to situate gentrification in its historical context, as a recent manifestation of multigenerational patterns of residential segregation and economic divestment [17], and to frame the potential relationships between gentrification and health.

The increased rates and scale of gentrification and other neighborhood change processes—such as urban development and redevelopment, revitalization, and neighborhood renewal—have provoked renewed interest in processes that shift neighborhoods' demographic characteristics over time. Researchers in sociology, economics, and urban planning have characterized causes

and trends of gentrification. However, work on consequences has been largely limited to debates on displacement [14, 34–36], crime [37–39], and a small number of studies on economic impacts [40–43]. Academic studies of gentrification and urban development, media sources [44], and activists from affected communities [45, 46] suggest that gentrification impacts health. But, there is limited empirical literature on how gentrification affects population health, health behaviors, or access to health care in the USA. To our knowledge, there have been no systematic efforts to evaluate and summarize the existing literature on health and gentrification, or on alternatively termed but similar processes of neighborhood socioeconomic ascent.

The term gentrification often has a negative and politically loaded connotation in both colloquial and, at times, academic contexts. Frontline community-based organizations, reporters, and impacted communities have described gentrification as a "profit-driven racial and class reconfiguration" [45], or a process of colonialization [47]. Such definitions explicitly highlight the potential resulting economic and cultural exclusion for working-class communities of color. Despite generally more neutral definitions in academia, we hypothesized that because of the everyday negative usage, some authors avoid the term gentrification, even when measuring forces of neighborhood change that could be defined as gentrification by other academics. We, therefore, expand the search terms in this review to include similar processes of neighborhood socioeconomic ascent not explicitly named gentrification. Further, gentrification is an ambiguous term. Even when expressly used, gentrification includes a range of processes and consequences [48]. We explore whether these multiple processes should be grouped into a single concept of gentrification.

Researchers have hypothesized both beneficial and detrimental health consequences of gentrification, particularly for low-income populations and communities of color [49–52]. For low-income populations able to stay in gentrifying neighborhoods, health benefits may accrue from poverty de-concentration, reduced segregation, enhanced safety, and improved access to resources, amenities (e.g., public parks), and economic opportunities [53]. The vast body of literature examining the adverse health effects of exposure to concentrated poverty and residential segregation suggests that reductions in these neighborhood exposures may benefit health [9, 54]. However, evidence on either the economic risks and benefits of income mixing [55, 56] or substantive social network overlap across racial groups *within* recently integrated neighborhoods is limited [56, 57], and debate remains about the direction of the relationship between gentrification and crime [13, 37, 39].

Conversely, neighborhood change processes can create neighborhoods of extreme income inequality [58] and exacerbate income polarization [56]; break down social cohesion and organizations [59, 60]; and displace culture, businesses, and political power [61, 62], all of which can negatively impact health, particularly for low-income populations [63]. As housing prices increase in gentrifying neighborhoods [64], some low-income families may be involuntarily displaced [51], and landlords operating in gentrifying neighborhoods may evict residents by clearing buildings or engaging in various tactics to push poor residents out in favor of higher-income residents [65, 66]. Both voluntary and involuntary displacement can catalyze a cascade of health consequences [67]. Displaced households may experience increasing financial strains because of relocation expenses; may lose access to neighborhood resources, schools, or jobs; experience disruption of protective social connections, resiliency strategies, and connections to place present in their former neighborhoods [59, 68]; and be exposed to discrimination and social marginalization at higher levels than in previous neighborhoods [68, 69]. Materialist and psychosocial stressors of the nature described above can elevate the risk of a variety of adverse health outcomes and create psychological burdens for families [59, 70]. Once displaced, limited availability of affordable housing may force low-income households to move to substandard units or become unstably housed, which can expose residents to a range of health risks [71, 72].

For low-income populations that remain in gentrifying neighborhoods, observing neighbors', family, or friends' displacement and anticipation of one's possible dispossession may present psychosocial burdens [73], which act as risk factors for a range of adverse health outcomes [74]. Additionally, increased housing prices reduce available income for medication, health care, transportation, healthy food, and leisure activities [75] and can impact households' abilities to achieve health. The existing evidence suggests that gentrification likely impacts population health, but more research is needed to understand the causal mechanisms at play, subpopulation effects, and the full range of potential implications for population health.

We present an original systematic review of empirical research on gentrification and health in the USA. We also examine the literature on urban development and other forms of socioeconomic ascent to ensure inclusion of studies that apply different terminology, but examine substantively comparable neighborhood change processes. We specifically focus on health impacts for low-income populations living in neighborhoods that undergo socioeconomic ascent. Our analysis can aid in better understanding of how these neighborhood socioeconomic and cultural changes impact equity, specifically disparities in health and health care access.

Methods

Literature Search

We conducted our systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [76].

Search Strategy

To identify empirical studies that examine associations between gentrification, and other differently termed but similar neighborhood change processes, and health outcomes published between January 1, 2000, and March 31, 2018, we performed a literature review in five electronic databases: Pubmed, Sociological Abstracts, Web of Science, Academic Search Premier, and EconLit. These databases index journals from each of the major fields that have produced articles on neighborhood effects research. We limited the time range to post 2000 because twenty-first-century gentrification differed substantively from gentrification in previous decades [23–25].

We compiled a list of exposure terms, identified by a review of articles on gentrification and health found in Pub Med, related Mesh terms, and review by topic experts. The terms included gentrification, as well as various processes of socioeconomic ascent including community development/revitalization, urban renewal, and neighborhood change. We expanded our search beyond gentrification because authors use multiple terms to describe processes of neighborhood change and SES ascent. We explicitly did not include words such as eviction or displacement, as they represent possible consequences of gentrification, or mediators in the relationship between gentrification and health. Search terms for health outcomes were based on outcomes previously examined in neighborhood effects research [77]. Finally, we included geographic search terms to identify studies at the neighborhood or area level.

We combined geographic and exposure terms with the Boolean operator "AND," then combined these with the health outcome/behavior terms, again using the Boolean operator "AND" (see Appendix Fig 2 Table 4 for an example of MESH search terms). We searched for our terms within title and abstracts in all databases, and if available by the database, additionally searched MESH terms and keywords related to health outcomes and various terms for neighborhood change processes.

We also conducted a "snowball search" examining the reference lists of included articles and additionally searched the grey literature on Google. For our Google search, we used search terms combining the exposure and outcome terms from Appendix Table 4, with the name of large cities (e.g., New York, Chicago, San Francisco). Though the search identified relevant reports, none included quantitative estimates of the relationship between gentrification and health. We, therefore, exclude the details of this search strategy. We did not perform a formal meta-analysis on included studies because of the diversity of outcomes assessed in the various included articles (Appendix Fig. 2).

Inclusion/Exclusion Criteria

To be included, studies had to conduct primary analysis on the empirical relationship(s) between gentrification or similar processes and health outcomes, assessed at either the individual or neighborhood levels. We limited our search to English-language articles with a US study population. This was because the context, drivers, and thus implications of gentrification and neighborhood change in other countries differ substantially from the USA. The historical racist actions and continued legacy of residential racial segregation in the USA created unique neighborhoods of concentrated poverty, and consequential opportunity for reinvestment in previously disinvested communities [31]. Therefore, patterns of neighborhood inequity and gentrification described in the included articles are likely to be unique to the USA.

During the full-text assessment, we excluded studies on general crime as an outcome but included studies that assessed homicide or violent crime specifically, as general crime is not a health outcome. Additionally, we

excluded articles based on exposure definitions; this included articles that evaluated stagnant neighborhood poverty and increasing neighborhood poverty; articles that did not identify the direction of neighborhood socioeconomic change; or studies in which participants moved, but neighborhoods did not undergo change, because they did not meet our definition of gentrification and related neighborhood processes. Finally, we also excluded articles in which there was no quantitative assessment between the exposure and health outcome.

Study Selection and Data Extraction

Once all identified bibliographic records from the electronic databases were compiled, titles and abstracts were reviewed by ASM and JJ using the above eligibility criteria, and only studies that met inclusion were added to the database. The same authors then reviewed and cross-checked the abstract and full articles to verify the inclusion criteria. This process was then repeated by ASM, and any disagreement on inclusion was resolved through discussion. A second full-article review was then conducted by both authors during the data extraction process, and additional articles were excluded. To quantitatively assess how gentrification affects health, only data from empirical studies were extracted and entered into a database (see Appendix Table 5).

To understand how gentrification has been conceptualized and operationalized, we recorded how the exposure was named and measured, and the description of the examined construct. Additionally, we report the main results and findings, and direction of results (positive, negative, no effect evident), as related to association or effects of the exposure and health. Table 1 also displays the author name(s), title, year, hypothesized effect and direction, and effect estimate and direction. Though not shown in Table 1, we also extracted information on discipline of publishing journal, explicit mention of guiding theory/framework and theory/framework name, stated article purpose, neighborhood definition, hypothesized connections between gentrification and health, dataset used, years studied and study location, study design, covariates assessed, and mediators and moderators considered. We additionally assessed if studies took a historical perspective on the process of gentrification by examining the history of community development policy or disinvestment in that area, if race/ethnicity was explicitly mentioned or operationalized in the definitions of the exposure, and whether the study required that neighborhoods were low-income or disinvested in the base year of the study period. These three topics are major areas of controversy in the gentrification literature, and therefore we sought to understand how the included studies considered these questions.

Results

The five-database search yielded 9879 articles. After removing duplicates, 9108 articles remained. The majority of these articles (8603) were excluded because they did not study a gentrification-relevant exposure, and an additional 190 articles did not examine US populations. We included 100 articles in our first full-text review but excluded an additional 80 publications during the data extraction phase, again primarily because they did not examine a gentrification-relevant exposure, leaving 20 articles that met inclusion criteria. We included an additional two articles from the snowball search strategy, for a total of 22 included articles (see Fig. 1, study selection flow chart).

Appendix Table 5 shows the author and publication year, primary exposure name, exposure definition, hypothesized effect and direction of the effect, and the resulting estimated effect and direction of the effect of the 22 included studies.

In Table 1, we summarize the publication year of the included articles, study population geographic location, exposure definition, and outcome(s). Only one article was published before 2005, which used data from the 1980s and 1990s. Of the remaining articles, eight (36%) were published between 2005 and 2009, six (27%) between 2010 and 2014, and the seven (32%) between 2015 and 2018. Nearly a third of articles examined East Coast cities (New York and Philadelphia specifically); and three examined Chicago and St. Louis.

Exposures and Outcomes

More than a quarter (eight) of the articles examined homicide, violence, safety, or mortality as a primary outcome. Nine articles (40%) assessed birth outcomes, health behaviors, and chronic diseases, and only two studies examined mental health (depressive symptoms).

Although all included articles measured some type of neighborhood change related to socioeconomic gain, the exposure was labeled differently by various researchers. Nine (> 40%) of the included articles named their

Table 1 Characteristics of 22 empirical quantitative studies of neighborhood change and health

	No. of studies	% of total studies
Year published		
2000–2004	1	4.5
2005–2009	8	36.4
2010–2014	6	27.3
2015–2018	7	31.8
Location		
National[b]	1	4.6
Multicounty (CA, Kansas, Oregon)	3	13.6
West Coast County (Cook County, WA; San Diego, CA)	2	9.1
East Coast City (New York City, NY; Philadelphia, PA)	7	31.8
Midwest City (Chicago, IL; St. Louis, MI)	5	22.7
West Coast City (Los Angeles [b], Seattle, Santa Ana CA)	3	13.6
Southern City (Birmingham, AL; Dallas, TX; West Wabasso, FL)	3	13.6
Outcome		
Homicide/violence/safety/mortality	8	36.3
Birth outcomes	3	13.6
Health behavior (physical activity, health care access, children's behavioral health)	3	13.6
Chronic disease (cancer, weight gain, hypertension)	3	13.6
Self-rated health/general illness	2	9.1
Mental health	2	9.1
Other (blood lead levels)	1	4.6
Exposure name		
Gentrification	9	40.1
Community/neighborhood change/trajectory	5	22.7
Neighborhood context (affluence/gentrification)/neighborhood position	2	4.5
Revitalization/improvement/renewal/development	4	18.2
Other (renovation, instability)	2	9.1

[a] One study included both a longitudinal and cross-sectional study design

[b] One study included both a national and LA-specific analysis

exposure gentrification, and an additional five (22%) referred to their exposure as community change, neighborhood change, or neighborhood trajectory. Though the terminology differed, 13 out of 14 articles that examined gentrification or neighborhood/community change defined the exposure as a process of neighborhood change that included a shift towards higher socioeconomic status (see Appendix Table 5 for exposure definitions); the Morenoff et al. (2007) defined gentrification as "a residentially mobile population consisting of young adults and few children under the age of 18." English et al. measured their exposure with census variables also commonly considered to indicate gentrification, but termed their exposure neighborhood instability. Among the remaining nine articles, four (18%) called their exposure urban/community development or revitalization/improvement, two (9%) neighborhood context or neighborhood position, and the remaining two termed their exposure neighborhood renovation or instability.

Seven articles (33%) lacked a priori hypothesis about the direction of the relationship between the exposure and health outcome of interest (see Appendix Table 5). Another eight articles (33%) hypothesized a protective relationship, and five articles (~ 25%) included both protective and detrimental hypothesis. Three articles (14%) [78–80] hypothesized that the relationship between the exposure and the outcome would be detrimental to the health of individuals exposed.

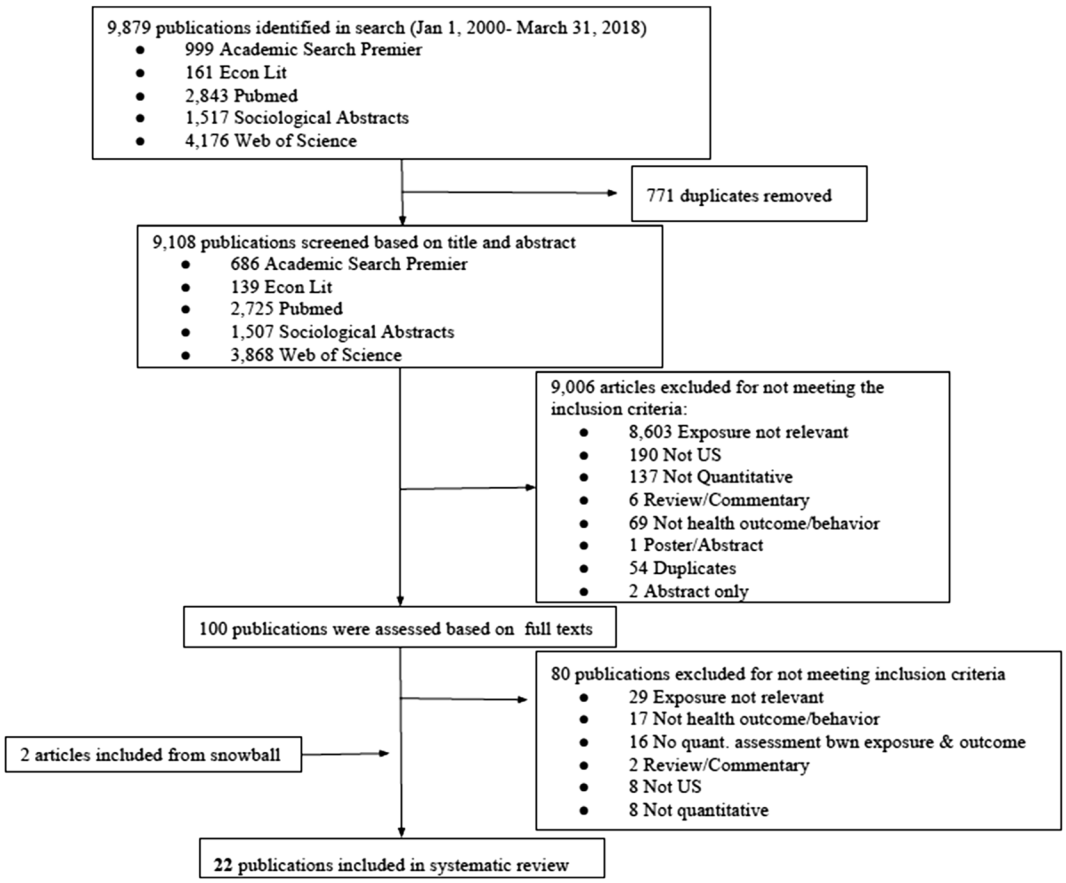

Fig. 1 Flowchart for study selection

Almost 90% of studies (19 articles) reported a significant effect of neighborhood SES ascent on health when including subgroup effects. Of these, one-third (eight) of the included articles reported significant health improvements associated with the exposure among the full study population, another third (eight articles) found both significant protective and detrimental effects depending on the subgroup assessed, and 20% (four articles) found significant harmful main effects, and the remainder (two articles) reported no significant main or subgroup effects.

Of the nine papers that named their exposure of interest gentrification, six of nine articles (67%) found a significant overall association (positive or negative) between gentrification on health, and all found significant associations between gentrification and health for at least one subgroup. For example, using a cross-sectional dataset, Gibbons found only a marginally significant effect ($p < 0.10$) for the overall association between gentrification and poor self-rated health, but significantly higher odds for Blacks compared to whites. Of note, this was the only study that included a self-reported outcome. Lim et al. (2017) found that for low-income groups remaining in gentrifying neighborhoods, residents experienced significantly higher rates of emergency department (ED) utilization, lower rates of hospitalizations, and no significant effect on mental health-related visits, in comparison to low-income residents in non-gentrifying neighborhoods [80]. The Lee article, which used a methodologically rigorous, quasi-experimental study design, found no significant effect of gentrification in low-income neighborhoods, and an increase in assaults in moderate-income neighborhoods undergoing gentrification.

There were additional contrasting results in terms of the protective or detrimental effects of gentrification on health. Four of the studies (44%) on gentrification found protective effects, and all but one of those articles examined violence. One study (11%) found only harmful associations, and four (44%) found both protective and

detrimental associations. Of these mixed-result studies, the authors offered differing explanations for their findings: one found contrasting effects by outcome assessed—emergency department versus hospital admission [80]; another by exposure measurement—density of coffee shops versus administrative economic data [81]; another by time period—1990s versus 2000s [82]; another by the economic status of the neighborhood—low versus moderate income; and the two found subgroup effects depending on participant racial category [83], and an interaction between participant race and neighborhood racial composition [84].

Studies on violence and crime (six of the nine articles) produced conflicting results, with some documenting a decrease [37, 39, 81, 85] and others an increase in violence associated with gentrification [38, 82]. Though, notably, Williams found that between 2000 and 2009, gentrification was associated with 52 (SE 13.56, $p < 0.01$) additional violent crimes than non-gentrifying areas, and Lee found that in moderate-income neighborhoods, each additional gentrifying household per 1000 led to annual average of 2.2 (SE 1.09, $p < 0.05$) more assaults per 1000. In addition to conducting primary analysis, Kreager et al. (2011) summarized earlier work, and the findings suggest a curvilinear relationship between gentrification and crime/violence over time, suggesting that early-stage gentrification—during the 1970s and 1980s—was associated with increases in crime, while crime rates declined during the 1990s. We caution direct comparison of the articles on violence, as they focus on different cities and periods, and include various measures of gentrification, and all but one used observational data, so it cannot show that gentrification caused changes in violence.

Study Design and Analysis Methods

Regarding study design, the vast majority of articles (90%) were observational, and only two (9%) articles used quasi-experimental designs, one instrumental variable [38], and one longitudinal pre-post with a control group [86] (see Table 2). Of those 20 observational articles, one article used both a longitudinal and cross-sectional study design [88], another eight (36%) used only a longitudinal cohort design, and the remaining 11 (55%) employed a cross-sectional or repeated cross-sectional design. Of the nine studies that examined gentrification, one (11%) used a quasi-experimental design, four (44%) used longitudinal designs, and four other (44%) studies used cross-sectional or repeated cross-sectional designs. The single gentrification study using a quasi-experimental design by Lee (2010) exploited the 1994 Northridge earthquake in Los Angeles as an instrument to control for bias due to neighborhood selection and found that in the short-term gentrification increased crime. Overall, however, studies using designs with a lower risk of bias (quasi-experimental, longitudinal) did not appear to differ concerning the likelihood of reporting either a positive or negative relationship between the assessed exposure and health.

Eight studies (36%) used a multilevel modeling approach, most nesting individuals within neighborhoods or communities, and another six studies used fixed-effects approach, though there was no difference in the direction or likelihood of significance for multilevel models versus fixed-effects approaches. The articles

Table 2 Study design and exposure measurement in studies of neighborhood change and health ($N = 22$)

	No. of studies	% of studies
Study design		
Observational		
Cross-sectional	5	22.7
Ecological (repeated cross-sectional)	7	31.8
Cohort (longitudinal)[a]	9	40.9
Quasi experimental		
Instrumental variable	1	4.6
Pre-post (with control)[b]	1	4.6
Exposure measurement category		
Administrative data	11	50
Development/demolition activities	2	9.1
Observational (coffee shops, property appraisal data, home loans)	5	22.7
Survey-based	5	22.7
Pre/post	1	4.6
Explicit mention of race in definition/operationalization		
Yes	5	22.7
No	17	77.3
Prior disinvestment (low-income in base year)		
Yes	10	45.5
No	12	55.5

[a] One study used both a cross-sectional and longitudinal study design

[b] Only longitudinal studies that included a control group were considered quasi-experimental

included various covariates that might bias the impact of the exposure on health outcomes. Common individual-level covariates included age, sex or gender, race/ethnicity, measures of socioeconomic status (income, education, wealth), a housing tenure-related measure, insurance status, marital status, and outcome at baseline. Common neighborhood-level measures included population count, neighborhood racial composition, percent foreign-born/immigrant population, and indices of concentrated disadvantage.

Nearly a quarter (5) of the included studies augmented census data with measures intended to capture the subtle cultural process of neighborhood change not evident in census data. Half of all studies (11) relied on administrative data to operationalize the exposure, primarily data derived from either the decennial census or American Community Survey (ACS); and another five (23%) studies employed various types of observational data, such as the count of coffee shops or analysis of property appraisals. Six studies (27%) used a longitudinal or repeated cross-sectional study design and measured the pre-post design as the exposure (e.g., before and after a development project).

Nearly half (10) of the studies tested whether the magnitude of the effect varied depending on a third variable, and six of those ten examined whether the magnitude or direction of the effect differed depending on respondents' race/ethnicity. Though Williams and Rabito found no race-specific interaction effects, the four remaining studies found support for differential effects either by individual race/ethnicity or neighborhood racial compositions. The four studies generally found either larger benefits for whites or white neighborhoods, or worse outcomes for non-white populations than white populations [83, 84, 87, 88]. Less than a quarter (5) of all included articles explicitely mentioned or operationalized race in their definitions of the exposure.

A major debate in the literature is whether a neighborhood must be poor or low-income to be eligible for reinvestment and considered eligible to gentrify or revitalize. Less than half (10) of the included studies required such a condition in the base year of analysis. Studies operationalized "eligible for reinvestment" in different ways: as those neighborhoods with below average median family income for the city [39, 84], neighborhoods where ≥ 50% of the residents live below 1.5 times the federal poverty level [15, 62, 89]; neighborhoods with higher than average poverty level [85]; or defined by a principal component analysis of multiple neighborhood-level characteristics [80]. Six articles [37, 81, 83, 84, 90] specifically mentioned displacement of lower-income households as part of the exposure definition, and all but one [90] of those articles termed their exposure gentrification.

Article Framing

Almost 60% (13) of the included studies explicitly mentioned or described a framing theory in the article text (Table 3). Most of those theories either fell into the category of ecological theories (social-ecological, ecological dissimilarity, human ecology, social disorganization, and relative deprivation) or social capital theories (social disorganization and collective efficacy). No included studies explicitly employed a participatory framework or approach.

We also examined if the presence of theory or historical assessment suggested the directionality of the hypothesized relationship between the exposure and outcome. No clear relationships emerged, though studies including a historical or theoretical perspective were slightly more likely to hypothesize a protective directionality, and no studies that included a historical perspective also assumed a detrimental impact. Eight (36%) studies hypothesized a protective effect, three (14%) hypothesized detrimental effects, seven (32%) lacked an a priori hypothesis, and four (18%) hypothesized that there would be both protective and detrimental impacts. Nearly one-third of studies that lacked a historical perspective of the exposure or neighborhood also lacked an a priori hypothesis. Among articles published in public health journals, 50% (five of ten articles) were both atheoretical and ahistorical, and the remaining five were either ahistorical or atheoretical; no studies published in public health journals explicitly addressed both theory and history.

Discussion

This review provides a summary of the last two decades of quantitative research on the relationships between health and gentrification, urban development, and other forms of socioeconomic ascent. Our results reveal limited literature on how neighborhood socioeconomic ascent impacts health, finding only 22 studies that met the inclusion criteria. While more research is needed, studies on gentrification, and related neighborhood SES

Table 3 Theory and historical framing, by direction of hypothesis, in studies of neighborhood change and health ($N = 22$)

		Hypothesis direction			
	Total *N*(%)	Protective *N*(%)	Detrimental *N*(%)	Protective and detrimental *N*(%)	No a priori hypothesis *N*(%)
Theory					
Theoretical	13(59.1)	5(22.6)	1(4.5)	4(18.2)	3(13.6)
Atheoretical	9(40.9)	3(13.6)	2(9.1)	0(0.0)	4(18.2)
Historical					
Historical perspective	8(36.4)	5(22.6)	0(0.0)	3(22.6)	0(0.0)
Ahistorical[a]	14(63.6)	3(13.6)	3(13.6)	1(4.5)	7(31.8)

[a] Studies were defined as ahistorical if they did NOT include any description of the history of the exposure measure or history of the study neighborhoods

ascent processes, and health represent a promising area of study about how changing places impact health. Of the limited studies available, the majority found evidence of significant associations between gentrification and other measures of socioeconomic ascent and health, though the direction of the assessed relationships was not consistent. Nine studies specifically examined gentrification, and of those, five found a protective effect of gentrification on health, though four of the five assessed the impact of gentrification on a measure of violence. The other four studies found either detrimental or both detrimental and protective impacts of gentrification on health.

Debates on gentrification and other neighborhood change processes are often framed as questions about whether such processes are uniformly harmful or protective [15]. Our results cannot provide definite conclusions to this question, with respect to health, and instead suggest that gentrification, neighborhood change, and urban development appear to both detrimentally and beneficially associate with health. In the following paragraphs, we describe some of the primary reasons the studies appeared to find diverging associations between neighborhood socioeconomic ascent and health. In particular, we discuss differences in contextual determinants of neighborhood change, outcomes and exposure measurement employed, and study design and analysis methods.

First, as suggested by ecosocial theory, underlying political, social, and economic neighborhood differences impact health [33], as well as the probability that a neighborhood will gentrify. Contextual differences include the preexisting spatial and racial inequity in cities, policy efforts underway, the level of affordable housing and community organizing present, speed at which change processes occur, and whether the cause of change is exogenous [91]. In future studies, such contextual factors should be considered as potential confounders or effect modifiers of the relationship between neighborhood socioeconomic ascent and health, when testing the relationship across multiple neighborhoods. In particular, racial residential segregation plays a foundational role in maintaining and replicating racial and socioeconomic inequity [9, 92]. Segregation and intentional disinvestment from, in particular, Black communities [93], created the conditions that result in over-representation of communities of color as disinvested and low-income, and therefore eligible to gentrify [94]. As the ecological dissimilarity hypothesis posits, residential segregation creates differential exposures and contexts for majority Black versus majority non-Black neighborhoods, and therefore neighborhood change produces divergent processes and outcomes depending on the prior racial/ethnic composition of the neighborhood and of the gentrifiers [95].

The theoretical and historical framing of an article can orient authors to the larger contextual factors operating in the places they study, and help authors identify potential effect modifiers, such as levels of segregation, to test for in studies. However, none of the articles in our review, that were published in public health journals, included explicit theoretical and historical framing, and overall, nearly two-thirds of the included studies did not include a historical perspective. The ahistorical studies did not explicitly engage with discussions on how larger political, economic, and cultural powers and processes, and divorced their explication of neighborhood change from the durability of racial segregation. Future research, particularly in public health, will benefit from explicitly engaging in larger discussions on

neighborhood inequities, and the propensity for certain neighborhoods to undergo change. The lack of theoretical and historical framing in the public health literature we examined also makes it challenging to distinguish gentrification from other forms of socioeconomic ascent. For example, neighborhood socioeconomic ascent that occurs as a result of public investment or economic development versus ascent due to an influx of new residents. We might operationalize both types of neighborhood change by measuring changes in income, but outcomes for residents are likely to differ. Such differences enforce the importance of clearly describing contextual antecedents and change processes.

We found included articles used a plurality of definitions and measures of gentrification and related exposures, and caution against assuming a uniform relationship between such exposures and health. Epidemiology traditionally requires a well-defined intervention to estimate causal effects. At this time, gentrification research is in a nascent stage of development, so the consistency assumption may not be the primary concern [96]. However, as research moves forward towards guiding potential interventions on gentrification, the issue of a well-defined intervention should be addressed.

Gentrification is one commonly measured form of neighborhood socioeconomic ascent [69], and we intentionally included differently named exposures in this review. Even within the studies explicitly terming their exposure gentrification, authors conceptualized and operationalized gentrification in numerous ways. It follows that exposures termed and measuring other forms of neighborhood socioeconomic ascent would likely produce differential outcomes. How a neighborhood changes—for example, the speed, whether internal or external forces catalyze the change, residents' feelings of ownership of change [97]—is likely as important for health as change itself. To address the import of change type, we intentionally avoid conducting a meta-analysis. A meta-analysis would require grouping our variously termed and measured exposures together to calculate a pooled effect. Instead, this article is intended to build a foundation for future work to answer the question of how to classify different types of neighborhood socioeconomic ascent as they relate to health outcomes.

Half of all reviewed studies relied on administrative, mostly census, data to operationalize their exposure. Census-based measures allow for small area estimates that approximate neighborhoods and allow for geographically meaningful comparisons across places, but may miss nuanced changes within neighborhoods [98]. Promising work in sociology uses systematic social observation and Google street view to capture the cultural and developmental aspects of gentrification [17]. But no authors have yet applied the measure to health studies. Application of measures using systematic social observation, or measures generated using various other forms of data, may help to differentiate gentrification from other types of socioeconomic ascent. Examples include data from the existing administrative data sources such as parcel-based home sales, property characteristics and permits, condominium conversions, tenant complaints, and 311 calls; indices based on social media sources—e.g., yelp Business reviews [99], user-generated geographic content [100], surveys of long-term resident perceptions' of gentrification, or mixed-methods approaches triangulating multiple data sources [98]. Such work can aid in understanding which types and qualities of gentrification matter for shaping health outcomes as well as the mechanisms by which this occurs. There has also been limited exploration of various gentrification subtypes in the health literature, for example, change induced by gay and lesbian populations [101], of gay and lesbian neighborhoods [102], or catalyzed by an influx of neo-bohemian and creative classes [103]. Extending gentrification work to consider subtypes may help to explain differential impacts across studies.

The literature, both the articles we reviewed on gentrification and health and the larger body of literature on gentrification generally, has failed to arrive at a consensus on definitions or measurement of gentrification and urban development processes [104, 105]. And, even those articles using the same term to describe their exposure do not apply consistent definitions for the term employed. For example, there is substantial debate in the literature about how to define and measure gentrification. Five of the articles on gentrification included displacement in their exposure definitions, while other researchers presented displacement as a consequence, rather than component, of gentrification [106]. Likewise, debates about which neighborhoods are eligible to undergo neighborhood socioeconomic ascent and gentrify [20, 106, 107], and if gentrification is an inherently racialized process [95] lead to differing decisions about which neighborhoods to include in a study, categorization of thresholds to identify treatment or control neighborhoods, and variables or data used to operationalize the exposure. Of our included articles, almost half (10) required prior disinvestment or

neighborhoods to be low income in the base year of the study, and 22% (5) studies included race in their exposure definition. These decisions can impact the significant and direction of results, as well as the interpretation of analysis and recommendations to stifle or encourage gentrification. We add to the definitional debate by identifying that the definition and operationalization of the exposure process also impact the health effects estimated. Rather than advocating for a single definition, we instead suggest researchers present a clear theoretical basis for their definitional and operational choices, so that readers can assess the position from which researchers are approaching their questions [108].

There did not appear to be a uniform directional relationship between exposures and outcomes across health measures, or even across multiple studies measuring the same outcome. More than a third of the reviewed studies examined violence and crime but found varying directional results. Given the inconsistent relationships that emerged depending on the outcome assessed, studies should consider including a more extensive set of potential health outcomes. For example, only one study included a self-reported health outcome, and none of the reviewed studies on gentrification examined mental health outcomes, though mental health and self-reported health may show rapid changes in the face of neighborhood change. Administrative databases, such as health insurance claims data, show great promise because of their ability to track longitudinal health outcomes and household addresses. For example, a study by Dragan et al. uses Medicaid claims data to compare utilization rates among children in low-income neighborhoods that gentrified to children in low-income neighborhoods that did not gentrify [109]. Administrative claims data could also be used to test hypotheses about gentrification and housing instability, which can be an enormous psychological and economic stressor for low-income residents and could impact acute cardiovascular events among those with existing cardiovascular comorbidities. In addition, gentrification can increase housing costs and limit low-income people's resources to cover needed medical expenses such as medications. We would expect these financial stressors to affect asthma emergency department visits (particularly among children), diabetes control, and, in the long-term, incidence of new chronic diseases.

For many of the included studies, aggregate results appeared to mask heterogeneity in the health effects across subpopulations of those exposed. In particular, though only seven studies measured effect modification by race/ethnicity or neighborhood racial composition. We found a suggestive pattern, whereby in several studies, white populations or residents of white neighborhoods appear to benefit from gentrification and Black populations experience adverse health outcomes [37, 83, 84]. For example, Huynh and Gibbons found opposite directional effects in analysis stratified by race but failed to find significant main results, suggesting that subgroup effects masked significant main effects. Articles published after our study have additional associations between gentrification and worse health for Black residents [110, 111], but no significant main effects. Together these findings suggest both the need to include tests for differential effects by race/ethnicity in gentrification studies and the potential that gentrification may exacerbate existing racial disparities in health.

Neighborhood change may produce heterogeneous impacts for different residents *within* changing neighborhoods. As described above, results may differ by race/ethnicity of individuals as well as the composition of neighborhoods. Long-term residents are likely to be most deeply connected with their neighborhoods and therefore most susceptible to disruption of networks via neighborhood change [55, 112], but none of the studies we reviewed included length of time in the neighborhood as a control variable. Comparing long-term residents of gentrifying and non-gentrifying previously low-income neighborhoods will help to isolate the impacts of neighborhood SES ascent on health further.

Methodological decisions about exposure and reference groups additionally appeared to impact study results. The included studies considered various control groups, such as residents of high-income and low-income neighborhoods, and we find that more explicit description of the target study population and control group will improve researchers' ability to assess the effect of these processes on health and disparities in health. For studies of neighborhood gentrification, low-income residents of geographically proximate, continuously low-income neighborhoods may constitute as a meaningful reference group against which to compare low-income residents of gentrifying areas. Residents of continuously low-income neighborhoods experience the likely outcome trajectory in the absence of gentrification, allowing for a less biased estimate of the population average treatment effect.

Neighborhood effects research tends to frame low-income neighborhoods as universally detrimental to

health [113, 114]. A myopic focus on the damaging impacts of economically deprived neighborhoods overlooks protective health factors that also exist in low-income neighborhoods, before an influx of higher-income individuals, and the potential for neighborhood change to disrupt these resiliency factors. For example, residents living in neighborhoods high in collective efficacy, or mutual trust and willingness to help other community members, have been found to report better overall health than those living in neighborhoods low in collective efficacy, after controlling for a range of individual and neighborhood-level characteristics [115]. Strong social connections and networks can mediate the effects of structural factors such as poverty and concentrate disadvantage [116]. Applying an asset-based framing [117], which suggests consideration of both positive and protective neighborhood factors when examining low-income racially segregated neighborhoods, can help to identify mediating factors that may protect health as neighborhoods change.

Low- and working-class voices are often absent in research on neighborhood change [13, 118], but listening to those directly impacted can help develop deeper understandings of neighborhood SES ascent processes, advance epidemiologic research by identifying complex causal processes, and shape policies to better address community needs [119, 120]. No included studies applied a Participatory Action Research (PAR), or Community Based Participatory Action Research (CBPAR) framing, though these and other forms of participatory epidemiology offer frameworks for inclusion [121–123]. Promising work in this area, such as the Healthy Neighborhood Study (HNS), provides a platform to include residents in the research study, definition of outcomes, and identification of mediators of the relationship between neighborhood development and health [97]. Other participatory research by the authors identified gentrification and displacement as the second most important neighborhood challenge impacting residents in Central Brooklyn in 2017 [46] and, research conducted with communities across New York found gentrification was among the top three most commonly identified structural psychosocial stressors [74]. While community organizing and activism are often pitted as enemies of development and rezoning processes, PAR offers opportunities to bring community members, developers, and policymakers to the same table to create understanding and plans for inclusive development. We can learn lessons about the importance, mechanisms, and consequences involved in gentrification from such projects, and PAR generally.

It is unclear whether low-income populations are benefitting from the spatial realignment associated with gentrification and urban redevelopment, and if poverty is re-concentrating in new areas. The limited research on this topic suggests the latter that low-income residents directly displaced by gentrification or who move out of gentrifying neighborhoods often move to even lower-income neighborhoods [17] or neighborhoods further from cities' economic cores. But, on average rates of displacement are not higher in gentrifying than non-gentrifying low-income neighborhoods [14, 15, 28, 43]. Low-income populations tend to live in poor housing conditions and exit, for both consensual and non-consensual reasons, at high rates in all types of neighborhoods [36, 106]. Other research suggests that low-income households are often locked out from moving into gentrifying neighborhoods because of high rental prices, and when low-income households move out of gentrifying neighborhoods they are often replaced by higher-income households, creating much of the turnover observed in gentrifying neighborhoods [106]. Health consequences, however, are not limited to physical displacement or lockout; the loss of social networks spurred by others' displacement can increase stress levels and detrimentally impact residents [83].

In part as a consequence of these changing residential configurations, patterns of economic and racial segregation prevalent in cities are replicating in the suburbs [124]. Our work indicates that between 2005 and 2015, the suburbs had on average lower rates of uninsurance and barriers to health care, but this advantage relative to urban areas fell over the study period and had disappeared by 2015. Nearly 40% of low-income suburban residents had an unmet care need due to cost in the past year, suggesting that if low-income residents move out of or are displaced to the suburbs, they likely face substantial barriers accessing care [125]. Further, a small body of literature has begun to examine gentrification in suburban areas [126]. Broadening of gentrification work outside or urban areas reflects more recent increases in suburban poverty and the reality that suburbs have been home to impoverished communities for decades [127], despite narratives of suburbs as homogenously affluent. Only one article included in our study examined access to health care, and they found that while ED admissions were slightly higher in gentrifying neighborhoods than a non-gentrifying

poor neighborhood, hospitalizations were lower in gentrifying neighborhoods [80]. Further research on how neighborhood change impacts access to health care can assist health departments and providers, particularly safety-net providers, in understanding how to distribute resources and services to better address care needs.

Limitations

We did not conduct a meta-analysis given the heterogeneity of the study designs, outcomes, data sources, and different ways of measuring gentrification and neighborhood change, and so do not present the range of estimated magnitudes for any outcomes. Additionally, given the limited number of relevant studies, we did not attempt to conduct any significance tests to understand the associations between study features and outcomes. Our results are limited by the time period, search terms, databases and review protocol we employed, and choice of different terms or protocol may have altered the included articles. We are aware of a small number of additional articles that have been published on the topic since the review was completed [111, 128] or in journals not indexed in the databases we searched [129]. However, our terms were broad, and we followed the systematic review with both snowball and structured Google search reviews, to ensure most relevant articles were not overlooked.

We recognize, but intentionally avoid, broader debates on causes of gentrification and debates on new urbanism [18, 130]. The literature suggests that a host of both supply and demand factors, as well as geopolitical and historical trends, drive gentrification and urban investment and that these factors are likely location specific in the degree to which they explain gentrification [35]. Researches have produced numerous works on these subjects, and we find it beyond the scope of this work to engage further in this debate because no studies relate these factors to health outcomes, but acknowledge their importance for understanding the larger implications of processes of divestment, investment, and gentrification. We suggest that future research on the subject consider mediating factors, both the upstream sociopolitical factors affecting the prevalence and intensity of neighborhood change processes, and those factors that mediate the relationship between neighborhood change and health, for example, by examining the level of social support and cohesion, factors that may both confound and mediate the relationship between gentrification and population health. Additionally, a body of literature, produced mostly in Europe, explores how urban renewal and regeneration can contribute to gentrification and other neighborhood change processes, and how in turn these impact health equity [131–133]. We limited the scope of our search to studies directly assessing the relationship between neighborhood socioeconomic ascent processes and health, but recent work in systems thinking offer methods of evaluating these dynamic interrelations and identifying the multiple complex causal processes at play in urban environments [134, 135].

Conclusion

Critical gaps exist in the literature examining recent changes in the geographic patterning of populations in the USA and implications for health. Documenting and explaining social inequalities in health is a central task of public health and understanding the geography of inequality is a fundamental tenet of population health. Despite the impacts of gentrification and neighborhood socioeconomic ascent on the public health and the health care fields, both fields have primarily remained on the periphery of public debates around the impacts of neighborhood change processes. We need further research to address this gap, particularly study designs that allow for a causal interpretation of effects—experimental, natural, and quasi-experimental longitudinal designs—and follow people across and within neighborhoods, as well as participatory studies that include the voices of impacted communities. We found that differences in study design, analysis methods, exposure definitions, and control groups explained differences in findings. To allow for comparison of studies across cities, outcomes, and time periods, it is imperative that researchers employ consistent reference groups, include theory-driven controls and exposure measures, consider and describe different types of gentrification and neighborhood change processes, test for subgroup effects where average population effects may obscure differential impacts by group, and explicitly document contextual and historical factors that generate understanding of the larger political and social context in which neighborhoods change.

Our review underscores the relevance of considering neighborhood change to accurately determine prevalence and incidence of area-level health outcomes.

Recognizing and documenting where the economically disadvantaged and the affluent reside, and how their contexts affect their health, aids in our understanding of the geographic distribution of health and wellness in the population. Overlooking shifting geographic patterns hinders our ability to accurately assess changes in population health, identify causes of ill or good health, and develop interventions and policies to address inequities.

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Appendix

Exposure: ((((("Residence Characteristics"[Mesh:NoExp] OR neighborhood*[tiab] OR community[tiab] OR communities[tiab] OR neighborhood change*[tiab] OR gentrif*[tiab]) AND ("Social Change"[Mesh:noexp] OR "Urban Renewal"[Mesh] OR redevelopment[tiab] OR revitalization[tiab] OR renewal[tiab] OR transformation[tiab] OR neighborhood change*[tiab] OR gentrif*[tiab] OR ascent[tiab] OR upgrading[tiab] OR up-and-coming[tiab] OR turnover[tiab] or regeneration[tiab]))

Health: (("Body Mass Index"[Mesh] OR "Overweight"[Mesh] OR overweight[tiab] OR obesity[tiab] OR "Mental Health"[Mesh] OR "Depression"[Mesh] OR "Depressive Disorder"[Mesh] OR depression[ti] OR mental health[tiab] OR self rated health[tiab] OR "Homicide"[Mesh] OR homicide*[tiab] OR "Suicide"[Mesh] OR suicide*[tiab] OR "Life Expectancy"[Mesh] OR life expectancy[tiab] OR "Mortality"[Mesh] OR mortality[tiab] OR "Hospitalization"[Mesh] OR hospitalization*[tiab] OR hospital admission*[tiab] OR "Emergency Service, Hospital"[Mesh] OR emergency room*[tiab] OR emergency department*[tiab] OR acute care[tiab] OR mental health[tiab] OR self rate*[tiab] OR "Wounds and Injuries"[Mesh] OR injury[tiab] OR injuries[tiab] OR "Cardiovascular Diseases"[Mesh] OR cardiovascular disease*[tiab] OR "Respiratory Tract Diseases"[Mesh] OR chronic obstructive pulmonary disease[tiab] OR asthma[tiab] OR "Exercise"[Mesh] OR physical activit*[tiab] OR "Pregnancy in Adolescence"[Mesh] OR teen pregnanc*[tiab] OR teenage pregnanc*[tiab] OR adolescent pregnanc*[tiab] OR teen birth*[tiab] OR "Infant, Low Birth Weight"[Mesh] OR "Infant, Premature"[Mesh] OR low birth weight[tiab] OR preterm birth*[tiab] OR Pressure, Blood[tiab] OR Blood Pressure[tiab] OR "Hypertension"[Mesh] OR "Hypotension"[Mesh] OR "Smoking"[Mesh] OR "Alcohol Drinking"[Mesh] OR "Substance-Related Disorders"[Mesh] OR "Drug Overdose"[Mesh] OR "Pregnancy, Unplanned"[Mesh] OR "Sexually Transmitted Diseases"[Mesh] OR "HIV"[Mesh] OR “Health Status”[Mesh] OR self-rated[Other Term]))

Fig. 2 Example search terms

Table 4 Search terms according to group

Group	Terms		
Group 1: geography	Residence characteristics	Neighborhood	Community/communities
	Neighborhood change	Gentrif*	
Group 2: exposure	Social change	Urban renewal	Redevelopment
	Renewal	Transformation	Neighborhood change

Table 4 (continued)

Group	Terms		
	Gentrification	Regeneration	Ascent
	Upgrading	Up-and-coming	Turnover
Group 3: health outcomes	Body mass index	Overweight	Obesity
	Mental health	Depression	Depression disorder
	Self-rate/self-rated health	Homicide	Suicide
	Life expectancy	Mortality	Hospitalization
	Hospital admission	Emergency service, hospital	Emergency room/department
	Acute care	Wounds and injuries	Injury/injuries
	Cardiovascular disease(s)	Respiratory tract diseases	Chronic obstructive pulmonary disease
	Asthma	Exercise	Physical activity
	Pregnancy in adolescence	Teen pregnancy	Adolescent pregnancy
	Teen birth	Infant, low birth weight	Infant, premature
	Low birth weight	Preterm birth	Blood pressure
	Hypertension	Hypotension	Smoking
	Alcohol drinking	Substance-related disorders	Drug overdose
	Pregnancy, unplanned	Sexually transmitted diseases	HIV
	Health status		

Table 5 Summary of included studies

Author/year	Exposure name	Construct description	Hypothesized effect and (direction)	Effect estimate and direction
Lim et al. 2017	Gentrification	Process through which deprived neighborhoods are revitalized by economic development, typically resulting in an influx of new residents of higher socioeconomic status	Residents living in the gentrifying neighborhoods were more likely to visit ED and/or get hospitalized than residents living in non-gentrifying, poor neighborhoods if gentrification itself had a negative impact on health. (Detrimental)	Residents of gentrifying neighborhoods, as opposed to those of non-gentrifying poor neighborhoods, had significantly higher rates of *ED visits* (RR: 1.1, 95% CI 1.0 ± 1.1), but rates of *hospitalization* were lower (RR 0.95; 95% CI 0.91 ± 0.98). The rates of *mental health-related ED visits* were not significantly different between these two groups.
Papachristos et al. 2011	Gentrification	A process that changes the character and composition of a neighborhood, resulting in the direct and indirect displacement of lower-income households with higher-income households	Crime rates (including *homicide*) will decline at a greater rate in gentrifying neighborhoods as population shifts stabilize. Any crime-reducing effect associated with gentrification will be lower in Black neighborhoods as compared to non-Black neighborhoods. (Protective)	Neighborhoods that experienced gentrification (as measured by coffee shops also experienced a greater than expected decline in *homicide* ($b = -0.182$; SE 0.039; $p < 0.001$), though the effect of coffee shops ($b = -0.077$; SE = 0.04; $p < 0.10$) became insignificant at the 0.05 level after controlling for census factors. The effect of coffee shops on homicides was larger for White ($b = -0.121$; $p \leq 0.001$) as compared to Hispanic (-0.055 $p > 0.05$) and Black neighborhoods ($b = -0.047$; $p > 0.05$), but the effect was negative (increasing coffee shops, decreasing homicide) for all groups.
Smith 2014	Gentrification	Temporal and spatial churning process of higher-income households directly and indirectly displacing	Gentrification in the form of demographic change and coffee shops has a negative effect on *gang*	As neighborhood mobile white population and SES increased, the number of *gang homicides*

Table 5 (continued)

Author/year	Exposure name	Construct description	Hypothesized effect and (direction)	Effect estimate and direction
		lower-income households changing the character and composition of a neighborhood	*homicides* over time. Hypothesis 2: Gentrification in the form of public housing demolition has a positive effect on *gang homicides* over time. (Protective and detrimental)	significantly decreased per neighborhood cluster over time, before (mobile white: $b = -0.53$; SE 0.05; SES $b = -0.47$ SE 0.05) and after adding control variables (mobile white: $b = -0.52$; SE 0.06; SES: $b = -0.48$; SE 0.05). Lagged coffee shops also had a negative effect on the number of gang homicides over time (b = − 0.08; SE 0.04), but the effect was only marginally significant ($p \leq 0.01$). The overall public housing demolition indicator variable had a positive and significant effect on gang homicide ($b = 0.36$; SE 0.16; $p < 0.01$), though the effect was only marginally significant after controlling for prior gang homicide ($b = 0.31$; SE 0.18; $p \leq 0.1$).
Gibbons et al. 2016	Gentrification	The process by which higher-income households displace lower-income households of a neighborhood, changing the essential character and flavor of that neighborhood	(H1) Improvements in quality of life associated with gentrification will be associated with increased *self-rated health* regardless of race. (H2) Non-white racial minorities living in a neighborhood that is gentrifying have poorer health than those residing in a neighborhood that is not gentrifying. (H3) Non-Hispanic Blacks living in a neighborhood that is gentrifying have *poorer health* than those residing in a neighborhood that is not gentrifying. (H4) Non-Hispanic Blacks living in a neighborhood that is experiencing gentrification by affluent Blacks will have similar health outcomes to those in neighborhoods experiencing gentrification as a result of an influx of affluent whites. (Protective and detrimental)	Gentrification had a marginally ($p \leq 0.10$) significant negative relation to *poor/fair SRH* ($b = 0.806$). Gentrification caused by the influx of affluent whites was not significant. In the fully adjusted models, Blacks who lived in a gentrifying neighborhood experiencing an increasing Black population were almost 75% more likely ($b = 1.732$; $p < 0.01$) to report *poor/fair SRH* than their counterparts who lived in other types of neighborhoods. No CI or SE reported
Williams 2014	Gentrification	Reinvestment occurring after a period of community decline, marked by both compositional and economic change and quantified by the extent of reinvestment activity taking place during the gentrification between 1990 and 2000	H1: Gentrification in the 90's resulted in decreases in property and *violent crimes* in gentrifying communities. H2: Gentrification in the 1990s resulted in decreased property and violent crimes in gentrifying non-Black communities but increased property and *violent crimes* in gentrifying Black communities. H3: Gentrification in the 1990s resulted in decreased property and *violent crimes* in gentrifying communities not characterized by concentrated disadvantage at the onset but increased property and *violent crimes* in disadvantaged gentrifying communities. H4: Gentrification resulted in initial property and *violent crime* increases followed by eventual property and violent crime declines. (Protective and detrimental)	Gentrifying neighborhoods were predicted to experience 132 ($b = -131.99$; SE 44.35; $p < 0.01$) fewer *crime* incidents, and 1.45 ($b = -1.45$; SE 0.589; $p < 0.05$) fewer *violent crimes* between 1990 and 2000 than their non-gentrifying counterparts. In 2000–2009, gentrifying neighborhoods were associated with higher rates of *violence* ($b = 51.99$; SE 13.56; $p < 0.01$) than other areas, and violent crime rates were higher in gentrifying than in appreciating or depreciating areas. Additionally, when gentrification was measured as a continuous exposure, higher levels of gentrification, were associated with higher levels of *violent crime* ($b = 392.32$; SE 166.37; $p < 0.05$). The gentrification-racial composition interaction term failed to reach significance in the models for both violent and property crime in both decades.

Table 5 (continued)

Author/year	Exposure name	Construct description	Hypothesized effect and (direction)	Effect estimate and direction
Huynh and Maroko 2014	Gentrification	Economic and social changes that are a result of an influx of higher-income residents and housing investment. Also characterized by the displacement of lower-income residents as housing stock values rise	No explicit hypothesis	In the overall sample, gentrification was not associated with low birth weight. However, when stratified by race/ethnicity, very high gentrification was a significant predictor of *low birth weight* for non-Hispanic Blacks in the fully adjusted model (AOR = 1.16; 95% CI 1.01–1.33), and very high gentrification was protective for non-Hispanic Whites (AOR = 0.78; 95% CI 0.64–0.94).
Barton 2016	Gentrification	No explicit definition	Decline in *crime* in New York City associated with gentrification after a "tipping point." (Protective)	Each percent increase in the percent gentrified census tract in a sub-borough was associated with a 0.008 (SE 0.001; $p < 0.001$) reduction in the *homicide* index in the unadjusted model, and 0.007 (SE 0.001, $p < 0.001$) reduction in the fully adjusted model. This association remained after controlling for variation across time and within traditional predictors of crime.
Kreager et al. 2011	Gentrification	The class transformation of those parts of the city that suffered from systematic outmigration, disinvestment, or neglect in the midst of rapid economic growth and suburbanization. Process that only applies to urban areas that underwent substantial neglect.	Gentrification in the 1980's was positively related to *crime* change, but then reversed in the 1990s in Seattle. (Protective and detrimental)	Gentrification predicts 147 (SE 42.76; $p < 0.001$) *fewer crimes* than other tracts between 1990 and 2000. In gentrifying compared to non-gentrifying but poor tracts, there was a predicted − 104.77 (SE 47.62; $p < 0.05$) fewer crimes. Adding covariates including net migration, household income, foreign-born population, mean mortgage investment, percent Black population, and a spatial error term slightly increased the magnitude of the observed relationship between gentrifying neighborhoods and declining *crime* ($b = -117.54$; SE 41.91; $p < 0.05$), in comparison to poor but not gentrifying neighborhoods.
Lee 2010	Gentrification	When middle- and upper-income individuals purchase homes in lower-income neighborhoods	In the short term, when middle- and upper-income individuals purchase homes in lower-income neighborhoods, neighborhood crime decreases. (Protective)	The OLS and IV estimates showed no significant effect of gentrification on *crime* or *violent crime* in low-income tracts. In moderate-income neighborhoods, there was a significant positive gentrification effect (+ 2.2 assaults per year; SE 1.09; $p < 0.05$). In moderate-income neighborhoods—including lagged effects—an increase in one gentrifying household leads to an average yearly increase in the following year of 3.1 assaults per 1000 (SE 1.41; $p < 0.05$).
Morenoff et al. 2007	Neighborhood context, affluence, and gentrification	Neighborhood-level variables that characterize the sociodemographic structure of neighborhoods. Gentrification specifically defined as a residentially mobile population consisting of young adults and few children under the age of 18.	No explicit hypothesis specific to gentrification	Significantly lower odds of *hypertension prevalence* (OR 0.7; CI 0.6 to 0.9; $p < 0.05$) in gentrifying/affluent neighborhoods, but no significant effect for the odds of hypertension diagnosis or awareness.

Table 5 (continued)

Author/year	Exposure name	Construct description	Hypothesized effect and (direction)	Effect estimate and direction
Althoff et al. 2009	Neighborhood socioeconomic position	Neighborhoods with public housing residents, residents of low-income neighborhoods without public housing, and residents of higher-income neighborhoods without public housing, excluding neighborhoods with a mixture of public and private residential units and neighborhoods undergoing gentrification (a decrease from ≥ 50 to < 50% living below 1.5 times the FPL from 1990 to 2000)	No explicit hypothesis specific to gentrification, as the study excluded all gentrifying neighborhoods from the analysis	Age-adjusted, *all-cause mortality* in NYC neighborhoods decreased from 1989–1991 to 1999–2001, with the greatest decrease in residents of low-income neighborhoods (28%) and the smallest decrease in residents of public housing (16%). Found a narrowing mortality disparity between non-gentrifying low-income and higher-income neighborhoods.
Mair et al. 2015	Neighborhood change	The displacement of lower-income residents in a neighborhood by higher-income households.	Individuals living in neighborhoods with increasing levels of social cohesion and safety, decreasing violence and stress, and improving aesthetic environments would have improved reports of *depressive symptoms* compared to those living in neighborhoods undergoing the opposite types of neighborhood change. (Protective, compared to neighborhoods with decreasing higher-income households)	An increase in neighborhood social cohesion was marginally associated with a 2.82-unit *decrease in depressive symptoms* score (95% CI − 6.10, 0.46; $p = 0.09$), after adjustment for individual covariates.
Jackson and Mare 2007	Neighborhood change	Socioeconomic position of neighborhoods, and change over time in SES.	No explicit hypothesis	Both the cross-sectional and longitudinal measures of neighborhood poverty produced similar estimates of the association between neighborhood and *child well-being:* children living in a complete poor neighborhood experience 1.5–3 times more internalizing behavior problems than a child living in a completely non-poor neighborhood. Significant association between longitudinal neighborhood poverty and internalizing behavior problems for Hispanic children, but not any other racial/ethnic groups.
Barrett et al. 2008	Neighborhood change	Rapid residential area economic change (change in SES between 1990 and 2000)	No explicit hypothesis	Residential area socioeconomic upward change was significantly associated with the probability of *distant metastasis at diagnosis of breast cancer*. Specifically, for each unit increase (about 1 SD) in the rate of neighborhood change, the odds of distant metastasis at diagnosis increased by 9% (OR = 1.09; CI 1.01 to 1.18; $p = 0.029$). African–Americans were more likely and Hispanics were less likely to have distant metastasis at diagnosis, both compared to white women.
Margerison-Zilko et al. 2015	Longitudinal trajectories of neighborhood poverty (early poverty increase and late poverty increase)	Early poverty increase: tracts that were low or moderate income in 1970, became high or moderate income *by 1990 or earlier*, and remained high or moderate after that; late poverty increase: tracts that were low or moderate income in 1970, became high or moderate *after 1990* and remained high or moderate after that.	No explicit hypothesis.	Neighborhoods that experienced early poverty increases were associated with a 37% increase in odds of *preterm birth* (95% CI = 1.09, 1.72), compared with long-term low-poverty neighborhoods. Later poverty increase and poverty decrease were not significantly associated *with preterm birth*.

Table 5 (continued)

Author/year	Exposure name	Construct description	Hypothesized effect and (direction)	Effect estimate and direction
Leonard et al. 2017	Changes in the neighborhood environment	Changes in the quality of the physical neighborhood environment. Measure in relative terms how desirable a neighborhood was compared to the average neighborhood in the county.	(H1) neighborhoods that homebuyers prefer more will be associated with less *weight gain*, and (H2) the effects will be similar for both movers and non-movers. (Protective)	A 1 standard deviation increase in average homebuyer neighborhood preference was related to 0.7 ($B = -0.651$; SE 0.337; $p < 0.10$) fewer *kilograms gained* adjusting for adjusting for individual socio-demographic characteristics, mover status, the Heckman Correction factor, and neighborhood housing structures. In stratified analysis, a 1 SD increase in neighborhood condition was associated with 0.5 (S .0.0432; $p > 0.10$) and 1.4 (SE 0.573; $p < 0.05$) *fewer kilograms gained* for movers and non-movers. The effect was stronger for both movers ($b = -1.46$; SE 0.528; $p < 0.05$) and non-movers ($b = -1.872$; SE 0.786; $p < 0.05$) after propensity score matching to account for non-random assignment to mover status.
English et al. 2003	Neighborhood measures of instability	Communities that experience rapid change including high population growth, population mobility, social discord, and economic pressure	Communities that experience rapid change have poorer *reproductive outcomes* than stable neighborhoods, and neighborhood measures of instability are related to local increases in poor reproductive outcomes. (Detrimental)	In the model examining only neighborhood level measures: a 1% increase in the percent of the following variables were associated with increases in *term and preterm low birth weight* between 1980 and 1990: non-Hispanic African–American race/ethnicity ($b = 0.099$; $p = 0.024$), percent of residents with a college education ($b = 0.124$; $p = 0.032$), and increasing rent-to-income ratio ($b = 0.037$, $p = 0.026$). While the following variables were protective against increases in *low birth weight*: percent of people living in the same house ($b = 0.048$; $p = 0.011$) and the same county ($b = 0.073$, $p = 0.010$) for the last 5 years. In the model controlling for both neighborhood and individual variables, only an increase in the percent living in the same county for the last 5 years was significant. For *preterm low birth weight*, only percentage of college graduates ($b = 0.105$; $p = 0.039$) and increase in the rent-to-income ratio ($b = 0.029$; $p = 0.031$) were significant and stayed significant after adjustment for individual characteristics.
Semenza et al. 2007	Community development	Creation of a community-designed, environmentally beneficial gathering places	Community development intervention will improve community depression score. (Protective)	There was a consistent decline between the first and the second survey in the estimated marginal mean for the *depression scale* ($b = 1.95$; $p = 0.03$).
Harduar-Morano et al. 2008	Community improvements	Removal of abandoned homes; establishment of bus routes; installation of streetlights, new septic systems, water mains, and connections; construction of new homes and sidewalks and repair of existing homes; and improvements to parks	No explicit hypothesis	62% of survey participants responded positively when asked if their children missed *fewer school days due to illness* after compared to before the intervention. Of respondents who reported improvements across all community improvement categories, 99%

Table 5 (continued)

Author/year	Exposure name	Construct description	Hypothesized effect and (direction)	Effect estimate and direction
				responded positively when asked if improvements in their community positively affected their *mental and physical health.* All but 3 of the 7 community improvement issues, when examined separately, were significantly associated with respondents' increased *mental and physical health*.
Day et al. 2007	Renovation	Renovation of inside apartments, street renovation, streets converted to 1 way, and improvements to the appearance of the built environment	Renovation associated with (1) increased *perceived pedestrian safety and increased actual pedestrian safety* for residents of the renovated street; (2) improved perceived and actual safety from crime on the renovated street; and (3) increased *walking* on the renovated street. (Protective)	The renovation was associated with a significant increase in the *perceived safety of children; perceived pedestrian safety* from traffic was also higher post-intervention. The perception of the renovated street as safe from crime was lower in post surveys, although this finding was not statistically significant (p = 0.056). Post-survey respondents also reported that they *walked to the grocery store* more often ($p <$ 0.001), compared to the pre-surveys.
Dulin-Keita et al. 2015	Revitalization	Replacing distressed public housing, improving surrounding neighborhoods, reducing the concentration of low-income families, and building sustainable communities	Residents who lived closer to HOPE VI would experience increases in *physical activity.* (Protective)	The analysis tested the relationship between various independent variables associated with HOPE VI, but not the impact of exposure to HOPE VI directly. They found no significant differences in the proportion of residents who changed their physical activity 1.21 (95% CI 0.72–2.03; p = 0.464) based on their distance from HOPE VI projects.
Rabito et al. 2007	Urban renewal (demolition activities)	Individual exposure to demolition activity	Demolition activities associated with urban renewal will increase *blood lead levels* in children (detrimental)	Exposure to multiple demolitions was found to have a significant effect on children's *blood lead levels* (adjusted coefficient: b = 0.281; 95% CI 0.069, 0.493; p value 0.010; unadjusted coefficient: b = 0.096; 95% CI 0.009, 0.183; p value 0.031).

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