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Multidimensional attributes of neighbourhood quality: A systematic review

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1. Introduction

The onset of COVID-19 has prompted an unprecedented disruption to our collective daily routines. National 'stay at home' orders and lockdown restrictions have required people to work from home, significantly reducing overall movement and public transportation use, thereby restricting residents to spend more time within their neighbourhoods [1]. Especially during strict lockdown restrictions, people were only permitted to leave their homes for very limited tasks, making their immediate neighbourhood surroundings the dominant geographical location where people would live, work, study, and play. Due to the rise of hybrid ways of working because of the pandemic-induced lockdowns, neighbourhoods in capital and regional cities are currently experiencing significant transformations (i.e., inner-city shrinkage, and the decline of the central business district (CBD)/high street) [2]. While the mid and long-term implications of these changes have yet to emerge, researchers argue that the pandemic provides an opportunity to redefine the neighbourhood as an appropriate tool to allocate resources towards the targeted development of disadvantaged neighbourhoods [3,4]. These emerging transformations rekindled global interest in neighbourhood design, such as the "15-min city" and/or "20-min city", where residents can access essential destinations at distances in the proximity of their homes within 15/20 min on foot or by bicycle [5–8].

In addition to the renewed importance of the neighbourhood environment in the post-pandemic world, existing research highlights the potential benefits of the neighbourhood environment. While some studies have concluded the role of the neighbourhood environment in encouraging physical activity [9–11] and its associated physical health outcomes [12–14], many studies have highlighted potential benefits of neighbourhoods on mental health [15,16] as well as child development [17–20] and elderly people's well-being [21,22]. In addition, physical and mental health issues caused by exposure to harmful environmental conditions such as noise and air pollution as well as neighbourhood deprivation [23–25], physical disorder [15,26], and unhygienic living conditions [27,28] were also denoted. Many studies have determined the strong link between the factors such as safety condition [20,29,30], social cohesion and integration [31–34] within a neighbourhood and mental health and well-being. Hence, designing high-quality (i.e., healthy, resilient) neighbourhoods will continue to be critical in the post-pandemic era.

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2. Neighbourhood quality

Studies have shown that the immediate home environment has a direct influence on its residents' health and quality of life [35]. Neighbourhood quality (NQ) has been defined as the characteristics of a neighbourhood and its combined impacts on residents [36]. Batson and Monnat [37] have further stated that NQ can be conceptualised as the aspects of a person's living situation which enables residents to maintain good health and independence, as well as be physically, mentally, and socially functional. NQ, comprising a multifaceted assessment of the living environment, including its physical, economic, and social aspects, collectively shapes the sense of community and place attachment. The development and changes in neighbourhoods for purposes like urban renewal, urban regeneration, and redevelopment aim to meet the needs and requirements of the people [38]. Researchers such as Bolt and Kempen [39] and Salleh and Badarulzaman [40] have used the overall perceived satisfaction of residents to determine NQ. However, others argue neighbourhood attachment is a more effective tool for evaluation [41,42]. For instance, Corrado et al. [41] claimed that satisfaction measures alone did not consider the significance of different evaluation methods, such as the personal and affective aspects of a given neighbourhood. To achieve a more comprehensive model for identifying NQ, Corrado et al. [41] suggested measures of attachment should also be included. In assessing NQ, researchers often consider both subjective evaluations provided by residents and objective assessments conducted by trained observers. While subjective evaluations capture residents' perceptions, satisfaction, and experiences within their neighbourhoods, objective assessments involve measures such as the condition of physical spaces, environmental quality, and the presence of amenities [43–45]. These combined approaches provide a holistic understanding of NQ, encompassing both the residents' perspectives and empirical observations.

Researchers from different disciplines have strived towards identifying and measuring factors to evaluate neighbourhood's quality of life [38,46]. For example, Najafpour et al. [46] reviewed 17 research articles to reveal the factors impacting NQ and highlighted the most significant factors associating with physical environment of urban neighbourhood which resulting in the amount of quality of life. Kruize et al. [47] emphasized the importance of research to understand NQ and its associated impacts on residents' health and well-being, with the goal of developing more targeted interventions. Despite the recognizable significance of NQ for assessing the performance/quality of neighbourhoods in terms of their liveability and resilience [2,48], a holistic understanding of multiple attributes related to NQ remains elusive. This gap in knowledge prompted us to contribute to this ongoing conversation by reviewing the research produced from 2010 to 2022 to identify the key attributes associated with NQ. The research questions (RQ) addressed by this study are:

RQ1. Which attributes of the neighbourhood environment have been considered as determinant factors pertaining to NQ shaping the quality of life, health, and well-being of residents?

RQ2. What are the domains and measures of these attributes?

RQ3. Which methods and tools are used to measure NQ?

With respect to RQ1, keywords and elimination criteria have been determined. The research dataset (86 articles) was reviewed to identify the key attributes of the neighbourhood environment that influence NQ in the broader area of residents' health and wellbeing. To answer RQ2, the domains and measures of each attribute, data collection and analysis methods have been classified. The attributes associated with NQ were classified under six categories; namely urban green and blue, amenities, housing quality, physical environment, accessibility and urban mobility, socio-economic environment. Thus, the focus of our review was on examining the various approaches, measurement techniques, and instruments for assessing NQ utilising environmental attributes. (RQ3). Our study is the first comprehensive literature review that makes use of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA method) [49] for measuring NQ.

The rest of this paper has been structured as follows: the methodology of this literature review and its outcomes were included under section 3 and 4, respectively. Key findings were discussed in Section 5 from the aspects of neighbourhood definitions and uncertainties in measuring the attributes of NQ to answer RQ3. Lastly, in Section 6, the conclusion with a snapshot of the collective understanding of NQ over the last decade was presented.

3. Methodology

This systematic literature review employed the PRISMA method [49] to conduct this analysis. The search for relevant studies was conducted using the Scopus and Web of Science databases. The keywords for the search were defined by authors as (neighbourhood OR neighbourhood) AND (quality) AND (wellbeing OR well-being) OR (health) OR (quality of life). The relevant records exported to an Excel spreadsheet, which were used for the screening process. The studies have been included in the analysis only if they met all the following inclusion criteria:

- Full-text available in English,
- Peer-reviewed Journal article and conference proceedings,
- Published between 2010 and 2022 (inclusive),
- Focused on measuring the quality of the neighbourhood.

The keyword search results of the above phrases returned 189 and 128 publications/studies in the Scopus and Web of Science databases respectively. The results from the two databases were merged to remove duplicates, resulting in 200 total documents. An

Excel spreadsheet was created to screen abstracts and further refine the selection list. Documents that were (i) a literature review, (ii) could not be obtained in full text, and (iii) did not meet the selection criteria were excluded from this list. This process allowed the exclusion of 114 documents. A further stage review involved the elimination of non-relevant articles (i.e., did not satisfy the inclusion criteria) and a final set of 86 articles were included in the analysis (Fig. 1). Two co-authors involved in the data extraction independently, and a third reviewer among the co-authors acted as an arbiter in case of disagreements.

4. Results

4.1. Distribution and evolution of papers across time, countries, and subject area

The database analysis shows that NQ is a rapidly growing research topic. Over half (63.90 %) of the records were published in the last 6 considered years (2016–2022). 48.80 % of the studies were conducted by researchers who have an affiliation with the USA, followed by the UK- affiliated researchers (10 studies out of 84, 11.90 %), and Canada-affiliated researchers (9.52 %) (Fig. 2). The subject area of most of the publications was medicine (41.05 %), which was followed by social sciences (36.84 %) and environmental sciences (21.05 %). This shows the diverse nature of studies conducted on NQ. It also seems to vary across a whole range of disciplines (medicine, social science, environmental science, art and humanities, biochemistry, genetics, molecular biology, etc.).

4.2. Attributes used for quantifying neighbourhood quality

Bibliographic data has been used to create a network of keywords co-occurrences with the use of VOSviewer based on the dataset containing 86 studies to provide an understanding of the content covered in studies associated with NQ. VOSviewer is a computer program which can be used for analysing bibliometric network data for creating, visualizing, and exploring bibliometric maps of science [50]. In network visualization the keywords on the map are represented by its weight, the size of the label and the circle of a keyword becomes larger when its weight is higher. The colour of an item is determined by the cluster to which the item belongs, and lines represents the links between keywords [51]. The distance between two keywords in the map approximately indicates the relatedness of the two keywords, the closer two keywords are located to each other, the stronger their relatedness.

In this study, co-occurrence analysis has been done with the RIS file of the selected articles. The network visualization map shows the general distribution of co-occurrence regarding to the size variation (grouping sphere representing the number of publications per subject) (Fig. 3). This map helped to analyse the most and least active terms and to validate the list of attributes in measuring NQ. When "full counting" was deployed a total of 105 keywords were extracted from dataset (with the minimum number of occurrences set to number 2). For each of the 105 keywords, the total strength of the co-occurrence links with other keywords has been calculated, some of the items which were not connected to each other excluded from the analysis (3 keywords). The largest set of connected items consisted of 102 items.

The network map (Fig. 3) shows two dominant keywords which are "neighbourhood" and "neighbourhood quality". In particular, researchers in the cluster of NQ have focused on quality of life, socio-economic environment, neighbourhood disorder, housing quality, affordability, accessibility, built environment and green space etc. As such, the co-occurrence network of keywords has confirmed the dominance of the studied topics within the body of knowledge on NQ. The closest keywords to NQ such as social support, stress, crime, neighbourhood disorder, socio-economic status were found to have fairly strong links, which reflects the dominant view in literature.

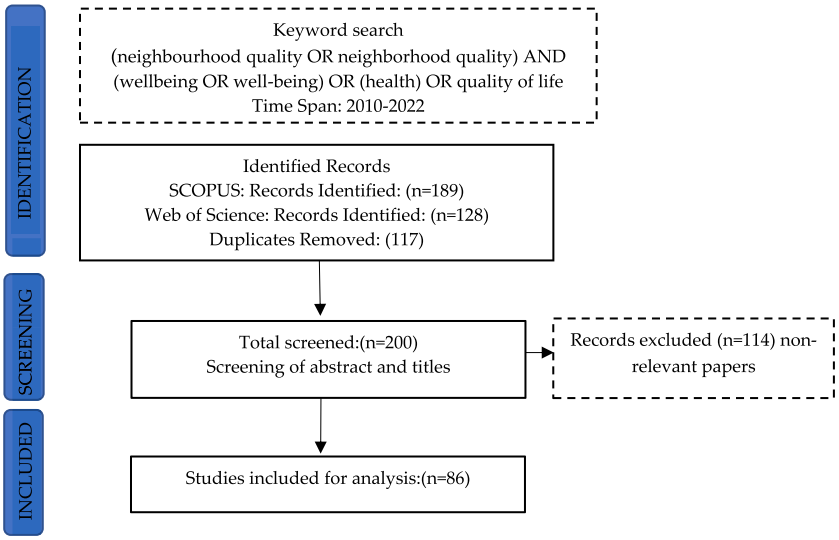

Fig. 1. The PRISMA Flow diagram summarising the study selection process.

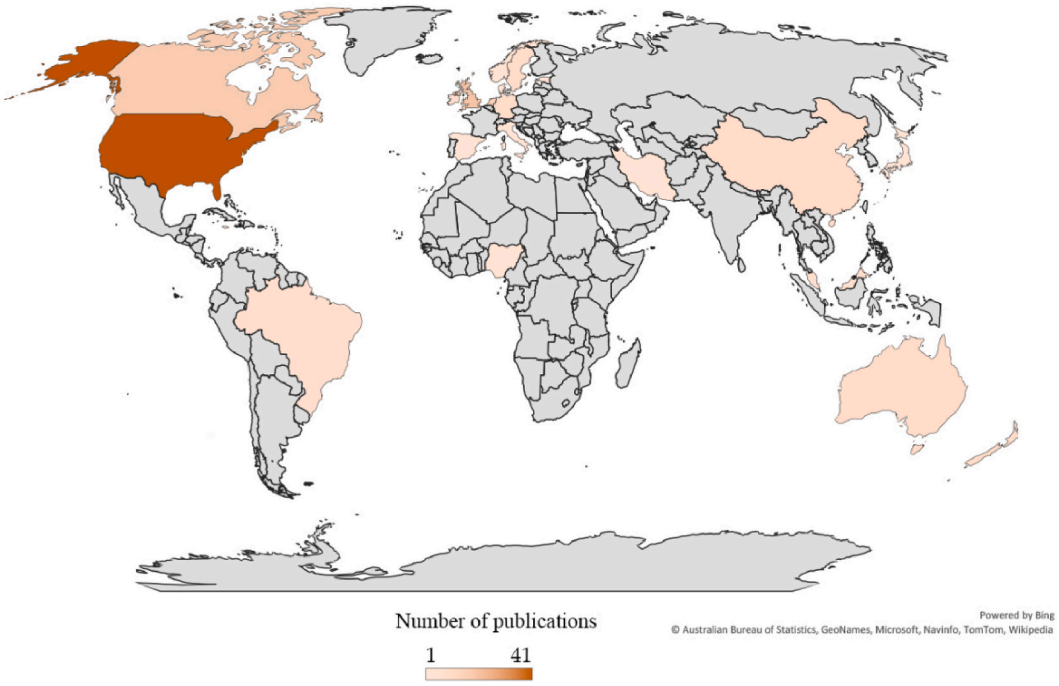

Fig. 2. Affiliation of the researchers reviewed in this study.

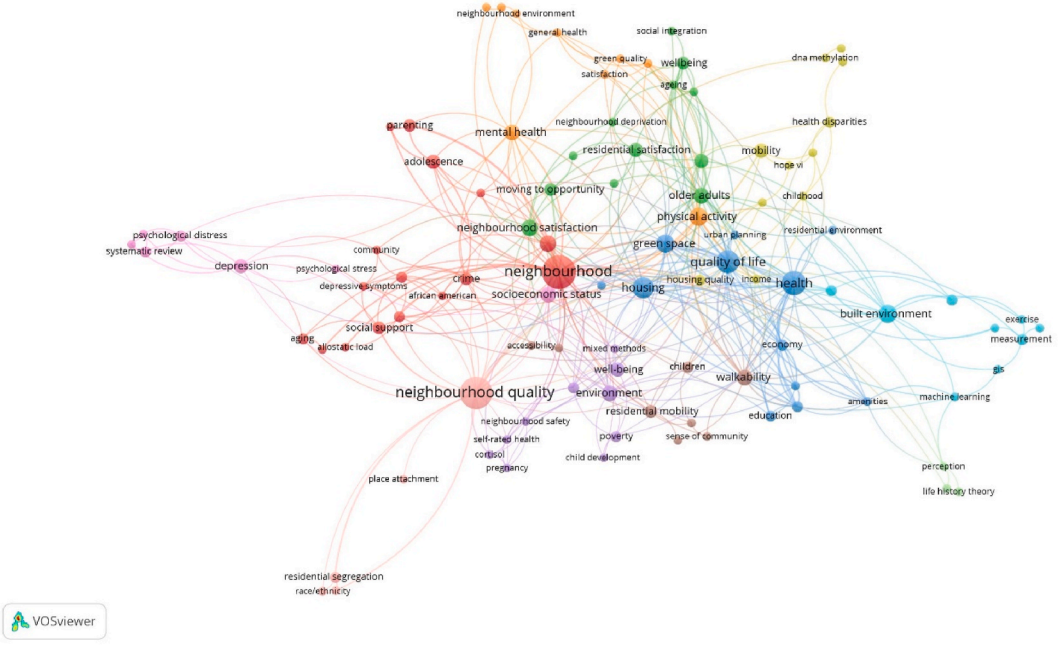

Fig. 3. Co-occurrence network of keywords of the studies associated with NQ. (Source: VOSviewer).

Moreover, the distance between the nodes on the network brought to light that "physical environment" and "quality of life" have been hardly addressed in NQ studies as illustrated in Fig. 3.

Based on the frequently referred key terms in literature to define environmental attributes, the primary attributes associated with NQ were studied under six categories: urban green and blue, amenities, housing quality, physical environment, accessibility and urban mobility, and socio-economic environment (Fig. 4, Table 1). This also shows the diversity of terminology used in NQ studies. Fig. 4presents the main attributes and their key domains, measures, and input data types.

Fig. 4. The key attributes studied in the NQ research dataset. (Source: Authors).

Table 1
Definition of the key attributes pertaining to the major keywords in co-occurrence network.

Key Attributes	Major keywords from the co-occurrence network map
Urban Green & Blue	green space, park, environment, waterways
Amenities	alcohol outlets, business and economics, land use, environmental facilities
Housing quality	community-dwelling, building type, housing, housing quality, public housing, dwelling quality
Physical Environment	physical environment, urban city, urbanization, neighbourhood disorder, urban restructuring, urban planning, built environment, noise
Accessibility & Urban Mobility	walking, walkability, accessibility, physical activity, transportation, walk score, active transportation, walkable access
Socio-economic environment	social cohesion, hostility, quality of life, wellbeing, intellectual disability, community effect, sense of community, health disparities, loneliness, crime, immigrants, poverty, aging, rural migrants, education, income, ethnic density, socioeconomic status, affordability

Fig. 5. Distribution of studies on each attribute.

Fig. 5 illustrates the number/percentage of the studies which included one and more attributes in measuring NQ. The number of studies researching five or more attributes only accounted for 5.46 % of the total publications reviewed in this paper. "Socio-economic environment" and "Urban green & blue" were the two key attributes addressed in the NQ research. Other research focused on "Accessibility & Urban mobility", while others sought physical environment, amenities and housing quality. However, it is noted that studies investigating more than two attributes and their associations with NQ were very few. This pattern shows the need for a comprehensive approach for NQ studies to understand the multi-dimensional nature of the "neighbourhood" with all its attributes and their combined impact on residents.

4.3. Six main attributes and their key domains, measures and input data types have been discussed below

4.3.1. Urban green and blue

"Urban green and blue" was assessed through several indicators, including "green space and greenery", "parks and recreation facilities", "open spaces", "nature", and "urban water" (Table 2).

The scope of "green space and greenery" includes "green space", "landscape", "trees", and "greenery". The presence of any green space and street landscaping that had been observed objectively and subjectively in the residential areas was used to determine the NQ rating. Using ArcGIS and Google Street View as their primary tools to gather data, several researchers evaluated the presence of green space through objective observation [52–54,82,83]. The predominant procedure researchers used to calculate green space was to measure the mean percentage of green space within a 500-m radius from the centre of each neighbourhood. Access to green space was determined by calculating the shortest walking distance from the residents' postcode to the nearest green spaces [54].

The presence of green spaces was also assessed subjectively through questionnaires that asked locals to evaluate the amount, size, and species of street trees in their neighbourhoods [12,45,55–58]. The areas of green spaces and walkable paths were generally assessed by local residents based on their accessibility and aesthetic quality via a binary scoring system in the questionnaires [59]. Researchers such as de Jong et al. [9,60] also objectively assessed perceived quality of green qualities within 300 m distance from participants' residences. In addition, the green qualities were elaborated by landscape architects and both perceived and objective measures were standardized to make effect estimates on neighbourhood satisfaction.

The presence of squares and parks and the distance to residences were assessed as another objective method of measuring this attribute (Table 2). Ortega-Momtequín et al. [65], for example, used the pedestrian access time technique, which is based on the time and distance required by a pedestrian to access the nearest green space on foot. Similarly, the percentage of residents living within a 400 m (0.25 mile) radial distance of a park or recreational facility was investigated to identify the accessibility of parks [22,66].

Aside from the number and quantity of green spaces, the quality of "open spaces" was also studied. The liveability, vitality, and identity of open spaces were measured by Oppio et al. [59] through multi-dimensional evaluation models which considers the combined use of spatial analysis developed by geographical information systems (GIS). The perceptions of local residents regarding the maintenance of open spaces, such as streets, footpaths, urban squares, and parks were also collected in order to understand the quality of open spaces [24,67]. Furthermore, the accessibility of playgrounds [58] were included in the evaluation process to identify the quality of open spaces.

The term "nature" was used in several studies to refer to natural elements such as local woodlands and mountains; in particular, the protection of the natural environment [25,61] were assessed. The presence of "urban water", such as lakes and rivers, close to the residential areas was also investigated. Bougouffa and Permana [61], for example, measured "urban water" indicator to undertake an exploratory factor analysis, transforming factor scores into a scale of 0 (non-existent) to 1 (existent) to evaluate the quality and provision of water bodies. The analysis also reveals a noteworthy disparity in the extent of research attention dedicated to water bodies compared to urban green spaces within the studies. There appears to be a relative paucity of literature addressing the influence of water bodies, such as urban beaches and waterfronts, on NQ. This disparity underscores an important gap in the current research landscape.

4.3.2. Amenities

The presence, diversity, and quality of amenities as well as their accessibility were studied within various domains (Table 2). The presence and number of amenities (e.g., café, restaurant, grocery, religious buildings etc) within the neighbourhood [52,69] was studied either by investigating the total number of the facilities or by using a dichotomous ("dummy") variable denoting presence/absence of facilities in the neighbourhood.

Another key domain of this attribute that was objectively investigated was the diversity of amenities within a neighbourhood [44,72,90] by calculating a continuous "land use mix score" ranging from 0 (single land use) to 1 (even distribution across a range of amenities). Typically, five types of land use were identified: (i) residential, (ii) retail, (iii) office, (iv) health, welfare, and community, and (v) entertainment, culture, and recreation, with geospatial data used as source for these studies. In addition to such quantitative assessments, some studies [22,28] focused on the quality of the facilities determined by the subjective evaluation of the survey participants. Zhang et al. [66] conducted a perceived quality inquiry using Google spatial data and the frequency of comments and likes posted via social media, among other measures, to determine whether residents in that neighbourhood were satisfied with the quality of services available.

Accessibility to specific amenities was another key domain investigated by multiple studies in relation to NQ. Several studies including Ostwald et al. [67] and Rezazadeh et al. [58] implemented surveys to gather such data, while others reviewed official documents i. e census data [44]. More recently, Ortega-Momtequín et al. [65] investigated the distance to the nearest health centre based on the time it would take a pedestrian to walk from the geometric centre of a district to the health centre at an average speed of 4 km per hour. Similarly, Oppio et al. [59] identified the spatial coverage of the educational facilities by measuring the distance between these facilities and residential premises. Supplementary neighbourhood observations were also carried out by non-resident observers to provide further objective data [59]. Securing non-resident data to complement these accessibility investigations was argued to reduce the risk of influences on one's perception of that environment.

A few studies, on the other hand, employed self-reported data to assess perceived accessibility to amenities. Participants were asked by these researchers if a lack of shops or shopping facilities would be a problem using Likert-style response categories such as from a scale of 1 (no problem at all) to 3 (a major problem) [26,44,72,90].

Table 2
Domains, measures, and input data types of attributes in NQ research.

Attribute	Domains	Measures & Methods (M)	Input Data Types & Tools (T)
Urban Green & Blue	Green space/greenery [9,12,18,25,45, 52,53,54,55–60,61,62,63,64]:	presence and quality of any green space, street landscaping, street trees access to green spaces and areas M: Multilevel (econometric) model Principle Component Analysis (PCA), Logistic Regression Models (LRM), Network distance analysis, Convolutional neural networks & log poisson regression models, (LPRM) Multi-attribute Value Theory (MAVT), Neighbourhood Deprivation Index (NDI),	• Subjective input data via perceived answers about the quality of green space • Census-derived input data via Google Street View and GIS data • Objective input data via direct observation of distance and time T: Google Street View, Google Map, ArcGIS, Statistical Package for the Social Sciences (SPSS), Amos, lavaan, GraphPad Prism, Service Area Solver
	Parks and recreational facilities [24,26, 28,43,65,66]:	presence and areas of parks percentage of residents living within the specific distance to parks M: PCA, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)	
	Open spaces [22,24,58,59,67]:	presence types and areas of open spaces M: Structural Equation Modeling (SEM), MAVT, PCA	
	Nature [23,25,44,61,68]:	natural elements M: PCA, Observer rating	
	Urban water [61,69]:	the presence of lakes and rivers M: PCA	
Amenities	Café, restaurant, grocery [22,28,52,58, 66]: Public places [20,22,44,58,59,67]:• Medicare, pharmacy, health care, day care, drugstore [28,59,67]:• Religious places [58,59]:• Historical buildings [69]:• Shops, Shopping centre [26,28,67]:• Educational facilities [59,65,69,70,71]:•	presence of facilities perceived quality of facilities easy to access lack of facilities M: PCA, LRM, SEM, Confirmatory Factor Analysis (CFA), Sensitivity analysis (SA), TOPSIS, AHP, NDI, MRA	• Subjective measurement via questionnaire • Objective measurements via google place data and social media for service quality inquiry T: STATA, SPSS, lavaan,
	Land Use [44,72,73]:	land use mix score from 0 to 1 M: Scoring Technique, Walk ScoreÒ, Generalized additive mixed models (GAMMs)	• Objective measurements via geospatial data T: SAS, ArcGIS, Google Street View
Housing Quality	Mix or housing types [12,53,57]:	single, family, detached etc. M: LPRM, Digital map analysis (DMA)	• Objective measurements via geospatial data (parcel-based land use data) • Official documents/database • Subjective measurement via questionnaire T: ArchGIS, Ordnance Survey (OS) Map
	Housing quality [12,15,17,24,43,44,57, 58,61,63,74,75,76]:	housing plumbing and insulation problems, size, appearance, damage, parking etc. M: SEM, PCA, SA, LRM, LPRM, Marginal quasi-likelihood estimation method (MQEM), Hierarchical lineer modeling (HLM), Exploratory factor analysis (EFA), DMA, multilevel random coefficient model (MRCM), multilevel hierarchical Linear Mixed Mode	• Subjective measurement via questionnaire • Objective measurements via Google Street view& observer T: SPSS, SAS, MLwiN, STATA, Amos, Residential Environment Assessment Tool (REAT 2.0),
Physical Environment	Physical disorder [12,16,17,24,26,34, 43,45,58,77,78,79,80]:	housing damage, litter or trash, vacant houses, graffiti broken glas M: MQEM, LRM, PCA, MRCM, MRA, Indices of Multiple Deprivation, HLM	• Subjective evaluation via questionnaire • Objective measurements via direct observation by a trainer T: STATA, SAS, SPSS, Amos
	Air quality [24,25,61]:	air quality & polluted air M: LRM,EFA, SEM, ANOVA	

(*continued on next page*)

Table 2 (*continued*)

Attribute	Domains	Measures & Methods (M)	Input Data Types & Tools (T)
	Noise/sound [23,24,43,58,67,61,77]:	traffic sound, sound from neighbours, absence of crowding M: LRM, EFA, SEM, PCA, MRCM, Bivariate Analyses, Indices of Multiple Deprivation	
	Cleanliness [23,25,27,28,67,61,62]:	the presence of trash bin clean sidewalks and streets M: EFA, SEM, Bivariate Analyses, ANOVA	
	Infrastructure [23,29,72,81]:	road accessibility, streetlight, pavement quality M: Active Neighbourhood Checklist, LRA, Bivariate Analyses	
Accessibility & Urban Mobility	Housing density [44,82,65,73]:	net residential density (m2 built/m2 land) (dwellings/acre) retail floor area ratio (RFAR) M: Geographical Weighted Regression (GWR), TOPSIS, Geostatistical analysis	• Objective input data via geospatial data (parcel-based land use data) & qualitative measures • Subjective input data via questionnaire & interview
	Connectivity [12,24,26,44,45,82,65,72,73,81]:	connection between roads and buildings number of intersections M: Walk ScoreÒ, Analysis of Variance (ANOVA), LRM, GAMMs, GWR, Ordinary Least Square (OLS), TOPSIS, Analytic Hierarchy Process (AHP)•	• Census-derived input data
	Walkability and pedestrian, cyclist, and disabled access [17,23–25,43,52,53,83,58,65,81,64,84]:	street networks, walking scores M:LPR, multistage clluster systematic sampling frame, LRM, Walkability Index, GAMMs, TOPSIS, AHP, Bivariate Analyses, MRCM, ANOVA, NDI, Convolutional neural networks, LPRM, PCA, CFALR	T: Google Street View, SPSS, ArcGIS, ArcView, Google Earth, OS Map, Service Area Solver, REAT, SAS Enterprise Guide
	Public transport [52,59,65–67]:	network, coverage, density of public transportation, accessibility M: MAVT, GAMMs, TOPSIS, AHP, NDI, ANOVA, CFA, LRM	
	Private transport [77]:	parking spaces, traffic condition M: Indices of Multiple Deprivation	
Socio-Economic Environment	Safety and security [17,20–23,25–29,43,66,85,62,63,86,87,88,64,80,89]:	perceived safety and security M: LRM, Bivariate Analyses, MRCM, ANOVA, LPR, SEM	• Subjective assessments via questionnaire & interview T: STATA, SPSS, lavaan, Mplus
	Social cohesion/integration [13,15,22,29,32–34,56,66,67,90,68,63,77,86,87,91,88,84,92–95]:	neighbourliness, connectedness, social neighbouring, social interaction, sense of place/belonging, social participation M: CFA, LRM, ANOVA, Indices of Multiple Deprivation, LPRM, Chi-square Automatic Interaction Detection (CHAID), MRA, HLM	
	Crime [13,15,32,33,58,90,96,85,63,91,74,95]:	poverty type M: PCA, LRM, HLM, MRA,SEM, SA	• Census-derived and indirect measurements
	Poverty [85,74,75,78,97,98,76,80]:	racial and ethnic groups M: LPRM, LRM•	
	Race/ethnicity [16,75,97,98,88]:	perceived stress/depression chronic medical conditions, pain interference, lower-extremity function, and body mass index M: LRM, EFA	• Subjective measurements via questionnaire & interview • Objective evaluations T: STATA, SPSS, Mplus, ArchMap, SAS
	Education quality/achievement [17,25,96,85,74,75,99]:	educational completion rate M: LRM, ANOVA, SEM, LPRM, SIMD, CHAID, SA	• Subjective input data via questionnaire & interview • Census-derived input data T: ArcMap, Google Maps, SPSS, Service Area Solver, STATA, SAS Enterprise Guide, FSL
	Income/cost [13,17,32,96,74,98,99]:	household income and cost M: LRA, SEM, LPRM, SIMD	• Subjective input data via questionnaire & interview • Census-derived input data T: ArcMap, Google Maps, SPSS, Service Area Solver, STATA, SAS Enterprise Guide, FSL
	Home ownership & property [15,65,85,78,75,76]:	homeowner or tenant M: TOPSIS, AHP,	

(*continued on next page*)

Table 2 (*continued*)

Attribute	Domains	Measures & Methods (M)	Input Data Types & Tools (T)
			CHAID, MRA, HLM•
	Employment [26,96,85]:		employment/ unemployment rate M: ANOVA, GAMMs, SIMD, MRA•
	Population [17,52,88]:		population density M: LRA, NDI, SA•

4.3.3. Housing quality

"Housing quality" could be defined as an individual's own environmental experience, focusing on both the immediate home environment and physical and socio-cultural factors (Table 2).

The subjective evaluation of the immediate home environment, including perceived satisfaction with housing quality, the appearance of housing, and diversity in architectural style, were also studied. The information for such analyses was gathered either through surveys completed by the local households (Table 2). Survey-based studies centred their investigation on the perceived quality of the housing, the presence or lack of facilities available, as well as desirable characteristics and features of the facilities. Since most studies relied on the perceived findings through surveys completed by households, the information used to define the quality of housing was limited. Objective observations of housing quality were also studied by using various data sources such as Google Street View [53,82] and geospatial data (parcel-based land use data) [73], as well as investigating official documents and databases [44,65,66,96,85]. For example, Khormi and Kumar [82] explored housing quality based on the density of houses, the width of streets, and the roof area of houses. Additionally, detailed field studies were also conducted to assess housing quality. For example, in the research of Ward-Caviness et al. [45] and Poortinga et al. [57], varying degrees of damage present in a building were evaluated by a trained assessor.

4.3.4. Physical environment

The "physical environment" domains considered for NQ assessment included place-keeping (litter, graffiti, broken glass, and rubbish in the sidewalks and streets); placemaking (including vacant houses and damaged houses); environmental quality (including air pollution, and noise (either from the surrounding environment or from neighbours), and streetscape quality (such as sidewalks, street lighting, cleanliness of pavements etc.) (Table 2). The information for the analyses was typically gathered through surveys completed by residents. Survey-based studies sought either the perceived quality of the physical neighbourhood environment via agreement to a statement or satisfaction rate, or perception of these problems (if any) as a major or minor issue. In some of the studies, participants were asked to answer using binary codes to relevant questions with either yes/no or neutral responses [67,62]. Since only a few studies [59,72,68] incorporated objective methods of assessment (e.g., an audit undertaken by the researchers and site investigators) and the majority of studies relied upon the subjective assessments of participants, there was a lack of information available which could define the quality of the environment with quantifiable data.

It was observed that environmental quality such as increased air pollution which was studied using different measures was considered an important indicator significantly associated with neighbourhood satisfaction. For example, increased air pollution was found to negatively impact residents' environmental perception [24,25,61].

Another aspect of the physical environment that was shown to be significantly associated with environmental perception was place keeping, referring to the long-term maintenance of public spaces [100]. Similarly, residents of neighbourhoods "having clean pavements and streets" tended to exhibit more positive environmental view, according to a study by Ostwald et al. [67]. The results of the study done by Dassopoulos et al. [101] highlight the significant impact of placemaking issues, such as vacant buildings, graffiti, and vandalism, on diminishing the sense of community within a neighbourhood. Residents' attachment to their community is notably reduced as physical disorder increases, signalling a breakdown in social control and overall neighbourhood satisfaction, regardless of their length of residence or residential stability.

Other physical environmental determinants of NQ, such as the presence and quality of street lighting [23,29] and sidewalks in the neighbourhood, were considered in relation to perceptions of streetscape qualities. For example, objective assessments of pavement quality and its relationship with cycling by Tabak et al. [81] demonstrated these two domains as being strongly interrelated. However, a study by Cassarino et al. [23] found no statistically significant interactions between the streetscape measures and environmental perception. Overall, the studies examined in this review demonstrated that inadequate physical environment quality in the areas of place keeping, placemaking, environmental quality, and streetscape quality had a negative impact on NQ.

4.3.5. Accessibility and urban mobility

Out of 86 publications reviewed here, 28 papers adopted "accessibility and urban mobility" as the key attribute to evaluate NQ (Table 2), characterized in terms of building (residential) and street network connectivity. Street connectivity was mostly measured using objective methods. Several researchers, for example, assessed the number of intersections with three or more nodes [81] either by dividing the total land area within a 1-km street network or buffering uniquely for each residence [73]. On the other hand, researchers also investigated "connectivity" by studying the connections between roads and buildings through a combination of questionnaires and archival sources [44,73,81]. Other research in this area used walk scores as the mode of measurement for walkability; these scores were determined by whether an amenity's street distance was within approximately 400 m (0.25 miles) [66]. In addition to these objective methods, several studies employed subjective assessments of "walkability and accessibility". The presence and quality of crosswalks, for example, were investigated through surveys to evaluate the walkability of a neighbourhood [24,53,83]. In the survey provided to residents, Rezazadeh et al. [58] created a scoring system, where a score of 0 represented a lack of transportation facilities and the absence of desirable characteristics and features, and a score of 1 demonstrated easy access to relevant road facilities.

Building density was another key domain used in studies to evaluate "accessibility and urban mobility" as an NQ attribute. In addition to physical measures of net residential density, subjective assessments (i.e., questionnaire participants asked to respond to queries relating to the proximity of buildings) were also used. The measurement of Residential Floor Area Ratio (RFAR) was introduced to increase the sensitivity to retail use believed to stimulate pedestrian activity [73] for block group Low RFAR was argued as a marker for areas with retail development that is likely to be accompanied by substantial parking space, whereas high RFAR was seen as a marker for buildings with smaller set-backs from the street, reflecting a pedestrian-oriented design. Since the measures relied on

values, such as structure floor area footprint and parcel land area, the accuracy of the parcel-based land use data was critical. These measures were employed on the premise that a higher intersection density represented more direct paths between destinations to maximise the connectivity of the street. Furthermore, a well-connected road network enables multiple modes of travel, contributing to the connectivity within the neighbourhood [24]. The accessibility of destinations within walking distance was also recognised to have an impact on urban mobility patterns since active travel is a time- and distance-limited activity. Cassarino et al.'s [23], for example, defined accessibility for pedestrians Cassarino et al.'s [23] as the distance between residences and amenities or services. Specifically, the neighbourhood was considered as the surrounding area of a house that could be reached by walking for 15/20 min. The distance to the city centre and other destinations were also considered as primary measure for determining "accessibility and urban mobility" [43,52,65]. For example, Ortega-Momtequín et al. [65] applied the pedestrian access time technique to measure the travel distance and time within the neighbourhood. Other studies assessed the commuting time [25] within the neighbourhood planning unit. The driving distance measured by the time of travel from the district centre to the nearest highway entrance provided another formula for the connectivity evaluation [24,53,83,65].

The condition and characteristics of roads and streets, in general, and access roads, in particular, were also evaluated as part of "accessibility and urban mobility" in a series of research studies [12,82,72]. In particular, the street width was measured by Khormi and Kumar (2011) to classify the quality of the road as low quality (1–5 m), medium quality (5–10 m), and high quality (10 m or wider) [25,65]. Finally, the presence of heavy traffic volume provided another area to measure connectivity and its relationship with NQ [45].

Another recurring domain recurring in reviewed studies was access to public and private transport. Access to Public transport" was considered in relation to access to key transit access sites, such as train stations and bus stops, as well as the spatial coverage of the public transit networks (Table 2). For instance, Zhang et al. [66] measured the percentage of residents living within a 400 m (0.25 mile) radial distance of a bus stop, or 800 m (0.5 mile) radial distance of a public transit stop. Similarly, a public transport index was developed by Mouratidis [52] to calculate the aggregate number of departures per hour during the peak period from all public transit stops within a radius of 500 m from the centre of each neighbourhood. Similarly, access to "Private transport" also played a vital role in evaluating NQ [77] and the availability of parking spaces served as the main item of measurement. Yakubovich et al. [77], for example, were able to measure the respondents' satisfaction with parking spaces within the neighbourhood.

4.3.6. Socio-economic environment

"Socio-economic environment" was assessed through several aspects, including: "safety and security" "crime", "social cohesion/integration", "poverty", "race/ethnicity", "education quality/achievement", "home ownership/property", "capital/asset", "employment", and "population" (Table 2).

The scope of "safety and security" includes perceived safety and security. A lack of neighbourhood security and feelings of safety were considered to be ambient stressors [86]. In all studies reviewed here, data on this domain was gathered using surveys or interviews and discussions with focus groups. The significant relationships between "safety and security" and NQ were explored through house ownership, residential mobility, health and well-being, and walkability. An illustration of the importance of this domain was evidenced by Tan and Lee [62], whose survey respondents cited neighbourhood safety as one of the significant determinants considered when deciding where to buy a house. Its impact on neighbourhood walkability has also been studied in relation to day- and night-time activities. It was found that feeling safe to walk in the neighbourhood during night hours had significant effects on wellbeing [22].

"Social cohesion/attachment" was also described using different keywords such as "neighbourliness" [55], "sense of place/belonging" [86], "social contact" [22], and "community engagement" [63]. Despite the different terminology used, all inquiry methods used in these studies captured an individual's perception of their neighbours and/or neighbourhood social environment through surveys, questionnaires, or open-ended interviews.

Positive social interactions through a variety of neighbouring activities, such as talking with neighbours, sharing items, doing favours, and collectively organising to address neighbourhood problems, were examined to evaluate the strength of bonds between neighbours. The attachment to the neighbourhood and participants' intentions of remaining in the neighbourhood [33] were found to be relevant to high social cohesion [34]. Support and trust among neighbours were the factors which affected the sense of belonging and perceived NQ, which provided a protective social resource to resist the negative influence of depression on social integration [87]. Ostwald et al. [67] reported that higher cognitive and emotional attachment to an area led to higher levels of life satisfaction.

It was noted that several research studied 'crime' as the attribute to assess NQ, notably in the setting of low-median income communities, instead of perceived safety and security. These studies gathered data on crime by investigating subjectively through the perceptions of the participants on (i) the presence of crime in the neighbourhood [32,33,90,63,91,78], (ii) frequency of crime [90], or objectively (iii) through official documents on violent/property crime risk [85].

Studies investigating 'poverty' as a domain of social environment mostly used objective data (i.e., census tract data), except Johnson [74], which explored poverty through the perceptions of the participants. Poverty was studied using data on crime [85,78,74], and race/ethnicity [75,97,98]. It was noted that compared to other domains of NQ, the majority of measures relating to crime were derived from questionnaires rather than through a quantitative approach.

"Education quality" was studied as one measure of general "education". While Johnson [75] focused on the average household expenditure towards school-age student education needs in the county area Johnson [75], and Roubinov et al. [99] analysed school quality and the ability of local residents to access essential skills and training as part of the education quality. The expectations of parents for children's academic and extracurricular results received frequent mentions in this domain under the key phrase "Educational achievement" [75]. Measurements of achievement involved the assessment of the percentage of people over 25 years old with a high school diploma [17,85,102], academic grades [96,85] and the percentage of high school students who dropped out of the school system [85].

"Income and cost" were a frequently mentioned domain for evaluating socio-economic environment as an NQ attribute. The annual median household income gathered from questionnaires and census surveys was typically studied by researchers [13,32,96,74,99].

"Home ownership and property" were other domains used for the assessment. The tenure status regarding renting or owning was measured through questionnaires [85,75]. For homeowners, home value Ortega-Momtequín et al. [65] was assessed through subjective input data collected from questionnaires and census-derived input data to identify its impacts on NQ.

"Employment" was another key domain in multiple papers. The employment and unemployment rates were assessed both objectively and subjectively through census data and questionnaires in various research papers (Table 2).

Finally, studies investigating "population" in relation to "socio-economic environment" provided further insights for evaluating NQ. As the foundation of the society, the demographic characteristics, especially the population composition and density were highlighted in related research [17,52,88]. Mouratidis [52] specifically measured population density by dividing the population of each neighbourhood by the area coverage in hectares.

5. Discussion

5.1. The need for a definition of a "neighbourhood" and its spatial boundaries

The systematic review of 86 papers shows that the spatial boundaries of the "neighbourhood" unit are still ambiguous. The definition of a neighbourhood can vary widely across studies, depending on research goals and geographic factors. Some studies use census block group boundaries, census tracts, or postal codes to define neighbourhoods, while others create buffers around participants' homes (ranging from 1 km to 2 miles). Administrative units like municipal districts are also used. Some studies define neighbourhoods as clusters of census block groups, and one even used a 10- to 15-min walk (1600 m) from home [22,59]. Population density criteria are applied in some cases to define urban neighbourhoods [29]. This flexibility in neighbourhood definition can significantly influence research outcomes, emphasizing the importance of carefully justifying the chosen definition for each study.

The reviewed studies most commonly used census data [78,103,70] or postcodes [12,20,41,96] resources for defining a neighbourhood. However, the approach of using census tracts and block-level data has been criticised since population size and spatial boundaries are not synchronous and vary according to the settlement density [27,104]. Moreover, the collection of information for census data is restricted solely to population size, and census tracts adhere to a requisite sample size of 1200 to 8000 people surveyed. Although these methods of data collection provide some useful demographic information, the dynamic nature of neighbourhood composition and spatial density cannot be adequately captured and represented through this data alone [27]. Furthermore, the data collected through these sources is infrequently gathered; in the USA, for example, a new census is conducted once a decade, while in Australia it is every five years. Thus, researchers should consider the fact that the characteristics of the residents would change during this time.

The description of neighbourhoods based on postcode or zip codes has other limitations. Since postal codes were created for the organisation and dissemination of mail, they do not necessarily account for residents' perceptions and lived experiences of their neighbourhood boundaries. Another frequently used measurement approach is defining a circular zone with a fixed radius (i.e., 1 km, 1 mile, 800 m etc.) centred at each resident's home. However, this circular zone ignores physical barriers, such as highways and bridges, to accessing amenities, parks, and waterways.

5.2. Uncertainty in using domains, measures and methods

The results of this systematic review identified three primary types of data used in NQ literature: (i) subjective input data collected through questionnaires and interviews, (ii) objective input data through (a) census-derived input data, and (b) geospatial analysis, Google Street View audits, and observations by trainers, (iii) along with the combination of all three. Subjective input data was found as the primary data type employed in the majority of studies (60.74 %). This data type mainly focused on collecting residents' perceptions by conducting questionnaires, interviews, and surveys. Subjective data such as the perceptions of residents can provide valuable insights into the quality of a neighbourhood. However, since subjective data is based on the opinions and perceptions of individuals, it can be subject to bias and subjectivity. This means that different people may have different opinions about the same neighbourhood, and these opinions may be influenced by factors such as personal experiences, cultural background, and social norms. As mentioned by Douglas et al. [24], individuals conformed or adapted to their residential environment over time and consequently reported a reasonably high level of satisfaction in relation to a longer duration of residence at a location. In addition, subjective data can provide insights into the symptoms of neighbourhood problems, but it may be more difficult to identify the underlying causes. It is also important to recognise the potential impact of the individual level factors on how people perceive their surroundings and the quality of their neighbourhoods. The qualities of a neighbourhood that are regarded as desirable or unfavourable can change significantly among cultures and geographical regions. For instance, the findings of the study done by de Jong et al. [60] underscore the significance of individual assessments in evaluating NQ. Individual assessments, often based on residents' personal experiences and perceptions, provide valuable insights into how people perceive and interact with their neighbourhoods. These assessments can offer unique and nuanced perspectives on neighbourhood satisfaction and vitality, shedding light on the human dimension of community well-being. In many papers, the combination of perceived objective input data collected from questionnaires or interviews together with the secondary data derived from the census database contributed to the evaluation of NQ. Several research papers integrated data from census results or databases in conjunction with the objective input data to evaluate NQ. Yet, these measurements rely heavily on the completeness and effectiveness of relevant databases. Furthermore, the census data or other databases predominantly focus on

macro-/meso-scale analysis (i.e., country, city, or suburb-level scales) rather than the more refined micro-scale environment (i.e., street or community level).

Only 2 % of the studies reviewed in this paper used only objective input data for assessing NQ. Objective input data provides further possibilities to evaluate NQ for instance a more standardized way to provide more comparable data across different neighbourhoods or time periods. In addition, the use of objective data can help ensure that decision making related to NQ is grounded in evidence and that resources are being allocated effectively to improve the lives of residents. In studies employing objective assessments of geospatial data, the most frequently adopted tool was GIS. GIS databases were used in many papers to obtain spatial and geographic data [54,60,75] as well as to generate thematic maps illustrating the key attributes of a neighbourhood. In some cases, the GIS databases were combined with census data [56]. The integration of Google Street View or satellite images and a binary label system enabled the researchers to evaluate the presence or absence of the environmental indicators [53,83]. However, there is a notable gap in the application of AI and machine learning techniques for automated street-level data analysis in NQ studies. This presents a promising avenue for future research, offering the potential for more efficient and comprehensive analysis of vast visual data, which could enhance our understanding of NQ attributes.

In our systematic review, we noted a diverse array of methods and tools employed by researchers to analyse the data collected. In the realm of data analysis tools, researchers frequently turned to statistical software packages such as STATA, SPSS, and Amos for quantitative analysis, employing techniques i.e., Principal Component Analysis (PCA) and Hierarchical Linear Modelling (HLM) (Table 2). Geospatial software tools like ArcGIS and Google Street View were pivotal for visualizing and investigating spatial relationships, often in conjunction with logistic regression models and Geographical Weighted Regression (GWR). Additionally, advanced statistical techniques i.e. Exploratory Factor Analysis (EFA) and the Marginal Quasi-Likelihood Estimation Method (MQEM) were utilized to delve deeper into the nuances of neighbourhood data (Table 2). These multifaceted methods and tools collectively contributed to the robust analysis of neighbourhood attributes in the reviewed studies. The researchers of the studied papers were able to develop a scoring or ranking system. Some of the studies developed scoring or ranking systems with the use of various methods i.e. analytical hierarchy process (AHP), technique for order performance by similarity to ideal solution (TOPSIS), multi-attribute value theory (MAVT) to assess the qualitative evidence gathered. However, in most of the research reviewed, the perceived answers varied based on the personal feelings, social contexts, and cultural backgrounds of respondents. However, the universal acceptance and standardisation of these scoring or ranking systems still need to be clarified for better capturing NQ in future studies. The methods for evaluating qualitative data remain ambiguous, and there is a lack of a consistent measurement system that can provide more reliable and objective evaluation procedures in this area. Finally, the uncertainty in defining weight scores or rankings in selected papers provides a barrier for future studies when discerning which attribute is more important than others to consider when measuring NQ.

6. Conclusion

This systematic review includes 86 research papers published in the last decade (2010–2022) to define the attributes associated with NQ. Since it is now generally accepted that people's health and well-being is influenced by multiple attributes of their home neighbourhood, it is profoundly important to investigate how the neighbourhood environment was quantified using a wide range of physical and socio-economic attributes. A major limitation of this paper is that reviewed studies were cross-sectional, resulting in a large range of measurements and research designs. Hence, further work should consider the inter-relations between these attributes. Additionally, this paper only reviewed research cited in the Web of Science and Scopus since 2010. Another shortcoming of this literature review is the lack of a systematic quality and/or bias assessment on the included studies. While some studies may not explicitly refer to their assessments as 'quality assessments' or may have a limited number of attributes, they were considered if their primary focus was on evaluating NQ in any capacity. A further challenge with systematic literature reviews is the high heterogeneity among the included studies. This could be addressed by narrowing the scope of the research topic, limiting the types of studies, or employing meta-regression or subgroup analysis to investigate the causes of heterogeneity. However, we intentionally adopted a broad scope to reflect the multidisciplinary nature of this research area, which includes a wide range of data sources such as spatial data, survey data, census data, and data-driven GIS, among others. While meta-regression analysis is a powerful tool for exploring sources of heterogeneity in systematic reviews, its applicability in our study context is limited due to the inherent diversity in data types, methodologies, and contexts across the included studies. Lastly, while we recognise the relevance of personal characteristics such as age, health status, and personal preferences as well as cultural/geographical differences and potential confounding factors such as individual socioeconomic status or access to healthcare in determining people's perceptions of their environment, our systematic review focused primarily on the environmental attributes, domains, and measures that define NQ. Notwithstanding these limitations, this paper contributed to the knowledgebase by providing a detailed review of key attributes of NQ, including urban green and blue, amenities, housing quality, physical environment, accessibility and urban mobility, socio-economic environment. Key findings indicate that there is no consensus on identifying the spatial boundaries of neighbourhoods, nor on measures and methods in assessing the various NQ attributes. This lack of consensus in the literature presents barriers and challenges for researchers attempting to compare research findings or replicate an existing research design in a similar context. Another key research gap identified in this review is the overreliance on residents' perceptions of their environment (i.e., perceived satisfaction, perceived safety, perceived quality of life etc.), rather than employing objectively assessed indicators. Evaluating such perceptual attributes is clearly important in creating environments supportive of human well-being; however, the results are generally inconclusive due to the subjective nature of the respondent data. Although such an objective measurement method would require a generous budget and time to collect refined and rigorous data that are generally available from existing datasets, such as census tracts, it is a critical approach in NQ studies to triangulate subjective findings and compare different urban contexts. By combining objective data with subjective data, policymakers,

planners, and community organizations can develop a comprehensive understanding of NQ and identify strategies to enhance it. More importantly, this review emphasized the importance of including multiple attributes of the physical and social environment in NQ investigations to gain a better understanding of the quality of the neighbourhood and hence life.

Data availability

Data used in this systematic review included in references.

CRediT authorship contribution statement

Ozgur Gocer: Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Data curation, Conceptualization. **Yuan Wei:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Ayse Ozbil Torun:** Writing – review & editing, Supervision, Methodology. **Seraphim Alvanides:** Writing – review & editing, Supervision, Methodology. **Christhina Candido:** Writing – review & editing, Supervision, Methodology.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Ozgur gocer reports financial support was provided by Urban Studies Foundation.

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