Discover Cities

Review

A systematic review of the association between neighborhood physical disorder and individual health

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Abstract
Neighborhood physical disorder (NPD) has been theorized to be associated with health outcomes at an individual level, with inconsistent evidence across studies. To address these discrepancies, a systematic review is imperative to unravel the discrepancies present in the literature and offer an evidence-based assessment of the association between NPD and individual health. This systematic review analyzed 50 studies that adhered to the inclusion criteria out of the 4185 articles retrieved. The majority of the studies included in this review were conducted in the United States and employed cross-sectional designs. The measurement of NPD predominantly relied on traditional methods, such as interview or questionnaire, and most studies focus on individuals' physical health and health-related behaviors, with relatively less attention paid to mental health, social health and self-rated health. Findings from the systematic review revealed that 20 cross-sectional studies showed a correlation, while 17 did not. Additionally, 10 cohort studies identified an adverse effect of NPD on health outcomes, whereas 8 cohort studies and 1 case–control study reported null findings. Subgroup analysis showed that the diversity of NPD types, variations in the indicator systems employed, and disparities in the definition of the neighborhood contributed to the heterogeneity of findings.

Keywords Neighborhood physical disorder · Neighborhood disorder · Individual health · Literature quality assessment · Subgroup analysis

1 Introduction

Individual health is related to various factors, including genetic [1, 2] and environmental factors [3]. Considering that genetic factors cannot be altered in a short period, the role of environmental factors in determining health outcomes has garnered significant attention [4, 5]. In addition to natural environmental factors, built environmental factors including neighborhood disorder have been identified as critical determinants of individual health. Neighborhood disorder refers to visible or perceptible signs of inadequate maintenance, disorderliness, or lack of control within a community or neighborhood, such as litter, graffiti, abandoned building, broken window and so on [6]. In contrast to the concept of "order", which symbolizes safety, stability and cleanliness, neighborhood disorder is a physical manifestation of disorderliness or nonconformity in a particular space within a community or neighborhood [7, 8].

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Numerous studies in public health and sociology have investigated the association between neighborhood disorder and individual health, with some indicating a negative association. Neighborhood disorder has been linked to detrimental behaviors and health outcomes such as overeating, reduced physical activity, alcohol abuse, and obesity [9–12]. Moreover, living in a disorderly environment has been suggested to cause stress, fear, anxiety, and distrust among residents [13]. Additionally, the negative impact of neighborhood disorder extends beyond individual health, as it can contribute to further environmental deterioration, resident migration, neighborhood instability, and ultimately, an increase in crime rates and community decline [14, 15].

However, empirical evidence supporting the hypothesized association between neighborhood disorder and individual health is mixed. For instance, Zanelatto et al. did not find any significant association between neighborhood disorder and blood pressure, including systolic blood pressure (SBP) and diastolic blood pressure (DBP), among adults [16]. Similarly, Vo et al. did not report a clear correlation between neighborhood disorder and asthma attacks in 5-year-old children [17]. Whitehead also failed to find a correlation between neighborhood disorder and subjective mental/emotional health [18]. Consequently, a systematic exploration of the association between neighborhood disorder and individual health is warranted.

It is worth noting that the term "neighborhood disorder" encompasses both physical and social elements. Neighborhood physical disorder (NPD) refers to the decay and decline of the urban landscape, typically characterized by vacant buildings, litter, and deserted vehicles [19, 20], while neighborhood social disorder pertains to threatening phenomena related to individuals and social control deficiencies, such as violence in public spaces [13, 21]. However, there is a scholarly debate regarding whether physical and social disorder represent a single underlying concept. On the one hand, social disorder carries social implications that extend beyond the theories' implications [16], while physical disorder exhibits a more stable, persistent, and visibly spatial nature [22]. On the other hand, measurements of physical disorder can be differentiated from deviant behavior and neighborhood crimes compared to social disorder [23, 24]. Consequently, it is more reliable to examine NPD and its association with individual health.

Numerous reviews on neighborhood disorder and individual health focused only on the association of neighborhood disorder with a single individual health outcome, such as cardiovascular disease risk [25], cancer [26] and dating violence [27]. A recent systematic review and meta-analysis study examined the impact pathways of neighborhood disorder on individual health but did not differentiate between neighborhood physical disorder and neighborhood social disorder [28]. In addition, this study did not carry out quality assessments of the literature. In contrast, the present study employs a systematic review approach to specifically analyze the association between NPD and individual health, while comprehensively assessing the quality of the relevant literature.

2 Method

2.1 Literature search strategy

We established a literature database to evaluate the association between NPD and individual health by searching the two main e-book item databases: Web of Science [ISI] and PubMed. The search strategy used for Web of Science was: TS = (neighborhood near disorder) or TS = (neighborhood near disorder) or TS = (physical disorder), and for PubMed, the strategy was: "neighborhood disorder" [title/abstract] or "neighborhood disorder" [title/abstract] or "physical disorder" [title/abstract]. Following the removal of duplicate records, we assessed the search results by scrutinizing abstracts and full texts, and only included articles which met the following criteria: (a) the publication language is English; (b) the publication type is a journal paper; (c) the publication is published and the full text is available; (d) the association between NPD and at least one individual health outcome is examined; (e) the indicators of NPD are clearly and distinguished from neighborhood social disorder; (f) the research design is of quantitative nature. The database was fully updated on April 18, 2023.

2.2 Literature quality assessment

We undertook a rigorous quality assessment of the included literature by employing the observational literature quality evaluation standard recommended by the Agency for Healthcare Research and Quality (AHRQ) in the United States [29]. For the cross-sectional study, we utilized the updated AHRQ scale which consisted of 11 items with three corresponding options for each item, yielding two possible scores. "No" and "Not clear" were scored 0 while "Yes" were scored 1 (see

Appendix file: Table S1). The maximum score for each literature was 11, with literature scoring 8 or above included in the follow-up analysis. For the cohort and case–control studies, we utilized the updated Newcastle–Ottawa (NOS) scale, which evaluated literature bias across three dimensions: object selection, comparability, and outcome measurement. While the maximum score for all items was 1, except for one item with a maximum of 2, overall literature could earn a total of 9 points. Literature scoring 7 or above was included in the follow-up analysis (see Appendix file: Tables S2, S3).

We ensured examination accuracy by requiring two auditors to evaluate literature quality independently. In instances where the two auditors provided inconsistent evaluations of specific item(s) in the same literature, a consensus was reached during subsequent discussions.

Based on the exclusion of duplicate literature, a total of 4345 articles were initially procured in the database. Subsequently, in accordance with screening criteria, a preliminary review of the title and abstract was conducted, resulting in the acquisition of 875 articles. Further scrutiny of the full text led to the exclusion of 160 articles. Quality assessment resulted in the identification of 50 articles (see Fig. 1).

2.3 Analysis

Data on study characteristics, sample demographics, indicators and measurement methods of neighborhood physical disorder, outcomes and measurement methods of individual health, covariates, analysis models, and results were extracted from each article. A summary of the extracted data from the 50 articles was provided (see Appendix file: Tables S4–S6). The diverse indicators and measurement methods of NPD, study population, individual health outcomes and analysis models precluded the use of meta-analyses. Consequently, the research results are presented by means of narration.

The articles were categorized based on publication year, study area, and study design. Further statistical analysis was conducted on the different types and measurement methods of NPD and the types and measurement methods of individual health. Among this, NPD was categorized into two distinct components: neighborhood perceived physical disorder (NPPD) and neighborhood objective physical disorder (NOPD). NPPD refers to the subjective perception of NPD by residents, whereas NOPD represents the NPD level observed objectively by residents or investigators. In accordance with the World Health Organization's (WHO) definition of health, individual health was classified into five categories, including physical health, mental health, health-related behavior, social health, and self-rated health. As some articles utilized more than one type of disorder and health outcomes or focused on more than one type of study population, they appeared in more than one group, which were repeatedly counted when counting.

The results of each study were measured against the most comprehensive model for predicting health outcomes. Effect sizes for the included studies were calculated using OR (95% CI) for those utilizing logistic regression models and B(SE) for those utilizing linear regression models. These were then presented using Forest plots. Given the potential for

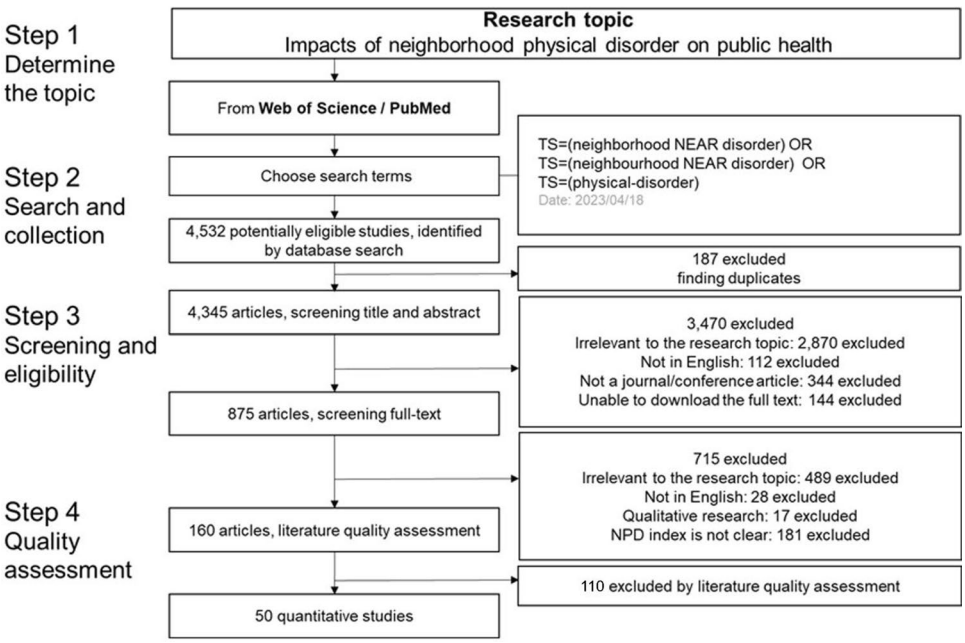

Fig. 1 Literature screening process

health outcomes to encompass multiple health indicators (e.g., sleep problems involving difficulties in falling asleep and poor sleep efficiency, etc.), our study comprehensively examined all individual health indicators reported in each article. Thus, in cases where one health indicator of an individual's outcome demonstrated an association with physical disorder, the NPD was considered to be associated with the individual's health outcome. We also noted both significant and nonsignificant indicators for further analysis.

To investigate the potential sources of heterogeneity observed in the 50 studies, subgroup analyses were conducted based on NPD type, neighborhood definition, and NPD indicators. These analyses aimed to explore whether variations in these factors contributed to the divergent findings across the studies.

3 Results

3.1 Characteristics of the studies

3.1.1 Study design and settings

The earliest included articles can be dated back to 2002 [22]. In addition, the number of articles on the association between NPD and individual health increased significantly in the past 10 years (39, 78%) (see Fig. 2). The majority of the studies included in the analysis were conducted in the United States (41, 82%) (see Fig. 3). The majority of articles (33, 66%) relied on cross-sectional study designs, with only a few studies employing cohort (16, 32%) and case–control designs (1, 2%). The majority of the studies focused on adult participants (18, 36%). However, attention was also given to other vulnerable groups including older adults (16, 32%), adolescents (11, 22%), and children (5, 10%). A limited number of studies included only one sex as their study population. Specifically, 4 (8%) studies focused on women while only 1 examined men who were involved in homosexual relationships. In addition, 2 (4%) studies have also considered the different implications of NPD for men and women.

3.1.2 Types and measures of NPD

In terms of the types of NPD, most studies mainly focused on NPPD (25, 50%). Few studies focused on NOPD (22, 44%), and very few studies (2, 4%) combined NOPD and NPPD to measure NPD together. In addition, there was one study that regarded NOPD and NPPD as two different independent variables and explored the correlation between them and individual health.

The majority of studies (28, 56%) still used traditional questionnaire or interview methods to obtain the results of NPPD (see Table 1). Systematic social observation (SSO) (17, 34%), government records (4, 8%), and virtual audits (4, 8%) have been used to measure NOPD. NPD was often evaluated using a variety of indicator scales employed by different studies, which include a maximum of 11 indicators [30] and a minimum of 1 indicator [31, 32]. Typically, NPD is coded forward, meaning the higher the NPD index, the higher the NPD level, but 3 studies have coded backward [31, 33, 34].

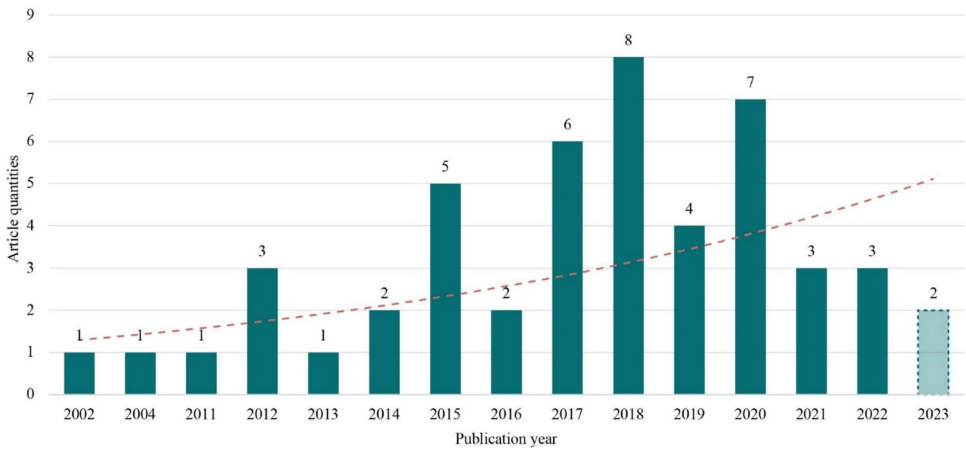

Fig. 2 Annual number of published articles

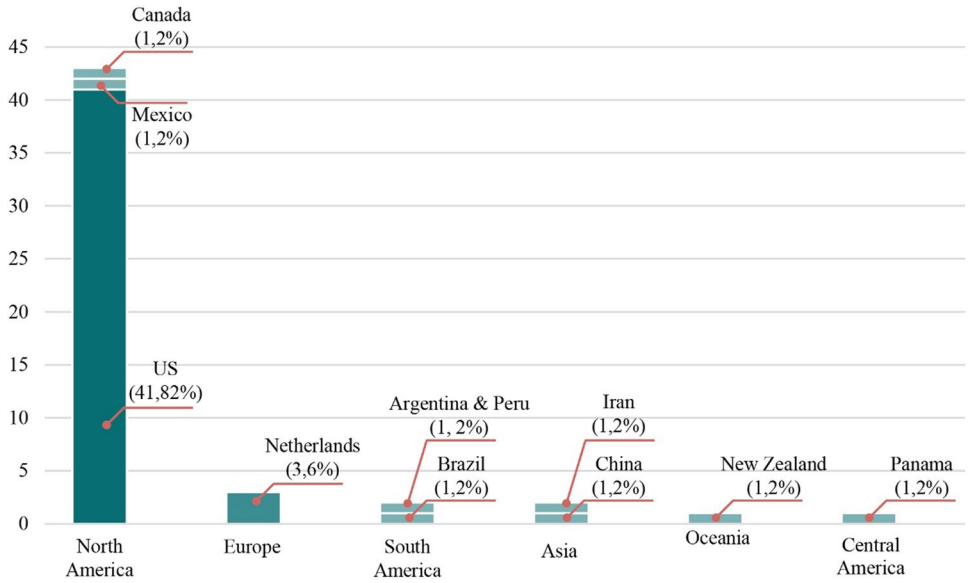

Fig. 3 Geographical distribution of the articles

3.1.3 Types and measures of individual health

The majority of studies have primarily investigated the physical health (21, 42%) outcomes, followed by studies examining health-related behavior (16, 32%), mental health (13, 26%), social health (7, 14%), and self-rated health (3, 6%).

The majority of studies (33, 66%) collected participants' health information through questionnaire surveys, often performed through face-to-face interviews or audio computer-assisted self-interview (ACASI). Some surveys chose to gather individual health data through reports from primary caregivers (5, 10%) due to children's difficulty in comprehending the questionnaire information. Certain studies focusing on physiological health or health-related behaviors utilized biological measurements (11, 22%) to obtain reliable values for participants' blood pressure, physical activity, and other relevant parameters. In addition, a few studies (4, 8%) evaluated participants' health levels through collaboration with medical institutions, collecting input from medical workers or reviewing medical records (see Table 2).

3.2 Evidence of the association between NPD and individual health

A total of 20 cross-sectional studies found an association between NPD and health outcomes, while 17 studies failed to confirm this relationship. 10 cohort studies showed that NPD could lead to adverse health outcomes, while 7 cohort studies and 1 case–control study fails to demonstrate the existence of the association. Findings of NPD and individual health see Figs. 4, 5, 6, 7, and 8.

3.2.1 NPD and physical health

Obesity (3, 6%): Mayne et al. demonstrated a cross-sectional study that women with heightened NOPD levels were at an elevated risk of developing obesity. Nonetheless, this study failed to establish a discernible association between NOPD and BMI [43]. Correspondingly, Hrudey et al. performed cross-sectional studies, where no substantial correlation was

Table 1 Measure methods of NPD

Types of NPD	Methods	Features	Costs	Time required	References
NPPD	Interview/questionnaire	Face-to-face or online	High	High	[16, 18, 20]
NOPD	SSO	In-person audits by researchers	High	High	[35–37]
	Record by government	Organized by government	High	High	[31, 32, 38, 39]
	Virtual audit	Virtual audit by images	Low	Low	[40–43]

Table 2 Measure methods of individual health

Methods	Evaluators	Features	Costs	Time required	References
Self-reported (33, 66%)	Participants themselves	Subjective evaluation	High	High	[17–20]
Primary caregivers report (5, 10%)	Primary caregivers	Subjective evaluation	High	High	[17, 35, 44–46]
Biological measure (11, 22%)	Medical instruments	Objective evaluation	High	High	[16, 36, 43, 47]
Medical records (4, 8%)	–	Objective evaluation	Low	Low	[25, 41, 48, 49]

observed between NPPD and children's BMI [50]. Consistent with these findings, a cohort study conducted by McTigue et al. among girls yielded comparable results, with no discernible link detected between NOPD and BMI [51].

Sleep problems (3, 6%): The 3 studies all focus on older adults. Chen-Edinboro et al. conducted a cohort study, which demonstrated a positive correlation between NPPD and trouble falling asleep as well as trouble waking up too early [52]. In a separate cohort study conducted by Kim et al., it was found that NOPD was negatively associated with sleep efficiency, but no significant relationships were observed with insufficient sleep, total sleep duration, and wake after sleep onset [48]. Additionally, Troxel et al. reported that there was no significant cross-sectional association between NOPD and sleep efficiency, wakefulness after sleep onset as well as total sleep time [36].

Fall (2, 4%): In 2 cohort studies focusing on older adults, Nicklett et al. found a negative correlation between the Neighborhood Quality Index (a reverse code of NPPD) and fall risk in older adults [34], whereas Schafer and Upenieks did not find an association between NPPD and fall risk [53].

Cognition (2, 4%): There are 2 cohort studies were conducted. Yu et al. found a positive correlation between NPPD and cognitive disorder in middle-aged and older adults [54], while Choi et al. reported an association between NPPD and cognitive decline in children [45].

Physical function (2, 4%): A cross-sectional study demonstrated a negative correlation between NPPD and physical function [47], while Schafer and Upenieks did not find an association between the two variables in their cohort study [53].

Adverse pregnancy outcomes (2, 4%): Mayne et al. conducted a cross-sectional study and found no significant association between NPPD and adverse pregnancy outcomes [41]. In addition, Giurgescu et al. reported no significant associations between both NOPD and NPPD with adverse pregnancy outcomes [39].

Other: Cross-sectional studies found a positive correlation between NPPD and the risk of asthma in preterm children [17], as well as a negative correlation between NPPD and muscle strength in older men [55]. However, no relationship was observed between NPPD and blood pressure in adults [16]. Three cohort studies separately demonstrated a positive correlation between NOPD and frailty in older adults [30], but did not establish an association between NPPD and cardiovascular disease in older adults [48] nor readmissions in adults [49].

3.2.2 NPD and mental health

Depression (4, 8%): A cohort study put forth the proposition that NPD (the combination of NPPD and NOPD) could potentially contribute to the development of depression among adolescents [46]. Furthermore, a cross-sectional study focusing on adolescents provided evidence supporting a positive association between NPPD and depression [56]. However, two other studies failed to establish a significant cross-sectional correlation between NPPD and depression in adults [57], as well as NOPD and major depressive disorder in students [31].

Fear (2, 4%): Two cross-sectional studies examining the relationship between NPPD and fear of crime. The first study by Lane and Fox focused specifically on eligible inmates [58], while the second study encompassed a broader sample of adults [59]. Both studies found evidence suggesting a significant positive association between NPPD and fear of crime.

Subjective mental well-being (2, 4%): A cross-sectional study revealed that NPPD, but not NOPD, was significantly negatively associated with mothers' subjective mental well-being [39]. Conversely, another cross-sectional study did not find a significant relationship between the two [18].

Other: Furthermore, two cohort studies have separately reported positive correlations between NPPD and behavioral problems in children [45], as well as feelings of loneliness in middle-aged and older adults [54]. Additionally, a cross-sectional study found a negative correlation between NPPD and self-esteem in adults [60]. Cross-sectional studies have indicated that elevated levels of NOPD are linked to a higher risk of PTSD, separation anxiety disorder, and agoraphobia

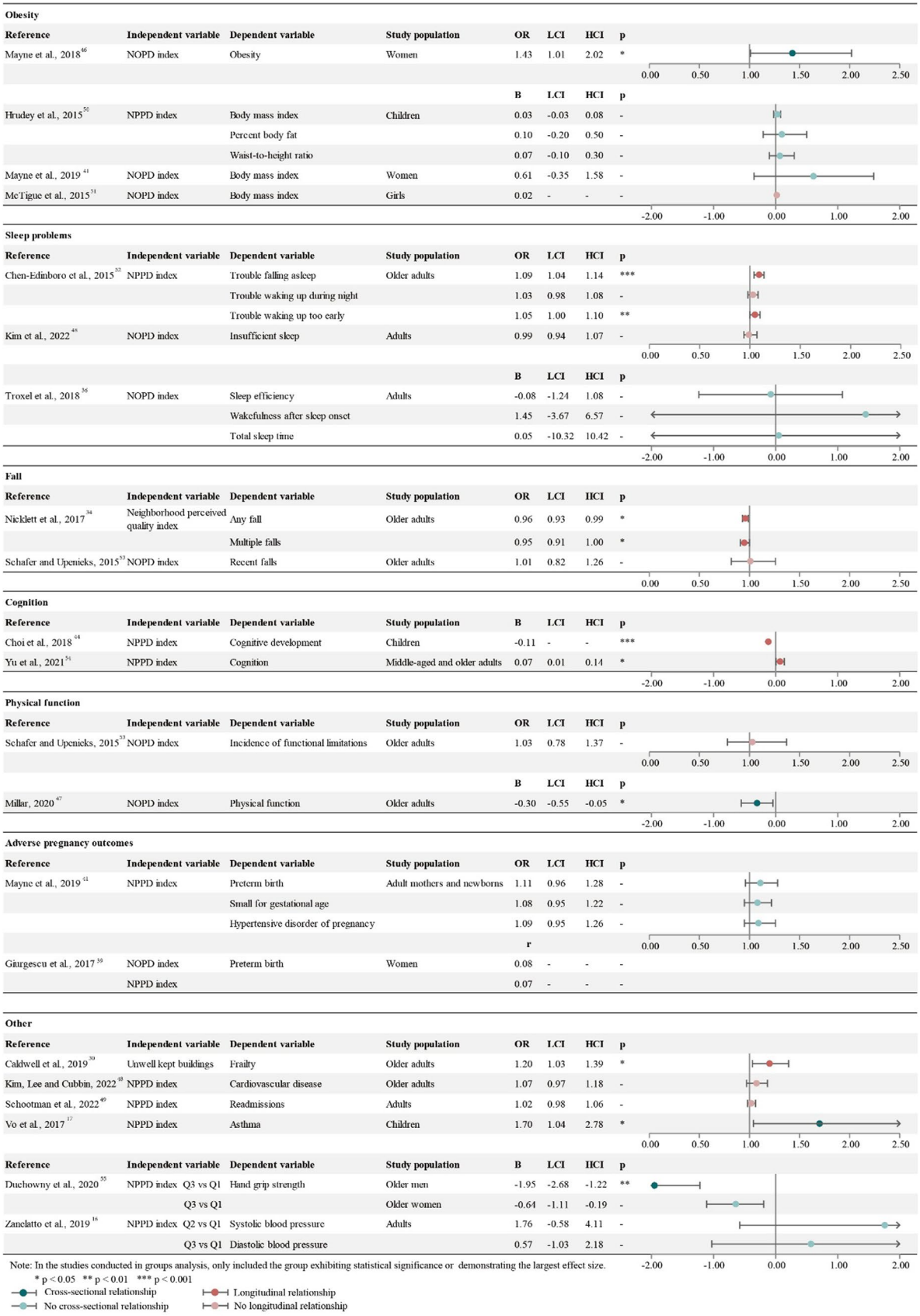

Fig. 4 Evidence of the association between NPD and physical health

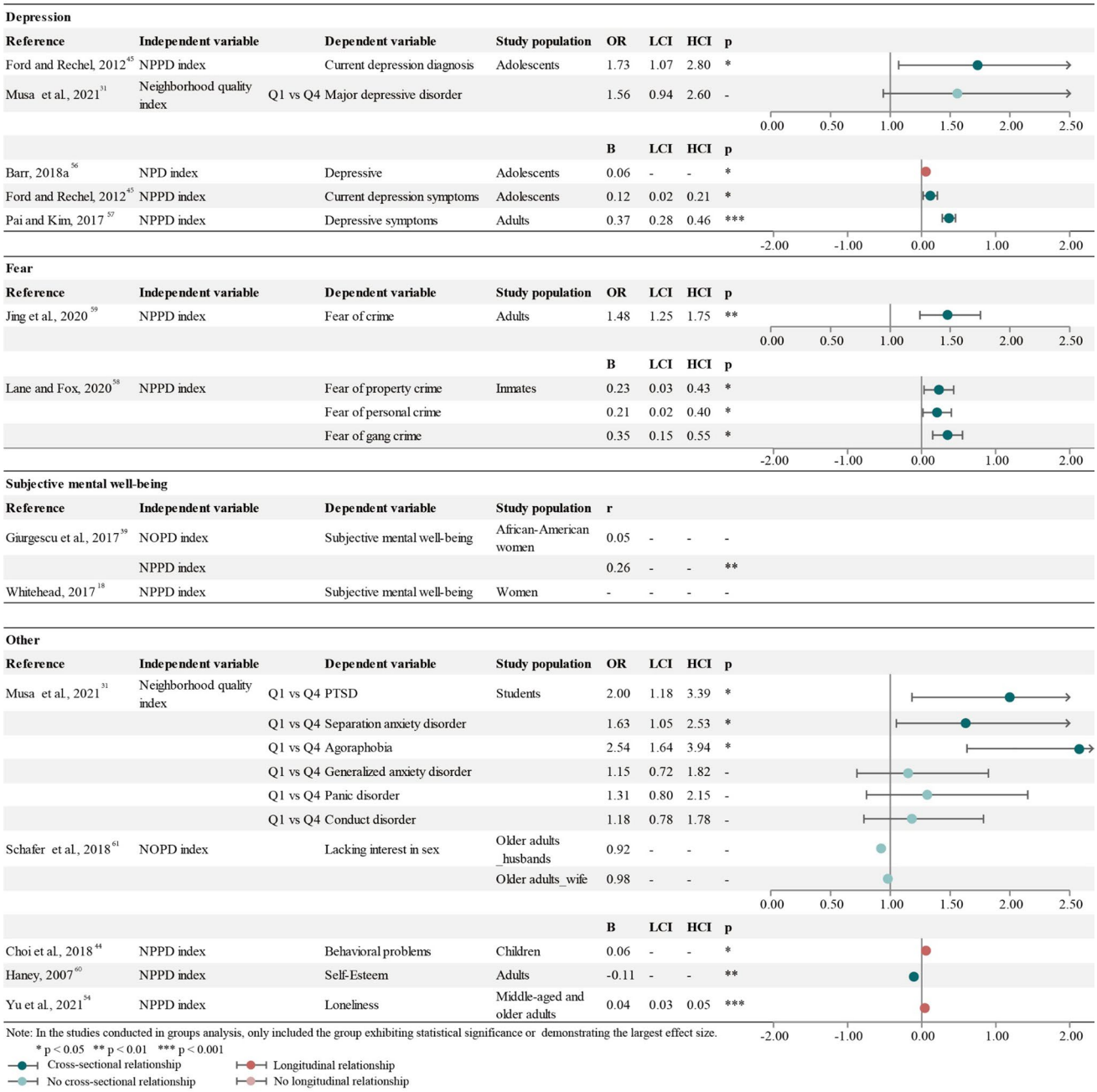

Fig. 5 Evidence of the association between NPD and mental health

[31]. However, there is no association between NOPD and the lack of interest in sex among older adults, regardless of gender (husband or wife) [61].

3.2.3 NPD and health-related behavior

Alcohol use (4, 8%): One cohort study revealed that NPD (the combination of NOPD and NPPD) could elevate the risk of alcohol use in adolescents [62]. Similarly, another cross-sectional study discovered a positive association between NPPD and binge drinking among adolescents [63]. These findings were consistent in studies involving adults, as individuals with medium–high levels of NOPD exhibited a higher likelihood of engaging in monthly binge drinking compared to those with low NOPD [42]. However, another cross-sectional study did not identify a significant association between NOPD and alcohol use disorder [31].

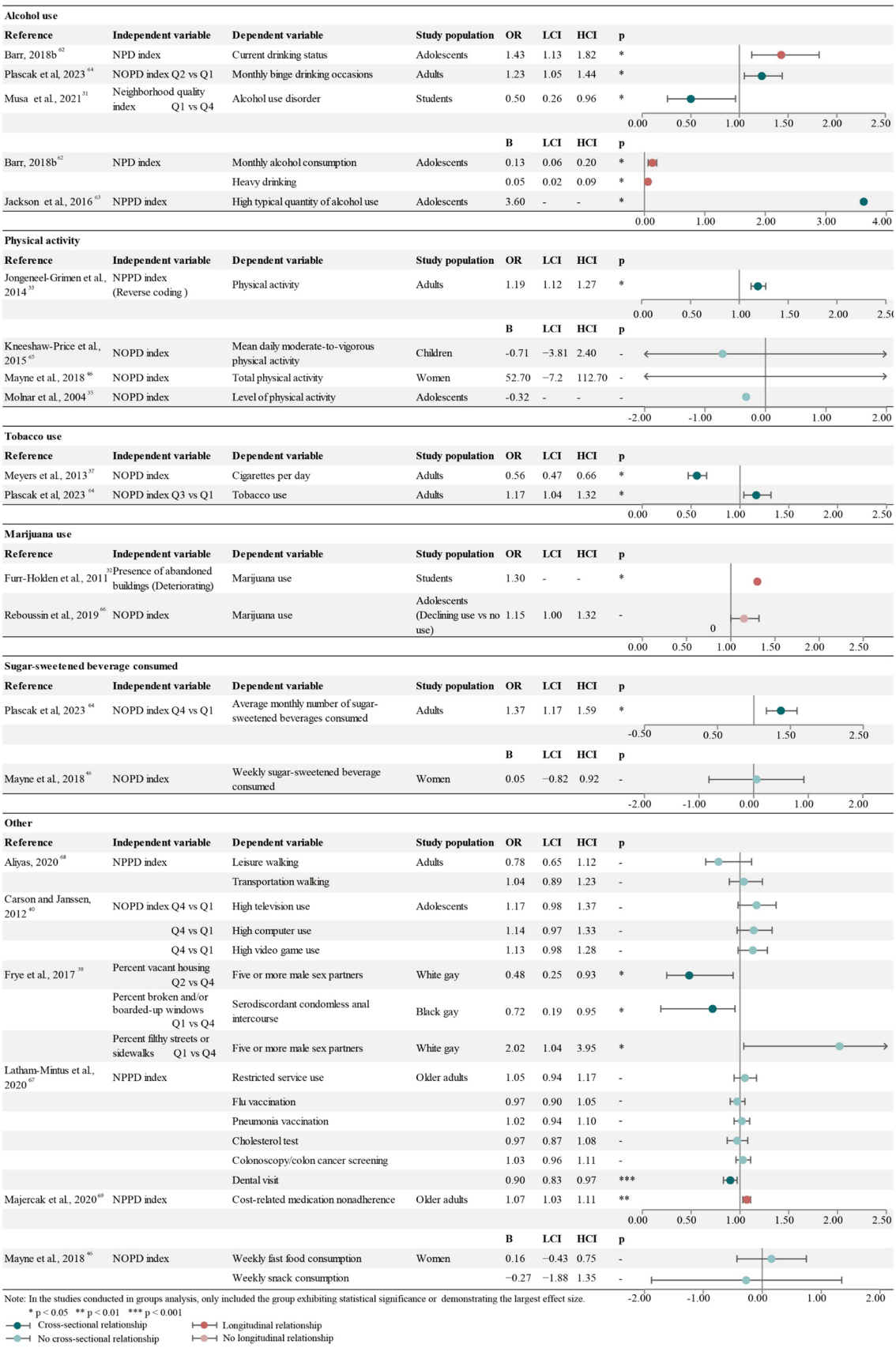

Fig. 6 Evidence of the association between NPD and health-related behavior

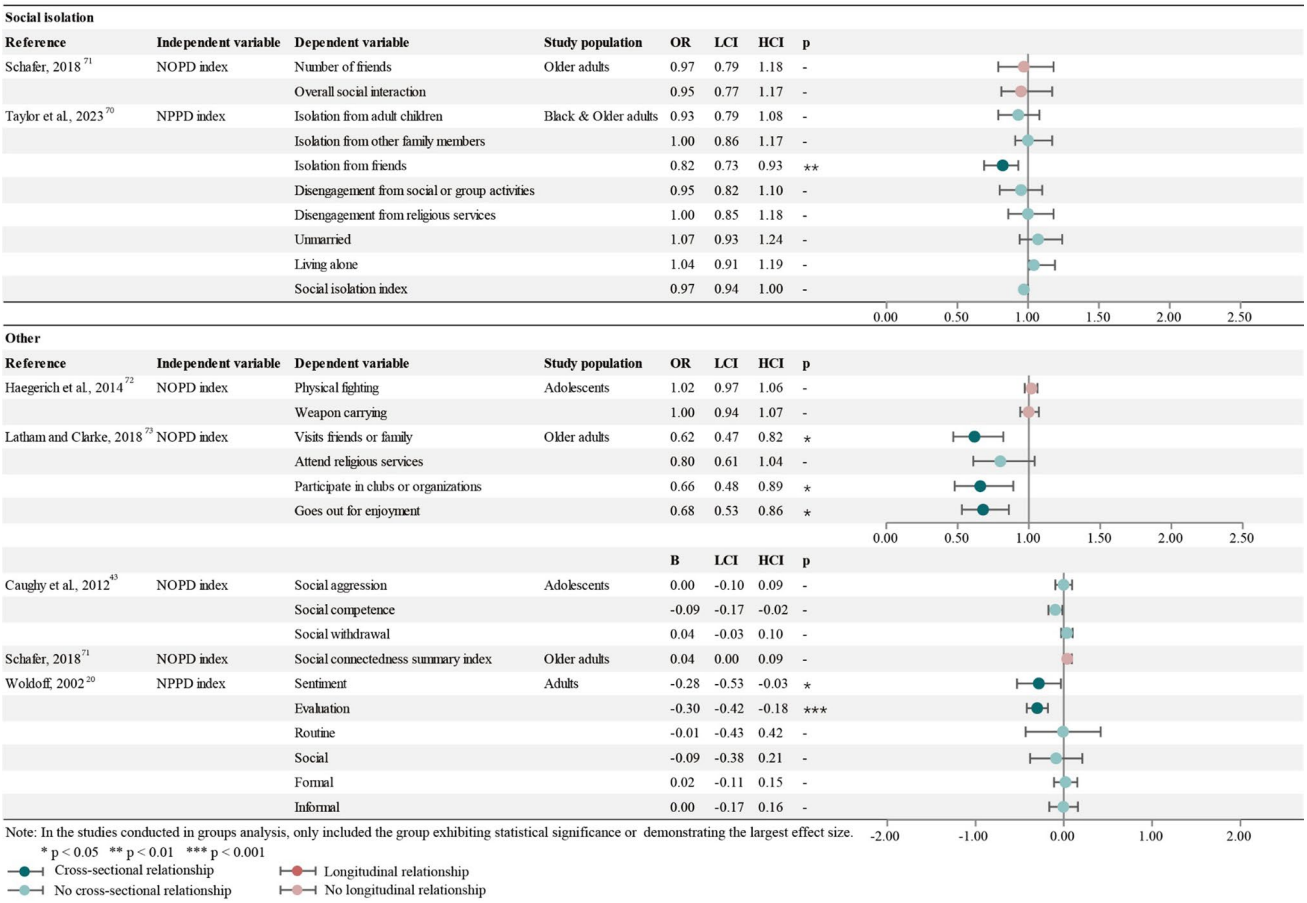

Fig. 7 Evidence of the association between NPD and social health

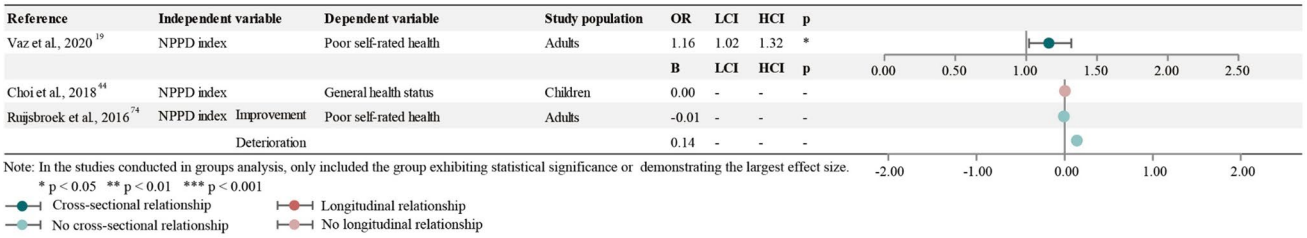

Fig. 8 Evidence of the association between NPD and self-rated health

Physical activity (4, 8%): Two studies yielded no evidence supporting a cross-sectional association between NOPD and the level of physical activity [35] or mean daily moderate-to-vigorous physical activity [64] among adolescents. Similarly, no correlation was found between NOPD and total physical activity in women [43], as indicated by another cross-sectional study. However, a separate cross-sectional study demonstrated a positive association between negatively encoded NPPD and physical activity levels in adults [33].

Tobacco use (2, 4%): One cross-sectional study examining smoking behavior revealed that adults with moderate to high levels of NOPD exhibited a heightened risk of tobacco use in comparison to individuals with low NOPD [37, 42]. Another cross-sectional study reached the opposite conclusion, namely that NOPD is negatively correlated with the number of cigarettes smoked per day.

Marijuana use (2, 4%): One cohort study has observed a positive association between NOPD and marijuana use among African American 12th graders [32]. However, another case–control study did not find any significant association between NOPD and marijuana use in adolescents [65].

Sugar-sweetened beverage consumed (2, 4%): Two cross-sectional studies examining the relationship between NOPD and the consumption of sugar-sweetened beverage yielded different results. The first study revealed that adults with medium–high levels of NOPD exhibited an increased risk of consuming sugar-sweetened beverages compared to those with low NOPD [42]. Conversely, the second study found no significant association between NOPD and sugar-sweetened beverage consumption specifically in women [43].

Other: A number of cross-sectional studies have provided insights into the association between NPPD and various health-related behaviors. Specifically, these studies have revealed a negative correlation between NPPD and dental visit utilization among older adults [66], as well as a positive correlation between NPPD and engaging in gay sexual risk behaviors [38]. However, no significant associations were found between NPPD and walking activity in adults [67], screen time in adolescents [40], or fast food/snack consumption in women [43]. Additionally, a cohort study demonstrated a positive association between NPPD and cost-related medication nonadherence among older adults [68].

3.2.4 NPD and social health

Social isolation (2, 4%): The first cross-sectional study revealed a negative correlation between NPPD and isolation from friend specifically among older adults of black ethnicity [69]. The findings from a separate cohort study indicated that NOPD was not associated with the number of friends among older adults [70].

Other: One cohort study did not identify a significant correlation between NOPD and physical fighting or weapon carrying behaviors among adolescents [71]. Similarly, another study found no cross-sectional correlation between NOPD and adolescents' social adjustment [44]. However, contrasting results emerged from two other studies. One cross-sectional study revealed a negative correlation between NOPD and social participation among older adults [72]. Similarly, the findings from another cross-sectional study demonstrated a negative correlation between NPPD and attitudinal attachment to adults [20].

3.2.5 NPD and self-rated health

In one cross-sectional study, a positive association was found between NPPD and poor self-rated health in adults [19]. However, another cross-sectional study did not identify a significant association between increased or decreased NPPD and self-rated health in adults [73]. Similarly, a cohort study yielded similar results, indicating that NPPD was not associated with the general health status of children as reported by their primary caregivers [45].

3.3 Findings from the subgroup analysis

To investigate the potential sources of heterogeneity observed in the 50 studies, subgroup analyses were conducted based on NPD type, neighborhood definition, and NPD indicators. These analyses aimed to explore whether variations in these factors contributed to the divergent findings across the studies.

3.3.1 Types of NPD

More than half of the studies examining the association between NPPD and individual health found a cross-sectional relationship (13, 26%) or longitudinal relationship (5, 10%) between the two. However, some studies did not demonstrate either cross-sectional (5, 10%) or longitudinal (3, 6%) relationship. In contrast, more than half of NOPD studies failed to find either cross-sectional (9, 18%) or longitudinal (5, 10%) relationship between NOPD and individual health. Other studies, however, indicated a cross-sectional (7 studies, 14%) or longitudinal (3 studies, 6%) association, including two studies that evaluated NOPD using SVI data combined with virtual audit methods.

Of note, Giurgescu et al. conducted a cross-sessional study that examined NPPD and NOPD independently, found no significant correlation between NPPD or NOPD and preterm birth using Pearson correlation analysis [39]. However, NPPD was found to be correlated with psychological stress, while there was still no significant correlation between NOPD and psychological stress.

Additionally, two cohort studies combined NPPD and NPOD into a single variable of NPD for analysis. These studies concluded that NPD has positive associations with alcohol use and depression in adolescents [56, 62].

3.3.2 Definition of neighborhood

Variability exists in the definition of "neighborhood" across studies, with only 27 out of 50 studies (see Table 3) providing a clearly stated definition. While 10 (20%) studies defined neighborhoods as buffer zones with varying distances from participants' residences, ranging from 0.25 to 1 mile, 9 (18%) focused on the immediate block of the participants. In addition, some studies (4, 8%) defined neighborhoods based on census areas, highlighting the contextual differences across countries in housing backgrounds.

Statistically, studies that operationalized neighborhoods as buffer zones demonstrated a higher propensity to exhibit significant associations between NPD and health outcomes compared to studies that delineated neighborhoods as block or census areas. Notably, six out of the ten studies yielded a significant association.

3.3.3 Indicators of NPD

Diverse studies employ distinct index systems to measure NPD. Statistical data indicates that common indicators included garbage or litter (45, 90%), graffiti (29, 58%), unwell kept buildings (26, 52%), vacant, abandoned, or boarded-up buildings (25, 50%), and vandalism (16, 32%). Other indicators such as complaints regarding disorderly youth, houses or lots taken illegally or invaded, too many dogs, absentee landlords, rodents, lack of signage for neighborhood watch or commercial and rough or broken footpaths were only found in a single study individually (see Fig. 9).

Nevertheless, it is noteworthy that only four studies conducted independent analyses to investigate the impact of various indicators of NPD on health outcomes. Among them, two studies employed a singular indicator to assess NPD. Caldwell et al. revealed a positive correlation between the prevalence of unwell maintained buildings and the risk of frailty among the elderly [30]. Similarly, Furr-Holden et al. found a significant association between the increasing presence of abandoned buildings and the likelihood of marijuana use among African American 12th graders [32].

Additionally, Nicklett et al. discovered that the absence of litter and rubbish, as well as feeling safe walking alone after dark, were associated with a higher risk of falls among the elderly [34]. However, the absence of vandalism/graffiti and vacant or deserted houses or storefronts did not yield significant associations. In another study by Frye et al., it was observed that a lower percentage of vacant housing was linked to reduced sexual risk behavior among white gay individuals [38]. Furthermore, lower levels of broken and/or boarded-up windows were associated with a decreased risk of sexually risky behavior among black gay men. Notably, no significant association was identified between the homicide rate and sexual risk behavior.

4 Discussion

4.1 Discussion of the findings

Neighborhood environments are associated with individual-level health outcomes; however, evidence regarding the relationship between neighborhood physical disorder (NPD) and individual health outcomes remains inconsistent. To address these discrepancies, a systematic review is necessary to uncover variations within the literature and provide an evidence-based assessment of the relationship between NPD and individual health. This systematic review analyzed 4185 articles, of which 50 met the inclusion criteria, and conducted a structured synthesis of these studies.

4.1.1 Discussion of study designs in previous research

The majority of the studies included in this review were conducted in the United States, which raises questions about the generalizability of the findings to a global context. This bias may be attributed to the inclusion of only English-language articles, overlooking studies published in other languages. However, it is worth noting that the United States benefits from extensive national health data sources, such as the Health and Retirement Study (HRS) [34, 52, 54, 55, 67], National Social Life, Health and Aging Project (NSFHAP) [53, 61], and Adolescent-to-Adult Health (AAH) [56, 62], which enable large-scale and longitudinal analyses. These robust data sources facilitate comprehensive investigations of NPD and its associations with various outcomes. In contrast, other countries may face challenges due to the limited availability of personal health data, making it difficult to conduct research in these regions.

Table 3 Definition of neighborhood

Neighborhood definition		Country	References	Correlation
Block (9, 18%)	The street (one block, both sides) where the participants live (5)	US	[30, 32] [53, 61, 70]	Y N
	On the block or within 100 yards of participants' residence (1)	US	[45]	Y
	The block face of the participants' residence (2)	US	[51, 65]	N
	Three blocks or less of home (1)	Argentina, Peru, Mexico, Panama	[19]	Y
The buffer zone around the participants' residence (10, 20%)	About 1 mile of the respondent's residence (4)	US	[34, 48, 52, 55]	Y N
	A 0.25-mile of the respondent's residence (3)	US	[36, 64, 74]	N
	A 0.5-mile of the respondent's residence (1)	US	[39]	Y
	The area around the respondent's residence, which is the area seen in all directions in front of the respondent's residence (1)	US	[72]	Y
	On the block or within 100 yards of their home (1)	US	[45]	Y
Census area (4, 8%)	Census (3)	US	[41] [43, 44]	Y N
	Neighborhood tabulation areas, subsets of New York public use microdata areas (1)	US	[38]	Y
Postal code areas (3, 6%)	Postal code areas of the respondent's residence (3)	Netherlands, US	[50] [31, 33]	N Y
Others (2, 4%)	1 km circular buffer surrounding each school (1)	Canada	[40]	N
	The area unit (non-administrative area, generally consistent with a respondent's neighborhood suburb) in which the respondent usually resided (1)	New Zealand	[63]	Y

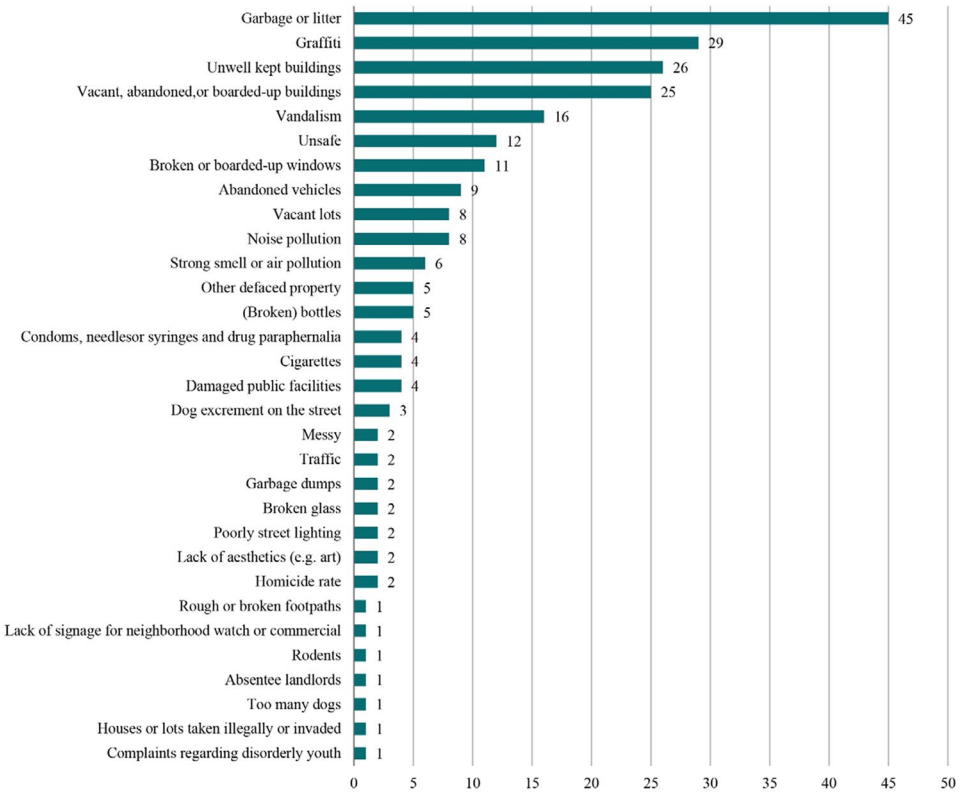

Fig. 9 Number of occurrences of NPD indicators

Approximately 66% of the studies included in this review employed cross-sectional designs, while the remaining 34% utilized longitudinal study designs. Cross-sectional designs provide valuable insights into the concurrent relationships between NPD and health outcomes but limit our ability to establish causal relationships or examine temporal dynamics. Longitudinal studies offer a distinct advantage by enabling the examination of associations over time, and can help elucidate the potential causal pathways between NPD and various health outcomes.

4.1.2 Discussion of NPD and IH measurement methods

The majority of studies continue to rely on conventional methods, such as traditional questionnaires and interviews, to assess neighborhood perceived physical disorder (NPPD) and Systematic Social Observation (SSO) to assess neighborhood observed physical disorder (NOPD). These methods are known for their time-consuming and labor-intensive nature. In recent years, however, there has been a growing recognition of the potential benefits offered by Street View imagery (SVI) data. Approximately 8% of the studies reviewed have started utilizing SVI virtual audits as a means to measure NPD on a larger scale. The adoption of SVI virtual audits represents a promising advancement in the field, offering a cost-effective and scalable approach to capturing NPD. Furthermore, in recent years, several studies have employed deep learning techniques to assess spatial disorder at scale, substantially enhancing the efficiency of NPD measurement [75, 76].

Studies primarily concentrated on individual physical health and health-related behaviors, with a comparatively limited number of studies investigating mental health, social health, and self-rated health outcomes. The assessment of individual health levels commonly relied on self-report measures, biological indicators, and medical records.

4.1.3 Discussion of inconsistencies in the relationship between NPD and IH in previous studies

Subsequent analysis revealed inconsistencies in the association between NPD and individual health across various studies. Among the included studies, a total of 20 cross-sectional studies provided evidence supporting the association between NPD and individual health, while 17 studies failed to establish a significant relationship. Furthermore, 10 cohort studies successfully found that NPD was associated with adverse health outcomes, whereas 7 cohort studies and 1 case–control study failed (see Fig. 10). Among these studies, a limited number even reported an unexpected negative correlation between NPD and adverse health outcomes [37]. These findings highlight the complex nature of

the relationship between NPD and individual health, with mixed results observed across different study designs. The variations in study findings also emphasize the need for further research to elucidate the mechanisms underlying the relationship between NPD and individual health.

The heterogeneity in the types of NPD across studies may have contributed to the inconsistent findings observed. Although previous research has demonstrated that neighborhood conditions obtained through SSO and virtual audits exhibit higher reliability [15, 77]. However, a statistical analysis of 50 articles indicated that, compared to the NOPD, the presence of NPPD had a more pronounced impact on individual health [39, 40]. Similar conclusions have been reached in previous studies, suggesting that the influence of neighborhood disorder on health is primarily mediated by residents' subjective perception of the disorder [78, 79].

This may be attributed to the fact that NPPD, derived from residents' subjective perceptions, tends to capture the true levels of NPD more accurately than NOPD. Longitudinal tracking of NOPD presents challenges due to the substantial workload and high cost associated with SSO, as well as the infrequent updates of Street View images [80]. Therefore, the assessment of NOPD is often conducted as a one-time audit, which may result in underestimation of certain NPD phenomena, such as abandoned vehicles, which are infrequent or temporary in nature.

Additionally, NPPD measures the extent of spatial disorder that is more closely related to the areas where participants engage in their daily activities, in comparison to NOPD. In line with findings from Duncan et al. [81, 82], which highlighted that imprecise and non-theoretical definitions of neighborhood environments can lead to contradictory conclusions about the relationship between children's neighborhoods and their health and developmental outcomes, this study similarly observed that variations in neighborhood definitions produced divergent results in assessing the association between NPD and individual health outcomes, further supporting this hypothesis. Even within studies conducted in the United States, there is considerable variation in the definition of "neighborhood", including buffer zones, blocks and census etc. Statistically, studies that defined neighborhoods as "buffer zones" were more likely to identify correlations between NPD and individual health, compared to studies that defined neighborhoods as "census" areas. Buffer zones, as compared to administrative areas are in closer proximity to the area of residents' daily activities.

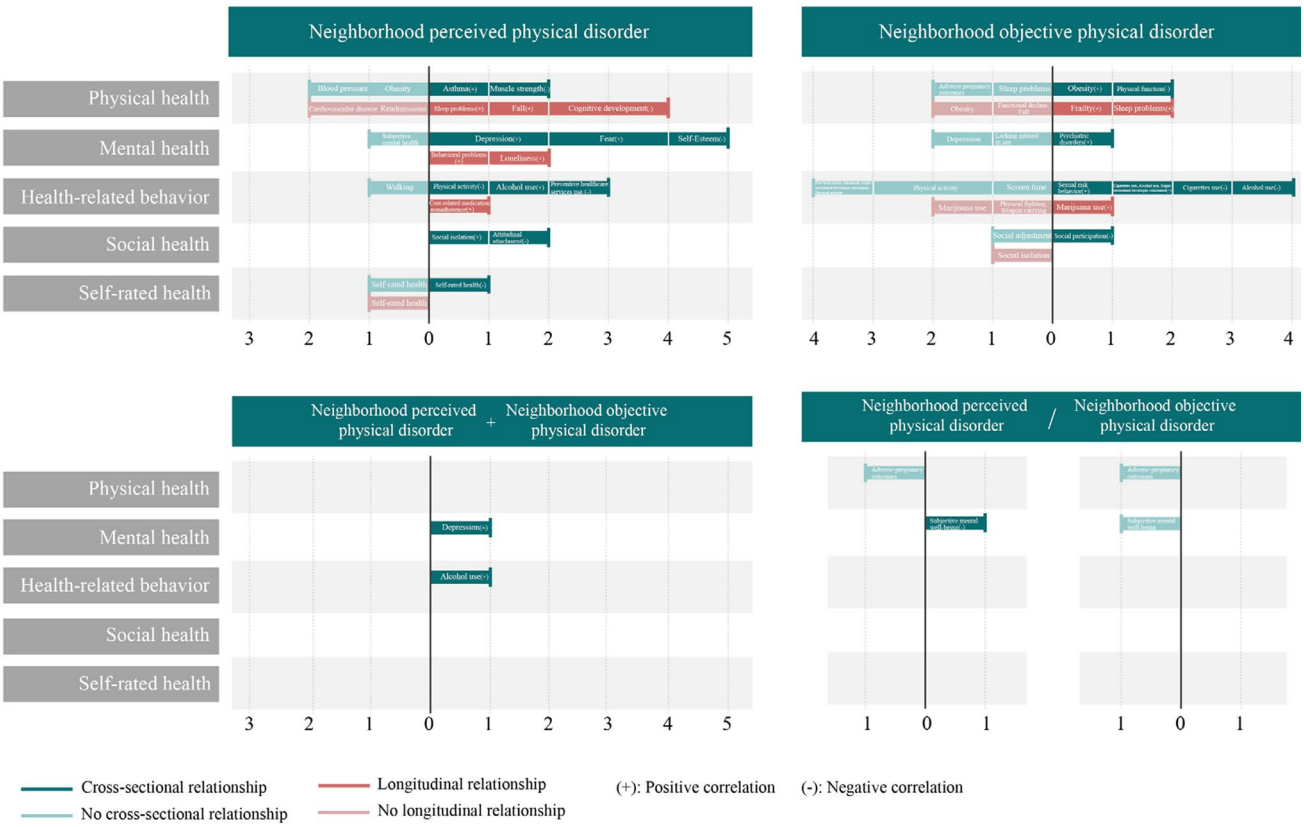

Fig. 10 Association between NPD and different types of individual health

The variability in NPD indicators may also contribute to the inconsistent findings observed across studies. It has been observed that different indicators exert distinct influences on health outcomes. However, current studies often utilize multiple indicators to create aggregated NPD index and analyze it correlations with individual health. The number and composition of these indicators vary across different studies, with some studies employing as many as 11 indicators and others using as few as one. NPD index may diminish the impact of specific indicators on individual health outcomes. For instance, Furr-Holden et al. conducted a study that revealed an association between the presence of abandoned buildings and marijuana use [32]. In contrast, Reboussin et al. constructed an NPD index by combining eight indicators, including abandoned buildings, but failed to identify a significant association between NPD and marijuana use in adolescents [65]. These contrasting results provide valuable insights into the nuanced dynamics between NOD and various dimensions of health outcomes.

4.2 Future research prospects

The available research on the association between NPD and individual health has yielded inconsistent findings. These inconsistencies highlight the necessity for additional investigations in future studies to gain a better understanding of this relationship.

1. Future studies should aim to incorporate diverse countries and international perspectives to enhance the global understanding of the relationship between NPD and various outcomes.
2. Given the limited proportion of current longitudinal studies, future research should prioritize the use of longitudinal designs to further advance our understanding of the complex interplay between NPD and various health outcomes over time.
3. The advent of street view images (SVI) has undoubtedly introduced a time-efficient and labor-saving approach to assess NPD in this field. Moreover, the emergence of deep learning technologies in recent years is poised to enhance this advantage even further. Nevertheless, given the significance of NPPD in influencing individual health outcomes, it is crucial to explore the interplay between NOPD and NPPD in future research. Specifically, efforts should be directed towards improving the prediction of NPPD using NOPD.
4. The definition of a neighborhood should align with the area of daily activities of its residents. In fact, recent studies have employed wearable cameras to assess individuals' mobility-based exposure neighborhood physical disorder [83], offering a valuable avenue to delve into the intricate mechanisms linking NPD and individual health outcomes.
5. Given that residents exhibit varying sensitivities to different indicators of neighborhood disorder, it is essential to consider the differential effects of these indicators on individual health. Moreover, from a health promotion perspective, researchers should identify key indicators of spatial disorder that negatively affect residents' health and propose improvement and optimization strategies tailored to these critical indicators.

4.3 Limitations of this review

We acknowledge the limitations of this review. Firstly, our literature search strategy focused solely on articles pertaining to NPD but did not encompass specific NPD indicators. Consequently, there is a possibility that studies examining the association between specific NPD indicators, such as abandoned buildings, and health outcomes may have been overlooked in our review. Additionally, we did not include terms closely related to NPD, such as "urban decay," "ghost towns," or "urban blight". In addition, due to the limited expertise within our team, we restricted our search to articles published in English, potentially limiting the generalizability of our findings on a global scale. Lastly, although we employed literature quality assessment to ensure the inclusion of high-quality articles, the reliance on peer-reviewed publications introduces a potential risk of publication bias.

5 Conclusions

Existing studies on the association between neighborhood physical disorder (NPD) and individual health outcomes yield inconsistent findings, underscoring the need for a systematic literature review. The statistical analysis of the 50 systematically screened articles revealed that the predominant focus of existing studies was on examining the relationship between neighborhood perceived physical disorder (NPPD) or neighborhood observed physical disorder (NOPD) and various aspects of individual health, including physical health, mental health, health-related behavior, social health, and

self-rated health. The geographical concentration of research in the United States and the prevalence of cross-sectional study designs were notable trends. However, the lack of consistency in specific NPD indicators and measurement methods hindered the comparability, verification, and generalizability of experimental findings across different regions. Moreover, this lack of consistency has contributed to significant heterogeneity in the outcomes reported by various studies and highlighted the substantial potential for future research in this field.

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Declarations

Competing interests The authors declare no competing interests.

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