

## RESEARCH ARTICLE

# A set of 99 healthy city indicators for application in urban planning and design

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## Abstract

Despite much interest in healthy, sustainable cities, currently they are often on the margins of urban planning and design, not the centre. Part of the reason for this is technical. Many planners are interested in designing healthier cities but wonder how to link their objectives with actions. This study develops 99 indicators for a healthy city. The basis for the development of indicators was the 11 objectives of a healthy city according to the World Health Organisation. Application of these indicators helps push healthy city objectives to the centre of urban planning and design in two ways: (I) the indicators can show gap with each objective; and (II) monitoring the indicators over time can show the performance of solutions for each objective. It is possible to explore synergies and trade-offs between the 11 objectives of healthy cities by examining the relationships between their 99 indicators. Trade-offs between healthy city objectives in some contexts might require local adjustment of these objectives. This, in turn, would require adjustment of their indicators. Thus, the set of 99 indicators can be used as a starting point in an iterative process of adapting healthy city objectives and indicators to local circumstances.

## KEYWORDS

cities, healthy city, indicators, sustainable development, urban design, urban health, urban planning

## 1 | INTRODUCTION

There are several sets of indicators for healthy cities, so why does this study develop another one? The existing sets of indicators are organised in categories of health determinants. So, if these indicators are meant to detect gaps with the objectives of healthy cities and show problem areas, it is unclear what indicators relate to what objectives. As indicators do not flow from objectives, it is also difficult to understand if some indicators are missing, less relevant or more critical. This study aims to develop healthy city indicators that flow from healthy city objectives. It involves a mixed-method study that results in a set of essential indicators. Most of indicators of this

study are either refined from existing indicators or new indicators to match the objectives of healthy cities.

### 1.1 | Healthy city: Context and significance

“A healthy city is one that puts health, social well-being, equity and sustainable development at the centre of local policies, strategies and programmes based on core values of the right to health and well-being, peace, social justice, gender equality, solidarity, social inclusion and sustainable development and guided by

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the principles of health for all, universal health coverage, intersectoral governance for health, health-in-all-policies, community participation, social cohesion and innovation". (WHO, 2020, 4).

Where we live has compound effects on our physical and mental health (Frank et al., 2006): on how much we walk or eat healthy, on the air that we breathe and water that we drink, on our shelter protection and access to health services, and on how much we earn and how many neighbours we know or how tense we feel on the daily journey to work or school (MHCLG, 2020). In cities, the impact of living conditions on health is more salient for most people in our urban century (Gu & Ming, 2021). Many local, national and international initiatives that support public health are now focused on improving urban living conditions.

The World Health Organization (WHO) initiated the 'healthy city' program in 1986 to promote health and wellbeing as guiding principles of urban policy (de Leeuw, 2003). Yet, healthy city is experiencing its second youth in the context of implementing the United Nations' Sustainable Development Goals (SDGs) (WHO, 2020). The healthy city initiative is to celebrate its 40th birthday in 2026. However, due to the ever-increasing pressures on health and health-related developments, the currency and significance of healthy cities are undisputable.

Healthy city is a global initiative led by the WHO. Healthy city initiative has active programs in all regions of WHO (WHO, 2020). The initiative encourages local authorities to adopt evidence-informed health plans to improve social, environmental, economic and physical determinants of health in cities (WHO, 2015a).

The rationale behind the rise of interest in the healthy cities stems from unsustainable urbanisation (WHO, 2020). Namely, cities have to find solutions to a myriad of environmental health impacts (Saxena & Sonwani, 2019), unprecedented number of climate refugees which is a result of climate change and global warming (National Geographic, n.d.), increasing cultural and ethnic diversity of cities (WHO, 2022), homelessness, air pollution (Amato, 2018), obesity and premature deaths (Kirby, 2013), and many others. The World Health Organisation (2016) reported that in 2016 alone, almost a quarter of all deaths globally were attributable to the environment. The pressures endured continue to disproportionately affect communities, with people at the bottom of the socioeconomic ladder being mostly affected (Baah et al., 2019). As such, there are calls for a systematic pursuit of healthy city objectives that help meet social, environmental and economic goals of sustainable development in a practical local framework (Amri, 2022; de Leeuw, 2022).

## 1.2 | Healthy cities help achieve sustainable development

Following the Millennium Summit of the United Nations in 2000, the United Nations announced 8 Millennium Development Goals (MDGs) for the year 2015 (Klopp & Petretta, 2017). They included: (1) no extreme poverty and hunger, (2) universal primary education, (3) gender equality, (4) less maternal and child mortality, (5) better maternal

health, (6) combating diseases, (7) environmental sustainability, and (8) global partnership for development. Public health and improvement of health determinants were reflected in all MDGs, although three goals (MDG4, MDG5, and MDG6) made direct reference to health. However, whilst the success of these health related goals was highly dependent on urban conditions, cities were neglected in the MDGs (Klopp & Petretta, 2017).

In September 2015, the '2030 Agenda for Sustainable Development' was adopted by the United Nations replacing the 8 MDGs with 17 SDGs (Liverman, 2018). The 17 SDGs involve (1) no poverty, (2) zero hunger, (3) good health and well-being, (4) quality education, (5) gender equality, (6) clean water and sanitation, (7) affordable and clean energy, (8) decent work and economic growth, (9) industry, innovation, and infrastructure, (10) reduced inequalities, (11) sustainable cities and communities, (12) responsible consumption and production, (13) climate action, (14) life below water, (15) life on land, (16) peace, justice and strong institutions, (17) partnerships (United Nations, 2015). In SDGs only one goal (SDG3) directly refers to health. However, improvement of environmental health determinants is reflected in all SDGs, including the new stand-alone goal for urban areas: SDG11: Make cities and human settlements inclusive, safe, resilient and sustainable. SDG11 has 10 targets and 15 indicators.

Each SDG has a set of indicators. The indicators were developed by the Inter-Agency and Expert Group on SDG Indicators and agreed upon by the United Nations Statistical Commission in 2017. These indicators assist in monitoring and planning steps towards each SDG. The indicators also enable the examination of the relationships between the SDGs to ensure that they constitute a synergic whole. For instance, a study of relationships between their indicators explored that SDG 3 (good health and well-being) has high amounts of synergies with other goals, including SDG 1 (no poverty), SDG4 (quality education), SDG5 (gender equality), SDG6 (clean water and sanitation), and SDG10 (reduced inequalities) (Pradhan et al., 2017).

Efforts towards building healthy cities support the achievement of the SDGs. Creating equitable, healthier places is central to the common pursuit of both initiatives (Douglas, 2004). Focus on urban health unravels the inextricable nexus between economic factors, social conditions, climate change, and the natural and built environments (WHO, 2020). Healthy city is a mature global urban movement that has been driven by WHO for several decades with clear objectives that are in line with the goals of sustainable development.

## 1.3 | Healthy cities have 11 objectives

Healthy city functions as a comprehensive rubric that gathers a whole range of stakeholders under a set of objectives (de Leeuw et al., 2015). WHO approaches healthy city as the process that creates the possibility of health in people instead of an end state (WHO, 2015b). Meanwhile, in order to help establish a common direction for different sectors, Hancock and Duhl (1988) suggested 11 objectives (or qualities) for a healthy city. These objectives cover a broad scope of human health and the health of multiple urban

**TABLE 1** The 11 Healthy City Objectives (Based on: Hancock and Duhl, 1988, 33)

1 A clean, safe, high quality physical environment (including housing quality)	2 An ecosystem which is stable now and sustainable in the long term
3 A strong, mutually- supportive and non-exploitative community	4 A high degree of participation in and control over the decisions affecting one's life, health and well-being
5 The meeting of basic needs (food, water, shelter, income, safety, work) for all the city's people	6 Access to a wide variety of experiences and resources with the possibility of multiple contacts, interaction and communication
7 A diverse, vital and innovative city economy	8 Encouragement of connectedness with the past, with the cultural and biological heritage and with other groups and individuals
9 A city form that is compatible with and enhances the above parameters and behaviours	10 An optimum level of appropriate public health and sick care services accessible to all
11 High health status (both high positive health status and low disease status)	

systems on which humans depend. The 11 Healthy City Objectives (Table 1) have been adopted by WHO (sometimes as the healthy city checklist) and many healthy city projects globally (de Leeuw, 2003, 2017, 2022). Figure 1 illustrates how actions to address the WHO's 11 Healthy City Objectives help progress towards the United Nation's 17 SDGs.

WHO European Healthy Cities Network is one of the strong WHO regional networks of healthy cities. It works directly with cities in producing City Health Profiles and City Health Plans that are required of all member cities (de Leeuw, 2003; de Leeuw et al., 2014). One of the first steps that healthy cities take is to develop a City Health Profile. It uses a set of indicators to provide a description of the health of citizens and the factors which influence their health. Many sectors work with Healthy City Coordinators to collect, analyse, interpret and present the information (Webster & Lipp, 2009). City Health Profiles provide the evidence base for health planning, including in the form of City Health Plans (O'Neill & Simard, 2006). City Health Plan is a strategy document that is put together with the contribution of many different statutory and non-statutory bodies to address the 11 Healthy City Objectives (WHO, 2015b).

#### 1.4 | Objectives of healthy cities do not have indicators: A gap for research

The need for indicators of healthy cities was clear from the outset of the initiative to produce City Health Profiles (Webster & Sanderson, 2013). Since the early work of WHO (1992) to address

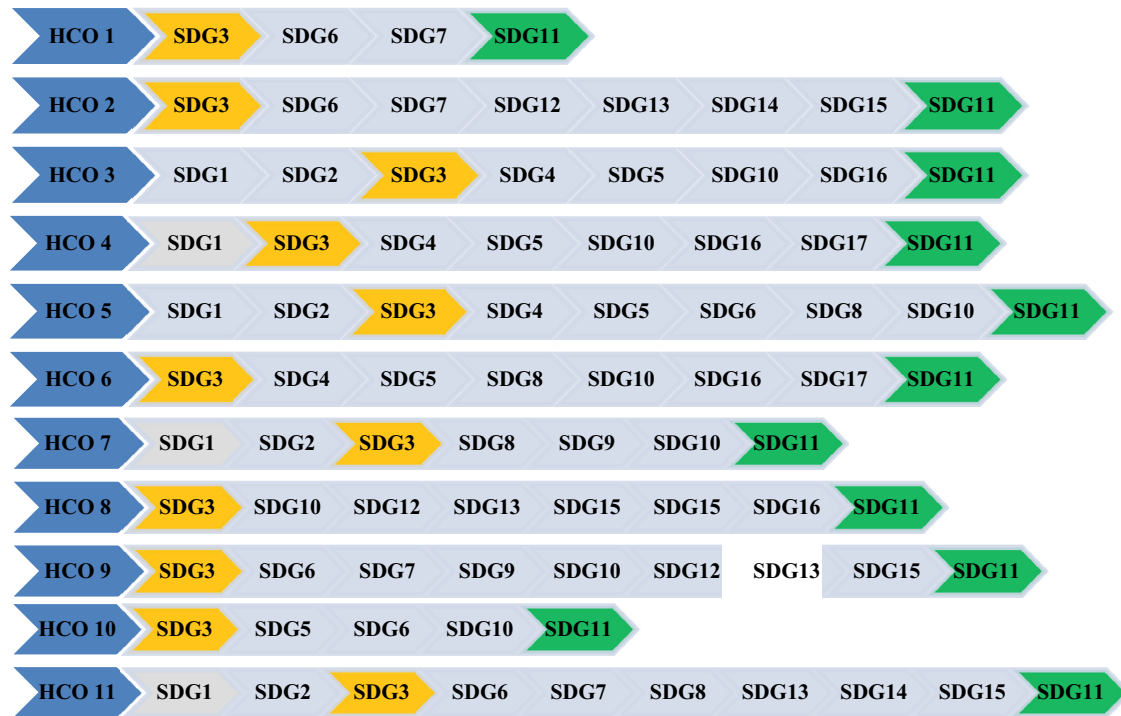
this need, the indicators have been developed in categories of urban health determinants. For instance, Nakamura (2003) presents healthy city indicators in 12 such categories. Pineo et al. (2018) began their study to develop indicators with selecting categories of health determinants in the physical urban environment. Then, they performed an investigation to develop indicators for each category (Pineo et al., 2018). Most recently, Luo et al. (2022) develop their indicators from six categories of urban health determinants. This approach to developing the indicators of healthy cities can support thematic comparison between cities and correlation studies. However, it has limitations in supporting most important uses of healthy city indicators.

Indicators are things that we measure for different purposes like comparing cases, exploring relationships between variables, and raising public awareness (Miller, 2001). Meanwhile, Ruan and Yan (2022, 41) define indicators as “measurable and quantifiable variables that are the building blocks of any objective assessment”. In other words, a main utility of indicators is to show how far we are from our objectives and identify problem areas (Dizdaroglu, 2015). Indicators with this utility, for example in the fields of sustainable development and urban health, should flow from objectives and goals (Steurer & Hametner, 2013). A good example is the indicators of the 17 SDGs. Hiremath et al. (2013) suggest that cities that aspire to become sustainable cities need to work with indicators that are associated with the objectives of sustainable urban development. da Silva Neiva et al. (2021) note that understanding the status quo of urban sustainability requires the use of indicators that are based on the objectives of urban sustainability. This would help identify problem areas for sustainable city planning and design (Hartmuth et al., 2008).

Furthermore, it is possible to explore synergies and trade-offs between objectives by examining the relationships between their indicators (Pradhan et al., 2017). Trade-offs between objectives might require adjustment of objectives which, in turn, would require adjustment of their indicators. The process of setting objectives and developing their indicators is inter-related and iterative (Hilden & Rosenström, 2008). The ability for iterative adaptation of objectives and their indicators to local conditions is missing in the current system of healthy city indicators.

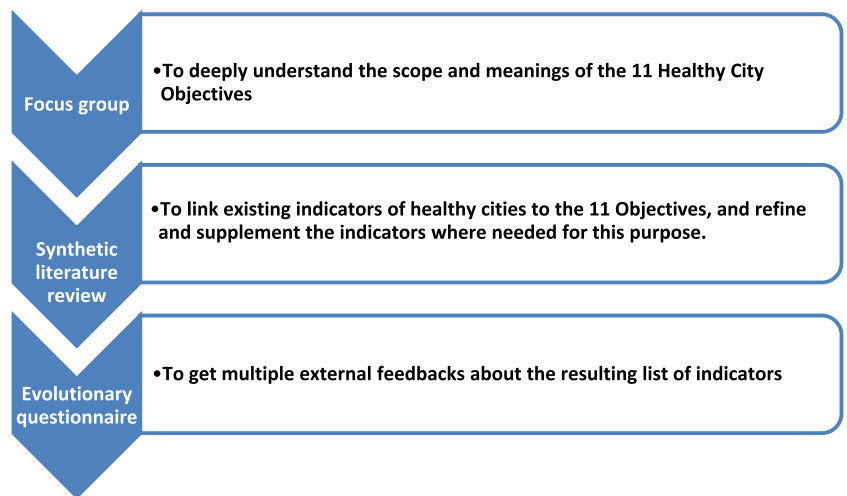
There is an additional reason to develop indicators of healthy cities according to their objectives. Objectives provide the criteria to judge what indicators are more relevant and what indicators can be screened for practical considerations. There are several sets of indicators for healthy cities. Some of them provide as many as 341 indicators that, for example, include ‘percentage of households identifying own family doctors’ (Nakamura, 2003). Whereas a large set of indicators might be helpful in principle, it is challenging in practice. Furthermore, even with a large set of indicators we might miss some important indicators and cover some less relevant ones.

Examining the existing sets of healthy city indicators with the lenses of the 11 Healthy City Objectives reveals that most suitable indicators are almost missing for some of the Objectives. These include Objective 3 (A strong and non-exploitative community), Objective 4 (A high degree of public participation and control),



**FIGURE 1** Actions to address the 11 Healthy City Objectives (HCOs) serve most of the 17 Sustainable Development Goals (SDGs) (Authors)

**FIGURE 2** Research methods applied in sequence in the study (Authors)



Objective 8 (Encouragement of connectedness with the heritage and with other individuals) and Objective 9 (A city form that is compatible with and enhances the other objectives). The list of indicators of a healthy city is endless, but we can optimise this list with the lenses that healthy city objectives provide.

## 2 | RESEARCH METHODS

As Figure 2 demonstrates, this is a multi-method study. The first research method was conducting a focus group interview. A focus group of 4 purposively sampled scholars publishing about healthy

cities in international scientific journals in the last 5 years was convened. The purpose was to solicit their views about the scope and detailed meanings of the 11 Healthy City Objectives that are taken-for-granted in the literature. The focus group provided a solid conceptual framework to synthesise the available indicator sets in the literature.

Table 2 provides an overview of the literature records on healthy city indicators that were included in the synthetic review. The literature synthesis was intended to develop a list of healthy city indicators according to the 11 Healthy City Objectives. The conditions for including literature records in the synthesis comprised the following: (a) they should provide indicator sets of healthy cities; (b) they should

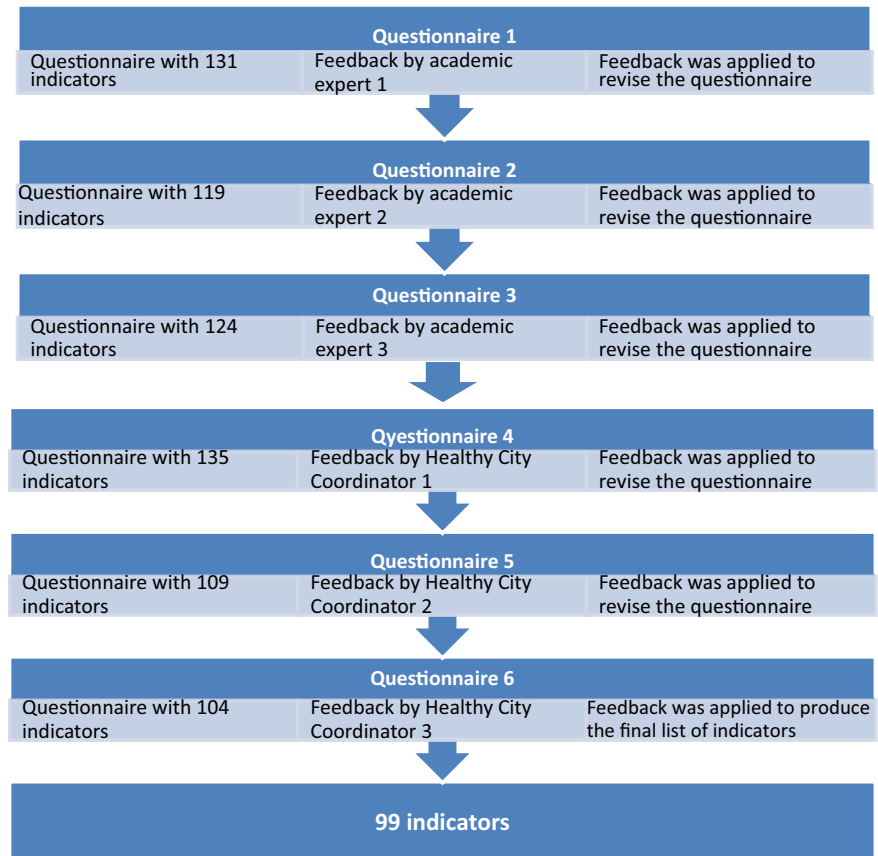
**TABLE 2** Literature records on healthy city indicators included in the synthetic review (Authors)

No.	Author	Study method	Main result
1	WHO (1992)	A feasibility survey in which a questionnaire consisting of tentative indicators was developed by a working group. The questionnaire was sent to 47 Healthy City Coordinators in WHO European Network for collection and submission of data.	53 indicators from four categories of health, health services, environment, and social and economic conditions were developed. The indicators were intended to reflect three global health promotion agreements: the Health For All (60% of the indicators), the Ottawa Charter (20% of the indicators), and the 11 Healthy City Objectives (20% of the indicators).
2	Webster and Price (1996)	Multi-disciplinary group analysis of the 53 indicators of WHO (1992).	A revision of the 53 indicators of WHO (1992) was recommended because: (a) some indicators, like a few indicators that reflected the Ottawa Charter, did not have quantitative data or were not measurable at the city level; (b) some indicators, like several indicators that reflected Health For All, involved different interpretations; and (c) sources of data for indicators were too wide.
3	WHO (1998)	Integrative review of reports and analyses about the 53 indicators of WHO (1992).	32 indicators were developed from the 53 indicators of WHO (1992).
4	National Institute of Public Health (2001)	Expert analysis of the 32 indicators of WHO (1998)	There was enough city level data available in WHO European Healthy Cities Network for 31 out of the 32 indicators of WHO (1998). The one indicator with insufficient data was on the 'percentage of disabled persons employed'.
5	Takano and Nakamura (2001)	Review of Japan's indicator archives	71 indicators from three categories of healthcare, residential environment, and socioeconomic status.
6	Nakamura (2003)	Scoping review	341 comprehensive indicators from 12 categories: population health; urban infrastructure; environmental quality; housing, living environment and sanitation; community action and activities; lifestyles and preventative activities; healthcare, welfare and environmental health services; education and empowerment; employment and industry; income and family living expenses; local economy; and demographics
7	Pineo et al. (2018)	(1) Review of indicators from peer-reviewed literature, (2) filtering indicators based on international data availability, (3) stakeholder workshops to validate remaining indicators	58 indicators from 10 categories of air quality, food access, green infrastructure, housing and buildings, leisure and recreation, noise pollution, resilience, safety and security, transport, utilities and services.
8	Li et al. (2020)	(1) Review of indicators from Chinese government documents, (2) focus group discussions and personal interviews with senior staff of healthy city-related work for suggestions of including/excluding indicators.	5 first-level indicators, 21 second-level indicators, 73 third-level indicators, and 3 characteristic indicators. These indicators are from five categories of environment, society, health services, healthy people, and health behaviours.
9	Giles-Corti et al (2020)	Integrating indicators of SDGs and the New Urban Agenda in desk research	43 indicators from six categories, including urban system policies and government investment, urban and transport planning and design interventions, daily living outcomes, risk exposures, intermediary outcomes, and injury and disease outcomes

TABLE 2 (Continued)

No.	Author	Study method	Main result
10	Luo et al. (2022)	(1) Systematic literature review, (2) a combined questionnaire and interview with relevant professionals to validate the indicators	37 indicators from six categories of urban form and transportation, health-friendly service, environmental quality and governance, community and facility, green and open space, and ecological construction and biodiversity.

FIGURE 3 Administering the six evolutionary questionnaires in the study (Authors)



come from international organisations or peer-reviewed scientific publications; and (c) their research methods should be consistent. The synthetic literature review consisted of two steps: (i) indicators of the literature records were pooled to screen similar indicators in favour of their simplest version; and (ii) from the remaining indicators some were screened (e.g., participation rate to health check-up of lung cancer) because there were alternative indicators for them with more urban policy relevance to the objective concerned – for example, Healthy City Objective 10: An optimum level of appropriate public health and sick care services accessible to all. Some indicators were in their current form assigned to the Healthy City Objectives, and some indicators were refined for this assignment. Ultimately missing indicators for the 11 Healthy City Objectives were generated. This was done by discussion in the multidisciplinary team of researchers informed by insights obtained from the earlier focus group about the scope and detailed meanings of the 11 Objectives.

The synthetic literature review resulted in 131 indicators for the 11 Healthy City Objectives. In the next phase of the study, the list of 131 indicators was put to external evaluation by two groups. They included: (a) academic experts who had participated in the earlier sense-making focus group, and (b) Healthy City Coordinators. From the four academic experts of the focus group three were available for this evaluation. We looked for an equal number of participants from Healthy City Coordinators. The first participant from Healthy City Coordinators was amongst UK-based professional contacts of the authors. The other two—one in Ireland and one in France—joined the exercise by referrals from the first participant with consideration of our preference for national diversity of participants.

The external evaluation of the set of indicators was designed in the form of a table questionnaire. It included the 11 Objectives, their 131 indicators, and columns for suggestions of removing, adding and refining indicators as well as a final column for explanations about

**TABLE 3** Examples of type B indicators (Authors' reflection on the questionnaires)

Original indicator	Refined indicator	Explanation for change
<ul style="list-style-type: none"> <li>Number of health volunteers per population</li> <li>Number of social support volunteers per population</li> <li>Number of environmental health volunteers per population</li> </ul>	% of community volunteers	(i) Diverse volunteering classifications in city databases (e.g., <a href="#">Bristol Quality of Life data dashboard</a> .)
Housing affordability	% of house rents at subsidised price	(i) Clarity; (ii) format consistency with international databases (e.g., <a href="#">OECD Affordable Housing Database</a> )
Kilometres of bicycle paths and lanes per 100,000 population	% of neighbourhoods with bicycle paths and lanes	(i) Neighbourhood planning relevance; (ii) ease of data collection
Number of homeless people per 100,000 population	Number of homeless people per 10,000 population	(i) Clarity: The original indicator is one of <a href="#">ISO37120</a> shelter theme indicators, but the refined indicator helps better understanding of homelessness in cities.
% of roads with sidewalks	Number of streets without sidewalks	(i) Clarity; (ii) ease of data collection
M <sup>2</sup> of public outdoor recreation space per capita	% of urban land allocated to open public space (excluding streets)	(i) International database availability (e.g., <a href="#">UN Habitat Urban Indicators Database</a> )
% of population with disability in moving around outside of houses	% of neighbourhoods with disability-friendly streets	(i) Neighbourhood planning relevance; (ii) clarity; (iii) ease of data collection
Flood exposure rate	% of buildings in flood risk zones	(i) Clarity; (ii) database availability (e.g., <a href="#">London Datastore</a> )

these suggestions. Participants were asked to complete the questionnaire according to the following indicator assessment criteria:

1. Consistency of the indicators of each Objective;
2. A close and practical link of indicators to urban policy recommendations or planning and design;
3. Suitable linking of the indicators to the 11 Objectives;
4. Database availability or relative ease of data collection for the indicators;
5. Clarity of the indicators; and
6. Adequacy of the indicators in relation to the 11 Objectives

The questionnaires were administered one by one with an evolutionary approach. The first completed questionnaire was analysed, and the result of this analysis was applied to revise indicators in the questionnaire that the second participant received to complete. This evolutionary administration of questionnaires continued until the last questionnaire was completed. The last participant (i.e., participant 6) therefore was given a questionnaire containing indicators revised five times on top of previous feedbacks. We termed this questionnaire method of feedback on feedbacks 'evolutionary questionnaire'.

Figure 3 illustrates how the evolutionary administering of the six questionnaires resulted in an ultimate list of 99 indicators. Overall, feedbacks from academic experts had particular focus on refining and supplementing indicators that were marked in the questionnaire as 'new' indicators. These indicators did not come from the literature but were generated by the researchers to address indicator gaps for the 11 Objectives. Feedbacks from Healthy City Coordinators played a main role in reducing and refining the indicators with considerations of database availability and clarity. The sequence of administering the

evolutionary questionnaires that started with academic experts was helpful. This is because Healthy City Coordinators could then feedback on the feedbacks of academic experts from their practical perspective.

There were cases where academic experts removed some indicators, for example about noise levels, because they argued that some other indicators—for example about economic sectors, public transportation, green spaces, and bicycle paths—would act as their data friendly proxy. This attention to causations and systematic relationships in optimising the number of indicators was yet another benefit of basing the indicators on their objectives. The resulting 99 indicators is not a small list when we consider the costs and efforts involved in providing data. However, it is a list of moderate size that covers all the 11 Healthy City Objectives and most of the 17 SDGs.

### 3 | FINDINGS

The 99 indicators that resulted from the evolutionary questionnaires are the set of indicators that this study proposes for healthy cities. Before presenting the set of indicators in this section, we provide a brief explanation about their originality.

#### 3.1 | Originality of the indicators

The list of 99 indicators could be grouped into three types in terms of their relationship with indicators of previous studies. Type A comprises indicators that are identical to indicators developed by previous studies but have been assigned to the 11 Healthy City Objectives in

**TABLE 4** Healthy city indicators (Authors)

Healthy City Objective	Indicator	New
1 A clean, safe, high quality physical environment (including housing quality)	Concentration of PM <sub>2.5</sub> µg/m <sup>3</sup>	
	% of buildings served by waste collection	
	% of buildings with potable water supply	
	% of buildings served by wastewater collection	
	% of buildings in flood risk zones	
	Number of traffic accident injuries per 10,000 population	
	Number of traffic accident deaths per 10,000 population	
	% of crimes against property	
	% of population who feel safe walking alone around the area they live	
	% of nightshift workplaces without car park	
	% of households that consider their house adaptable	
	% of neighbourhoods with public transport stops in their geographical centre	
	Number of streets without sidewalks	
	M <sup>2</sup> of public indoor recreation space per capita	
	% of neighbourhoods that have a park	
	% of neighbourhoods with bicycle paths and lanes	
% of population who live and work in the same neighbourhood		
2 An ecosystem which is stable now and sustainable in the long term	Tonnes per capita of greenhouse gas emissions	
	% of energy derived from renewables	
	% of buildings certified with a sustainability standard	
	Number of green urban areas ≥20 hectares	
	Per capita water consumption	
	% of sewage recycling	
	% of waste recycling	
3 A strong, mutually- supportive and non-exploitative community	% of new housing in brownfield	
	% of households relocating more than once in the last three years	
	% of subsidised housing in middle-class neighbourhoods	
	% of neighbourhoods that have a community centre	
	% of neighbourhoods that have exclusionary zoning	
	% of neighbourhoods with community owned assets	
	% of feeder schools	
	% of neighbourhoods that have a public school	
4 A high degree of public participation in and control over the decisions affecting one's life, health and well-being	% of community volunteers	
	% of neighbourhoods that have a housing cooperative	
	Number of voluntary sector organisations	
	% of public consultations that seek to identify urban problems	
	% of public consultations covering before, during, and after interventions	
	% of public consultations targeting underrepresented groups	
	% of house rents at subsidised price	

(Continues)



TABLE 4 (Continued)

Healthy City Objective	Indicator	New
5 The meeting of basic needs (food, water, shelter, income, safety, work) for all the city's people	% of population living in slums	
	Number of homeless people per 10,000 population	
	% of neighbourhoods with fresh food stores in their central geographical locations	
	% of neighbourhoods that have a community garden	
	% of households living below the national poverty level	
	% of neighbourhoods with cheap eating places	
6 Access to a wide variety of experiences and resources with the possibility of multiple contacts, interaction and communication	Number of regulated places for street vending	
	% of neighbourhoods with disability-friendly streets	
	Average number of land use types per neighbourhood	
	% of neighbourhoods that include day and night activities	
	Number of large city blocks with limited cut across	
	Number of pedestrian-only streets	
	Number of large public spaces inside city	
	Number of complete streets (with all modes of mobility)	
	% of urban land allocated to open public space (excluding streets)	
	% of population experiencing easy wayfinding	
	% of population in access zone of high-speed broadband service	
7 A diverse, vital and innovative city economy	Railway density (km/km <sup>2</sup> )	
	Road density(km/km <sup>2</sup> )	
	Unemployment rate	
	% of population with academic education in science	
	% of formula businesses	
	% of workers in manufacturing industry	
	% of workers in wholesale, retail, and eating establishments	
	% of workers in professional services	
	Number of small construction firms	
	Number of housing units built per year	
	% of population who live and work in the city	
8 Encouragement of connectedness with the past, with the cultural and biological heritage and with other groups and individuals	Number of start-ups and SMEs	
	Number of exporting economic sectors	
	% of heritage sites seen, passed through or utilised in everyday life	
	% of education providers located in buildings with historic design	
	Number of historic buildings demolished per year	
	% of neighbourhoods connected to city centre by one public transport line	
	Number of heritage landmarks	
	% of socially mixed neighbourhoods	
% of neighbourhoods that have nature strips		
% of neighbourhoods connected to urban forest by one public transport line		

TABLE 4 (Continued)

Healthy City Objective	Indicator	New
9 A city form that is compatible with and enhances the above parameters and behaviours	Population density (population per km <sup>2</sup> )	■
	% of attached mid-rise houses	
	% of high-rise buildings with ground level shops and community space	
	Urban form circularity (ratio of urban area to total area of the circle surrounding it)	
	Urban form fragmentation (ratio of fragmented urban area to the total urban area)	
10 An optimum level of appropriate public health and sick care services accessible to all	% of derelict urban area	■
	% of neighbourhoods that have a primary healthcare centre	
	% of primary healthcare centres with service availability in foreign languages	
	Number of medical doctors per 1000 population	
	Number of hospital beds per 1000 population	
	Number of pharmacies per 1000 population	
	% of neighbourhoods in which free digital health checks are installed	
	% of public hospitals in low income and vulnerable areas	
	% of neighbourhoods with disability rehabilitation service	
	% of healthcare centres that also provide virtual healthcare	
11 High health status (both high positive health status and low disease status)	% of population who feel in good health	■
	% of population perceiving stressfulness in daily life	
	Number of cases of food poisoning per 1000 population	
	% of population with obesity	
	% of population with diabetes	
	% of population with respiratory disease	
	% of population with heart disease	

this study. Type B comprises indicators that stem from indicators of previous studies but have been consolidated, differently quantified or otherwise refined to become more policy-relevant, simpler to understand and collect data, and linked to the 11 Objectives. Some examples of these indicators are displayed in Table 3 along with notes reflecting reasons that participants of the questionnaires provided for their refinements. Type C comprises indicators that have originally emerged in this study for the Healthy City Objectives. These indicators are marked as 'new' in Table 4.

### 3.2 | The list of indicators

The 99 indicators are presented for the 11 Healthy City Objectives in Table 4. All the indicators can produce city-level data. However, there are indicators that provide data about the neighbourhoods of city, and there are indicators that can provide data about a single

neighbourhood. The indicators that provide data about the neighbourhoods of city are usually new, with examples like: % of neighbourhoods with public transport stops in their geographical centre, % of neighbourhoods that have a park, % of neighbourhoods that have a public school, % of neighbourhoods with cheap eating places, % of neighbourhoods that have a housing cooperative, and % of neighbourhoods in which free digital health checks are installed. Examples for the indicators that can provide data about a single neighbourhood are: number of streets without sidewalks, % of population who live and work in the same neighbourhood, % of buildings served by wastewater collection, % of community volunteers, % of population with obesity, % of urban land allocated to open public space,  $M^2$  of public indoor recreation space per capita, % of population who feel safe walking alone around the area they live, % of households that consider their house adaptable, % of house rents at subsidised price, and unemployment rate.

With minor changes to their format most of the indicators may be used for a single neighbourhood. Examples are: change 'number of

traffic accident deaths per 10,000 population' to 'number of traffic accident deaths', change '% of neighbourhoods with disability-friendly streets' to '% of disability-friendly streets', change '% of neighbourhoods with cheap eating places' to '% of cheap eating places', change '% of neighbourhoods with bicycle paths and lanes' to '% of roads with bicycle paths and lanes', and change 'average number of land use types per neighbourhood' to 'number of land use types'.

## 4 | CONCLUSIONS

Despite much interest in healthy, sustainable cities, currently they are often on the margins of urban planning and design, not the centre (Forsyth, 2022; Grant et al., 2022). Part of the reason for this is technical. Forsyth (2020) mentions that many planners are interested in designing healthier cities but wonder how to link their objectives with actions. This study developed 99 indicators for a healthy city. The basis for the development of indicators was the 11 objectives of a healthy city according to the World Health Organisation. Application of these indicators helps push healthy city objectives to the centre of urban planning and design in two ways: (I) the indicators can show gap with each objective; and (II) monitoring the indicators over time can show the performance of solutions for each objective.

It is possible to explore synergies and trade-offs between the 11 objectives of healthy cities by examining the relationships between their 99 indicators. Trade-offs between healthy city objectives in some contexts might require local adjustment of these objectives which, in turn, would require adjustment of their indicators. Thus, the set of 99 indicators can be used as a starting point in an iterative process of adapting healthy city objectives and indicators to local circumstances.

Healthy city is a journey that might begin from any point. Healthy city is not just for developed contexts and cities with good resources. Some cities might not be able to provide a range of local level data to steer and monitor their journey to become healthier. The 99 indicators of healthy cities were developed with an inclusive approach to help cities with limited resources to provide essential urban health data. They only cover indicators that are essential according to the 11 objectives of a healthy city. The indicators are simple to provide data. The 99 indicators involve a close and practical link to urban policy recommendations or planning and design.

This study also provides methodological contributions. It provides a solid foundation for future research to develop indicators in connection with objectives and apply multi-methods to identify and evaluate indicators. Furthermore, the evolutionary questionnaire method created and applied for the first time in this study might be useful for researchers in a range of subjects. It is particularly useful when researchers need to solicit the views of different stakeholders in a process that those views refine each other and come to one conclusion.

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