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Resident participation in neighbourhood audit tools — a scoping review

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Background: Healthy urban environments require careful planning and a testing of environmental quality that goes beyond statutory requirements. Moreover, it requires the inclusion of resident views, perceptions and experiences that help deepen the understanding of local (public health) problems. To facilitate this, neighbourhoods should be mapped in a way that is relevant to them. One way to do this is participative neighbourhood auditing. This paper provides an insight into availability and characteristics of participatory neighbourhood audit instruments. **Methods:** A scoping review in scientific and grey literature, consisting of the following steps: literature search, identification and selection of relevant audit instruments, data extraction and data charting (including a work meeting to discuss outputs), reporting. **Results:** In total, 13 participatory instruments were identified. The role of residents in most instruments was as 'data collectors'; only few instruments included residents in other audit activities like problem definition or analysis of data. The instruments identified focus mainly on physical, not social, neighbourhood characteristics. Paper forms containing closed-ended questions or scales were the most often applied registration method. **Conclusions:** The results show that neighbourhood auditing could be improved by including social aspects in the audit tools. They also show that the role of residents in neighbourhood auditing is limited; however, little is known about how their engagement takes place in practice. Developers of new instruments need to balance not only social and physical aspects, but also resident engagement and scientific robustness. Technologies like mobile applications pose new opportunities for participative approaches in neighbourhood auditing.

Introduction

Since more and more people live, work and play in urban areas, the pressure on these areas is going to increase. This has implications for the health of the residents of cities, because their physical and social living environment contains many health relevant factors. A well-facilitated, clean, and safe physical urban environment is a necessary, but not the only requirement for a healthy city. The urban environment also has the potential to enhance or hinder healthy lifestyles and behaviours, e.g. physical exercise, and in this way impact on people's health.[1–3]

More and more (local, national, and international) authorities and various parties work towards a healthy urban environment. These include health promoters, environmental health experts, district community workers and municipal health coordinators. It has become clear that healthy urban environments require careful planning and a testing of environmental quality that goes beyond the requirements of statutory limits. It is also becoming apparent that healthy urban planning requires the inclusion of resident views, perceptions and experiences that help deepen the understanding of local (public health) problems.[4] In short, resident participation is a key factor in the development and application of successful policies in the field of urban environments.

In order to develop and implement plans for a healthy urban environment that link up with the residents' perceptions, it is important that the local situation of neighbourhoods and their populations be mapped in a way that is relevant to them. There are several ways to map neighbourhood characteristics. One option is to collect resident or other stakeholder views by surveys. Another possibility is to derive information about the characteristics of a neighbourhood (such as noise levels, air pollution concentrations, amount of green space, number of people within a certain area) from existing registries of data at neighbourhood level and/or postal code area level that is nationally or locally available. This is usually done by means of a Geographic Information System (GIS). In this paper, we focus on a third method, namely neighbourhood auditing which means obtaining insight into the characteristics of neighbourhoods by systematically visiting and observing them.

The purpose of most audits is to collect information about the neighbourhoods that cannot be derived from secondary data or registries (e.g. the number of trees, the width of sidewalks), in order to get a more complete picture: certain neighbourhood characteristics can only be measured properly by means of direct observations (e.g. the architectural character, maintenance of the landscape, the 'look and feel' of a place.[5,6] It is questionable, however, whether these types of observations reflect what people find important in their neighbourhood when it comes to health and whether they are able to capture related contextual factors that modify, increase or reduce neighbourhood environmental impacts.[7] For example, the mere presence of a cycle path (expert observation) does not necessarily mean people want to use it (resident perspective).[8] Insight in resident experiences and relevant contextual factors requires a 'citizen science' approach in neighbourhood auditing, that is the active participation of lay people in audit design, data collection and/or analysis. Haklay describes different levels of citizen engagement in research.[9] Not only can citizens help collect larger quantities of data or new information, citizen involvement in knowledge generation is also reported to produce knowledge that is more relevant to them.[10] Citizen science also has the potential to educate and empower residents as active people in their living environment.[11] To realize this resident engagement in neighbourhood auditing, tools are needed that facilitate their input and involvement.

Several audit tools have been developed in recent years. Nickelson and colleagues[12] presented 31 neighbourhood audit instruments in a comprehensive overview. They carefully registered the domains and sub-domains that were assessed for each instrument. Although their review might help researchers to select or develop an instrument to meet their own specific needs, it does not provide any information about whether, and how, residents (can) participate in the application of the different tools. With a view to continuing to build further on Nickelson's work, we therefore carried out a scoping review[13] to establish which participative systematic neighbourhood auditing tools exist and how these tools can be characterized. The scoping review method is a suitable approach to study key concepts in different types of publications.[14,15] As we intended to identify participatory tools, described in both existing scientific and grey literature about resident participation for neighbourhood auditing instruments, a scoping review is an appropriate method. Scoping reviews are less useful when the aim is to assess the quality of evidence presented. This study, being descriptive, did not require such assessment.

We are going to use the outcomes of our study as an input for the development of a participatory neighbourhood audit tool to be applied in the Netherlands.[16] New Dutch legislation on urban planning is currently being implemented, in which resident participation is a key element. In order to achieve this, local planners and policy makers need certain tools. Our study objectives were to identify participative audit tools, to describe the different levels of resident participation in these audit tools, to provide an inventory of what these tools measure; and finally, to describe the methods applied in the tools (e.g. paper form containing close-ended questions, photos, or a website).

Methods

Identification of relevant publications

Systematic literature search was carried out to identify publications which:

- *had been published in a (peer reviewed) scientific journal or as grey literature. In this last category we will find reports, websites and conference proceedings AND*
- *describe one or more neighbourhood audit tools, AND*
- *had been published between the first of January 2010 and the first of January 2015, AND*
- *had been published in English or Dutch language.*

Since we intend to develop a Dutch audit instrument, we used search terms in both English and Dutch. By studying several well-known audit instruments,[17–19] we developed a set of search terms (Supplementary appendix table A1a and b).

One researcher (J.D.) searched for scientific studies and published articles in the scientific database Scopus, which provides the largest abstract and citation index for peer-reviewed literature. Scopus was selected because this database includes MedLine and EMBASE and includes not only biomedical disciplines but also, e.g. journals in Health Sciences, Life Sciences, Social Sciences or Humanities. These are important areas in relation to the topic of our review.

Another researcher (A.C.L.H.) simultaneously carried out a systematic search of grey literature in the Google open database. Given that grey literature search often provides many hundreds of hits, we decided to view only the first 20 hits because we assumed that they best matched the search terminology. This assumption was tested by taking samples of hits after the first 20 and we found no relevant titles. Overall, 99 publications were identified.

Selection of relevant instruments

We checked whether the publications described a neighbourhood audit instrument (in some cases the tool described was a different type, e.g. a playground scan and these were excluded) and this yielded 68 instruments.

Next, we checked whether residents were involved in the development of the audit instrument and/or whether residents were involved in the implementation of the audit instrument. If at least one of these criteria was met, the audit tool was classified into the 'resident participation' category. If none of the criteria was met, the publication was classified in the 'no resident participation' category. We applied the rules that interviewing or surveying residents about their neighbourhood was not considered to be participation, while consulting residents about the content of an audit instrument was. When it was not possible to classify a paper, it was classified in the 'unknown' category.

The first researcher (A.C.L.H.) selected all the publications that fulfilled the resident participation criteria and a second researcher (L.d.B.) independently carried out the same procedure for verification. Selections were compared and differences discussed. In the event of disagreement, a third researcher (E.v.K.) was asked to advice. As a result, a list of 13 participative instruments was created (see table 2 under ''Results'' section).

Data extraction

For the 13 participative audit tools described in the selected papers, data extraction was carried out by one researcher (A.C.L.H.). Only characteristics of the 'audit tool' described were extracted from the papers. The following data were extracted about each selected instrument: Author (if available), instrument name, and country of origin.

To answer our research questions we also extracted data on the registration method and type of citizen science approach. Table 1 shows how we determined these aspects. We also extracted the topics, or 'domains' covered by each instrument, as well as more specific matching characteristics, or 'sub-domains' within those domains. An example is the 'amenities for outdoor public spaces' domain with, among other things, characteristics like public restrooms, street furniture and trash bins as matching sub-domains.

We used Nickelson's[12] domain and sub-domain classification and added two new domains, namely 'people and behaviours' (referring to observation and registration of presence of persons in the public space audited and their activities at the moment of observation) and 'local business and economy' (referring to the presence of commercial and public facilities). These domains were added on the basis of our previous research in the Netherlands, where residents helped define necessary elements of a healthy neighbourhood. The (health) behaviour of people in public space, and the availability and accessibility of commercial and public services were considered highly important by these residents.[20] Sub-domains for these two additional domains were developed, based on the information presented by the selected instruments. A meeting was set up (A.C.L.H., L.d.B. and E.v.K.) to discuss data extraction output tables and perform necessary corrections.

Results

Instrument selection

Our literature search yielded a total of 68 audit instruments (excluding 18 cases where there was no description of the instrument or where the original publication could not be retrieved) (figure 1). The majority of these instruments (54) were found in the scientific literature (2 duplicates removed). The remaining 14 instruments (1 duplicate removed) were found in grey literature.

The 68 selected audit instruments were investigated to determine the presence of resident participation in the audit instrument development or implementation. Instruments were divided among the 'resident participation', 'no resident participation' and 'unknown' categories when it was impossible to answer the questions about resident involvement in the instrument development or

Table 1 Data extraction: classifying registration methods and citizen science approach

Classification	Classify when	Do not classify when
Registration methods[12]		
Digital checklist	Digital checklist is main registration method during data collection (e.g. tablet)	Digital checklist only used for data processing after actual audit
Paper checklist	Paper checklist is main registration method during data collection	Paper checklist only used as guidance, but actual data registration carried out in another way
Digital application/tool	Any other digital applications, e.g. camera or audio used as main registration method	These applications only used as accessories during registration
Web site	Web site is used as main registration method, e.g. in case of auditing using street view images	Web site only used for data processing or data presentation
Unknown	Information about method of registration could not be found	Any other method of registration is applied
Citizen science approaches[9]		
Extreme citizen science	Residents involved in problem definition, data collection, analysis and interpretation	Residents involved in parts of these but not all professionals, but not residents, are involved as resident representatives
Participatory science	Residents involved in problem definition and data collection	Residents only involved in one of these professionals, but not residents, are involved as resident representatives
Distributed intelligence	Residents involved as volunteered thinkers and interpreters, providing lay input to the audit	Resident contributions not used for shaping or applying the audit process, not for analysis purposes
Crowd sourcing	Residents involved as informers carrying out data collection	Residents play a passive role, i.e. no active data collection but, e.g. being interviewed

implementation. After exclusion of those instruments that were classified as 'no resident participation' and 'unknown', 13 audit instruments which involved residents in the instrument development or implementation remained. Most of these instruments (9) originated from USA, while two instruments originated from the Netherlands, one from Canada and one from UK. A list of all non-participative instruments (47) and instruments classified in the 'unknown' category (8) with references is available in Supplementary appendix tables A2 and A3.

Instrument characteristics

Characteristics of the 13 selected participative audit instruments are shown in table 2.

A remarkable fact is that the BEAT Neighbourhood Assessment tool[25] and the Sidewalks and Street Survey[32] apparently were the only 2 instruments with resident involvement at the 'extreme citizen science' level. Residents were involved in these instruments during the whole process of problem definition, data collection, data analysis and data interpretation. The BEAT instrument provides a paper checklist with three-point scales for residents or community groups to audit the quality of an area with a special focus on sustainable and active transportation. Each question and the answer categories are explained in understandable, non-'scientific' language. This checklist also provides open questions that guide resident-based analysis as well as follow-up (e.g. the definition of alternatives or actions to take).The Sidewalks and Streets Survey provides a tool kit for organizers (either a professional or a community group) of a walkability audit including a workshop plan, supporting presentations, example invitation letters, and a checklist which can be adapted to the needs of a community. Residents that participate also help analyze the audit results. Four instruments involved residents at the 'participatory science' level in problem definition and data collection. The instrument described by Anderson et al.[22] was the only instrument involving residents at the 'distributed intelligence' level and invited residents to act as basic interpreters and thinkers in their New Hampshire Liveable Walkable Communities Toolkit with residents joining in the designing of 'community goals' as a starting point for the audit. Most instruments (6) involve residents at the citizen science 'crowd sourcing' level where they are involved as informers or data collectors. In the Neighborhood Observational Checklist[21] for example, residents collect data in a prescribed way, supervised by researchers.

Registration methods

Table 2 shows that most audits (11) were conducted with use of a paper checklist which auditors could fill in with a pen or pencil. The tool of Buman et al.[24] consisted of tablet-based data collection of audio narratives and photographs whereas the tool of Zenk et al.[30] consisted of a digital checklist used with handheld computers. The register method of Kleiboer et al.[26] used a different method. Participating residents used a map of their neighbourhood and placed green stickers at spots that they thought were positive spots and red stickers at spots that they thought were negative spots.

Measurement indicators

An overview of all the identified domains and the numbers of subdomains measured by all the instruments included is shown in table 3. The number of domains assessed with the audit tools ranged from 12 to 20.

The most commonly assessed domains were amenities for outdoor public space (10 instruments), landscaping/nature features (10 instruments), recreational uses/public spaces (10 instruments), and sidewalks (10 instruments). The least commonly assessed domains were ethnic identification (1 instrument), neighbourhood identification/legibility (1 instrument), barriers (3 instruments) and steepness (3 instruments). The additional domain local business and economy was assessed by 9 instruments and the 'people and behaviours' domain by 5 instruments.

A top three list of the most measured sub-domains by all included instruments are listed in Supplementary appendix table A4. Domains with the highest numbers of measured sub-domains are classified at the top of the table. The 'amenities for outdoor public space' domain measures comfort features such as street comfort facilities. The 'bus stops/transit stops' sub-domain was measured by 8 instruments, 'playground, sports equipment' by 6 instruments and 'street furniture' by 6 instruments as well. The sub-domain of 'street trees' from the 'landscaping/nature features' domain and the sub-domain of 'sidewalks' from the 'sidewalks' domain were measured by 9 instruments. Only 3 instruments measured the subdomain 'grade/steepness/slope' in the 'steepness' domain. In 3 cases, the domains to be measured depended on the resident input with residents being asked about their assessment of the environment in general terms, without a predetermined list of specific elements or aspects. The Community Asset Mapping Toolkit in particular provides a lot of space for personalized input. It only requires

Table 2 Characteristics of included instruments

Author (if available)	#	Instrument name (if available)	Country of origin[a]	Level of citizen science[b]	Registration method[c]	Domains covered[d]
(Agentschap NL, 2011)[21]	1	Wijkscan zwerfafval [Community litter scan]	1	2	2	1, 2, 6, 7, 8, 10, 12, 13, 15, 18, 21
(Anderson, 2014)[22]	2	New Hampshire Liveable Walkable Communities Toolkit	2	3	2	1, 2, 4, 6, 7, 8, 10, 11, 13, 14, 15, 16, 19, 20, 21, 22
(Brownson et al., 2004)[23]	3	St. Louis Audit Tool—Checklist Version	2	4	2	1, 2, 3, 4, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 19, 21, 22
(Buman et al., 2013)[24]	4	The Stanford Healthy Neighborhood Discovery Tool	2	4	3	*Unknown*
(EcoPlan, 2009)[25]	5	BEAT Neighbourhood Assessment (Built Environment & Active transportation)	3	2	2	1, 2, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22
(Kleiboer and Broens, 2012)[26]	6	Beleef je wijk! [Experience your neighbourhood!]	1	2	5	[e]
(O'Hanlon and Scott, 2010)[27]	7	The Walkability Assessment Tool	2	4	2	1, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, 21
(Robinson et al., 2014)[28]	8	Rural Active Living Assessment tool	2	4	2	1, 3, 4, 6, 7, 8, 11, 13, 14, 15, 16, 19, 21
(Welch et al., 2010)[29]	9	LEED—ND	2	2	2	1, 4, 6, 7, 10, 13, 14, 15, 17, 18, 19, 21
(Zenk et al., 2007)[30]	10	Neighborhood Observational Checklist	2	4	2	1, 2, 5, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 19, 21, 22
(Zoellner et al., 2012)[31]	11	CBPR intervention	2	4	2	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21
(AARP, 2010)[32]	12	Sidewalks and Street Survey	2	1	2	1, 2, 7, 10, 11, 12, 13, 14, 15, 19, 20, 22
(Preston City Council)[33]	13	The Community Mapping Toolkit	4	1	2	[e]

a: 1=The Netherlands, 2=USA, 3=Canada, 4=UK.
b: 1=Extreme citizen science, 2=Participatory science, 3=Distributed intelligence, 4=Crowd sourcing, 5=Unknown.
c: 1=Digital checklist, 2=Paper checklist, 3=Digital application/tool, 4=Website, 5=Other/unknown.
d: 1=Amenities for outdoor public spaces, 2=Architecture/building characteristics, 3=Barriers, 4=Cycling environment, 5=Ethnic identification, 6=Land uses, 7=Landscaping/nature features, 8=Maintenance/appearance, 9=Neighbourhood identification/legibility, 10=Parking and driveways, 11=Pedestrian environment, 12=Physical disorder, 13=Recreational uses/public spaces, 14=Safety, 15=Sidewalks, 16=Signs, 17=Smell/pollution/noise, 18=Steepness, 19=Streets/traffic, 20=Views/enclosure, 21=Local business and economy, 22=People and behaviours.
e: To be determined by participating residents.

residents to look at the broad categories of 'individual, community and institutional assets' and provide their personal assessments of these.[22] Only 1 instrument measured the sub-domain of 'neighbourhood monuments/markers/banners' in the domain of 'neighbourhood identification/legibility'. In addition, only 1 instrument measured the 9 sub-domains in the 'ethnic identification' domain. These sub-domains included measurements comprising businesses with diverse ethnic orientation (African American, Latinos, African, Caribbean, Mexican, Cuban and Spanish), matching signs, symbols, advertisement, symbols and murals. A total overview of all domains and corresponding sub-domains is shown in Supplementary appendix table A5.

Discussion

Main results

In total, we identified 68 audit tools. In 13 cases, residents were involved in auditing. In 6 of the 13 cases, residents were involved by carrying out data collection. In only 2 cases, citizens were involved in problem definition, data collection, and analysis and interpretation of the data that were collected.

Within the 13 instruments that involved citizens, we identified 22 different domains and more than 150 sub-domains. In addition to Nickelson,[12] we extended the number of domains with one domain involving 'business and economy', and another domain concerning 'people and behaviour'. Within the list of domains and sub-domains, the focus is mostly on the physical characteristics of the neighbourhood.

Most of the 13 instruments were paper forms, usually containing close-ended questions or scales. There was only one digital tool available. The Stanford Healthy Neighborhood Discovery Tool is suitable for tablets.

The engagement of citizens

Although the developers of several of the evaluated tools claim the instrument involves residents, we judged that only two tools really engaged them at all the different stages. Although we studied the available information and discussed how each instrument should be classified in terms of resident involvement, the exact determination of the type of resident involvement was difficult for a number of instruments, as the information was often unspecific or could be interpreted in different ways. It would therefore be worthwhile to study how resident involvement takes place in practice, e.g. by an in-depth evaluation of these instruments' local application.

It is possible that we may have missed some other, more participatory, tools for two reasons. Firstly, our grey literature search was restricted to the first 20 hits. However, testing the assumption that after 20 hits no relevant publications came up, we found no indication that we missed important tools. Secondly, resident-centred audit instruments may be developed and used at a very local level. We wonder whether these instruments will always be presented on the web, let alone in a scientific journal. Both Dutch tools were found by searching the web and many more, in other languages, may be available that we are not aware of due to the language criterion we applied. We also suspect that some tools might not even be retrievable using multi-language web searches.

Although we cannot be completely certain that we have found all relevant tools, we do think, given to overall outcomes, that our conclusions are probably justified.

Physical and social aspects combined

The strong focus on the physical characteristics of the neighbourhood that we found is similar to what Nickelson et al.[12] and other researchers[5,6,34] found in their overviews about audit tools. Although social neighbourhood characteristics were, to some extent, also included in the evaluated audit tools, the way this was done was

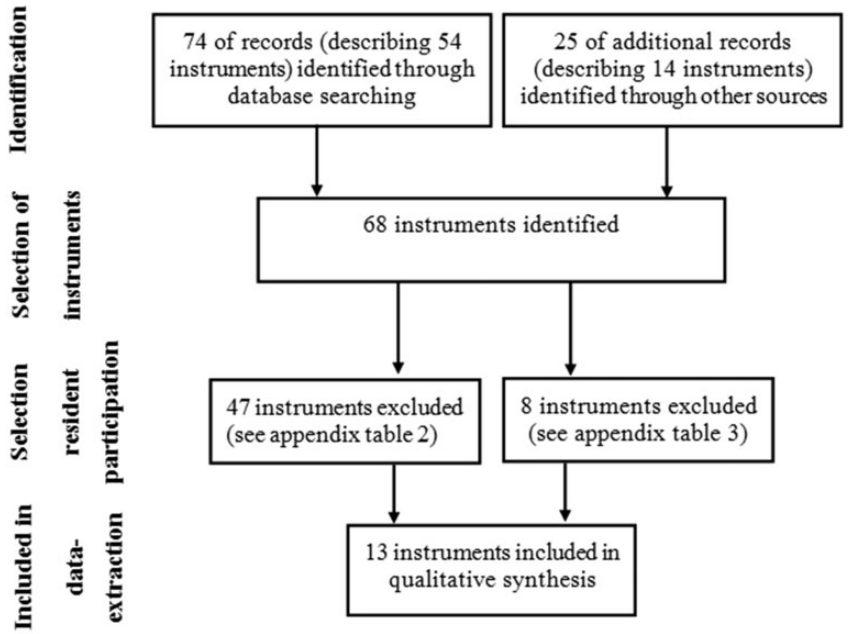

Figure 1 Flow chart data extraction

Table 3 Identified domains, numbers of sub-domains in each domain (more extensive information in table A4)

Domain	Number of sub-domains	Study number of neighbourhood audit instruments (see table 2)													*N* (%)[b]
		1	2	3	4[a]	5[a]	6	7	8	9	10	11	12	13[a]	
Amenities for outdoor public space	**16**	1	1	12	–	–	2	2	1	3	9	8	5	–	10 (76.9)
Landscaping/nature features	**17**	4	3	10	–	–	3	8	8	5	10	4	4	–	10 (76.9)
Recreational uses/public spaces	**3**	13	1	6	8	–	2	11	3	3	9	2	1	–	10 (76.9)
Sidewalks	**24**	1	4	4	–	–	13	6	2	5	13	9	13	–	10 (76.9)
Land uses	**14**	3	4	3	–	–	2	7	3	7	1	8	0	–	9 (69.2)
Parking and driveways	**12**	1	2	3	–	–	1	0	2	1	6	4	2	–	9 (69.2)
Safety	**25**	0	1	6	–	–	2	2	2	13	3	2	3	–	9 (69.2)
Streets/traffic	**36**	0	2	12	–	–	10	11	2	8	16	14	13	–	9 (69.2)
Local business and economy	**6**	2	2	2	–	–	2	2	4	2	2	2	0	–	9 (69.2)
Architecture/building characteristics	**20**	3	1	2	–	–	0	0	0	2	1	2	1	–	7 (53.8)
Cycling environment	**11**	0	3	4	–	–	3	3	3	0	5	8	0	–	7 (53.8)
Maintenance/appearance	**13**	8	2	0	–	–	2	1	0	7	4	1	0	–	7 (53.8)
Pedestrian environment	**17**	0	3	5	–	–	16	7	0	0	10	12	17	–	7 (53.8)
Physical disorder	**23**	4	0	12	–	–	2	0	0	12	4	2	7	–	7 (53.8)
Signs	**21**	0	2	11	–	–	0	1	0	9	1	1	0	–	6 (46.2)
People and behaviours	**13**	0	2	7	–	–	0	0	0	9	0	2	2	–	5 (69.2)
Smell/noise/pollution	**3**	0	0	3	–	–	0	0	1	3	2	0	0	–	4 (30.8)
Views/enclosure	**4**	0	2	0	–	–	0	0	0	0	2	2	2	–	4 (30.8)
Barriers	**10**	0	0	5	–	–	0	2	0	0	1	0	0	–	3 (23.1)
Steepness	**1**	1	0	0	–	–	0	0	1	0	1	0	0	–	3 (23.1)
Ethnic identification	**9**	0	0	0	–	–	0	0	0	9	0	0	0	–	1 (7.69)
Neighbourhood identification/legibility	**2**	0	0	0	–	–	0	0	0	0	1	0	0	–	1 (7.69)
Number of assessed domains		**12**	**16**	**17**	**–**	**–**	**13**	**13**	**12**	**17**	**20**	**17**	**12**	**–**	

a: To be determined by participating residents.
b: Total number (%) of instruments assessing domain.

highly variable. In addition, it seems that physical characteristics were often used as proxy for the resident behaviours and the social infrastructure in a community (e.g. condition of public recreational spaces and buildings, litter, vandalism). This implies an important pitfall in that these proxies might not capture the behaviour of the residents that actually live in the neighbourhood/community or street that is audited, nor the social quality of the area. Although not specifically included in our review because, strictly spoken, they do not fit in the definition of 'neighbourhood' audit instruments, we are aware of instruments that specifically register behaviour of people in specific types of public places, e.g. parks, playgrounds or school environments.[35–39] These tools involve the use of momentary time sampling techniques in which systematic periodic scans of individuals and contextual factors are made within predetermined target areas. These instruments may provide interesting approaches that could be included in participative

neighbourhood audit tools. After all, residents may be at least as interested in the social quality of their living environment as in physical aspects. The challenge is how to combine momentary measurements of targeted areas within a neighbourhood, for which a lot of observations are needed, with the measurement of more general physical features of neighbourhoods.

New directions in neighbourhood auditing

For future development of neighbourhood audit instruments two aspects are important. Firstly, the aim of the instruments has to be clear. The main reason for the observed diversity of domains and sub-domains included in the evaluated audit tools and audit tools in general might be that the aims of the different tools differ from each other. As Nickelson[12] stated, audit tools have been developed to meet the particular needs of different stakeholders, namely researchers, local authorities, local health workers, and sometimes citizens. An important question to consider then is whether the aim is to acquire knowledge for science and policy or to gather information on how the local population perceives their community and the opportunities and barriers for health within their community. These aims may be compatible, but it is a matter of give and take. The application of scientific indicators and a strong focus on inter-rater reliability may be useful for research purposes, but may not appeal to residents as it provides little space for their views and concerns. A resident-based way of auditing may help include individual or collective subjective assessments, but these are difficult to handle for scientists, in particular for those with a background in quantitative disciplines like environmental epidemiology. Moreover, researchers may tend to build on approaches that are common in their specific work field and that are considered 'good practice'. Including subjective elements may not fit into the mainstream paradigm of neighbourhood auditing.

Secondly, it is important to explore on new possibilities based on modern technologies. The strong focus on paper-and-pencil tools surprised us although it is understandable from a 'historical' point of view since an assessment of the instruments makes it clear that a lot of audit instruments are developed on the basis of earlier versions. However, new technologies like mobile applications have now become available, that could potentially support broader resident engagement, and more extensive participatory data collection. People can, e.g. turn their smartphone into an environmental monitoring sensor by means of an app.[40] Neighbourhood auditing instruments based on these new technologies need to be carefully developed in order to be both attractive to residents and useful for researchers.

Key points

- *'Participative' audit instruments mainly involve residents as data collectors*
- *These instruments focus mainly on physical, not social, characteristics*
- *New technologies are uncommon in participative neighbourhood auditing (but could be useful for public health research)*

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Supplementary data

Supplementary data are available at *EURPUB* online.

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References

1 Ferdinand AO, Sen B, Rahurkar S, et al. The relationship between built environments and physical activity: a systematic review. *Am J Public Health* 2012;102:e7–13.

2 Van Holle V, Deforche B, Van Cauwenberg J, et al. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *BMC Public Health* 2012;12:807.

3 Wendel-Vos W, Droomers M, Kremers S, et al. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425–40.

4 Vaandrager L, Wagemakers A, Saan H. Evidence in gezondheidsbevordering (Evidence in health promotion). *TSG Tijdschrift voor Gezondheidswetenschappen* 2010;88:271–7.

5 Brownson RC, Hoehner CM, Day K, et al. Measuring the built environment for physical activity: state of the science. *Am J Prev Med* 2009;36(4 Suppl):S99–123 e12.

6 Schaefer-McDaniel N, Caughy MO, O'Campo P, Gearey W. Examining methodological details of neighbourhood observations and the relationship to health: a literature review. *Soc Sci Med* 2010;70:277–92.

7 Macintyre S, Ellaway A, Cummins S. Place effects on health: how can we conceptualise, operationalise and measure them?. *Soc Sci Med* 2002;55:125–39.

8 Handy SL, Xing Y, Buehler TJ. Factors associated with bicycle ownership and use: a study of six small U.S. cities. *Transportation* 2010;37:967–85.

9 Haklay M. Citizen science and volunteered geographic information – overview and typology of participation. In: Sui D, Elwood S, Goodchild M, editors. *Volunteered Geographic Information, Public Participation, and Crowdsourced Production of Geographic Knowledge*. Berlin: Springer, 2012: 105–22.

10 Minkler M. Using participatory action research to build healthy communities. *Public Health Rep* 2000;115:191–7.

11 Bonney R, Cooper C, Dickinson J, et al. Citizen Science: a developing tool for expanding science knowledge and scientific literacy. *BioScience* 2009;59:977–84.

12 Nickelson J, Wang AR, Mitchell QP, et al. Inventory of the physical environment domains and subdomains measured by neighborhood audit tools: a systematic literature review. *J Environ Psychol* 2013;36:179–89.

13 Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8:19–32.

14 Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci* 2010;5:1–9.

15 Mays N, Roberts E. *Synthesising Research Evidence. Studying the Organisation and Delivery of Health Services: Research Methods* London: Routledge, 2001.

16 Cila N, Jansen G, Groen M, Meys W, Broeder L, Kr B, et al. Look! A healthy neighborhood: means to motivate participants in using an app for monitoring community health. Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems. Santa Clara, California: ACM, 2016; 889–98.

17 Pikora TJ, Bull FCL, Jamrozik K, et al. Developing a reliable audit instrument to measure the physical environment for physical activity. *Am J Prevent Med* 2002;23:187–94.

18 Cunningham GO, Michael YL, Farquhar SA, Lapidus J. Developing a reliable senior walking environmental assessment tool. *Am J Prevent Med* 2005;29:215–7.

19 Clifton KJ, Livi Smith AD, Rodriguez D. The development and testing of an audit for the pedestrian environment. *Landscape Urban Plann* 2007;80:95–110.

20 den Broeder JM, Pilon A, Van de Weerd A. *Gezondheid verbindt! Evaluatie van het project Gezond Slotermeer [Health Connects! Evaluation of the Project Healthy Slotermeer]*. Bilthoven: RIVM, 2015.

21 Agentschap NL. Handleiding wijkscan zwerfafval. *De wijk in beeld in 5 stappen [Guideline Neighbourhood Scan for Litter. Assessing the Neighbourhood in 5 Steps]*. Utrecht: Agentschap NL, 2011.

22 Anderson MJ. *New Hampshire Livable Walkable Communities Toolkit*. Manchester, NH: Southern New Hampshire Planning Commission, 2014.

23 Brownson RC, Hoehner CM, Brennan LK, et al. Reliability of 2 instrumentsfor auditing the environmentfor physical activity. *J Phys Activ Health* 2004;1:191–208.

24 Buman MP, Winter SJ, Sheats JL, et al. The Stanford Healthy Neighborhood Discovery Tool: a computerized tool to assess active living environments. *Am J Prev Med* 2013;44:e41–7.

25 EcoPlan. *The Built Environment and Active Transportation (BEAT). Neighborhood Assessment. Planning Communities for Active Living.* Vancouver: EcoPlan, 2009. Available at: http://www.physicalactivitystrategy.ca/pdfs/BEAT/B.E.A.T. Neighbourhood_Assessment.pdf.

26 Kleiboer E, Broens M. *Beleef je Wijk! [Experience Your Neighbourhood!]*. Eindhoven: Sportservice Noord-Brabant, 2012.

27 O'Hanlon J, Scott J. *Healthy Communities: The Walkability Assessment Tool*. Newark: Institute for Public Administration, University of Delaware, 2010.

28 Robinson JC, Carson TL, Johnson ER, et al. Assessing environmental support for better health: active living opportunity audits in rural communities in the southern United States. *Prev Med* 2014;66:28–33.

29 Welch A, Benfield K, Raimi M. *A Citizen's Guide to LEED for Neighborhood Development: How to Tell if Development is Smart and Green.* New York: Natural Resources Defense Council, 2010. Available at: https://www.nrdc.org/sites/default/files/citizens_guide_LEED-ND.pdf.

30 Zenk SN, Schulz AJ, Mentz G, et al. Inter-rater and test–retest reliability: methods and results for the neighborhood observational checklist. *Health Place* 2007;13:452–65.

31 Zoellner J, Hill JL, Zynda K, et al. Environmental perceptions and objective walking trail audits inform a community-based participatory research walking intervention. *Int J Behav Nutr Phys Act* 2012;9:6.

32 AARP. *Sidewalks and Streets Survey*. Washington: AARP, 2010.

33 Preston City Council. *The Community Mapping Toolkit*. Preston: Preston City Council, 2011. Available at: http://www.preston.gov.uk/yourservices/neighbourhoods-and-community/community-mapping-toolkit/

34 Day K. *Audit Tools for Research on Built Environment Features Tied to Active Living*. Irvine: University of California, 2007.

35 McKenzie TL. *SOPLAY: System for Observing Play and Leisure Activity in Youth. Description and Procedures Manual*. San Diego: San Diego States University, 2006.

36 McKenzie TL, Cohen DA. *SOPARC: System for Observing Play and Recreation in Communities. Description and Procedures Manual*. San Diego: San Diego State University, 2006.

37 McKenzie TL, Marshall SJ, Sallis JF, Conway TL. Leisure-time physical activity in school environments: an observational study using SOPLAY. *Prevent Med* 2000;30:70–7.

38 Sasidharan V, McKenzie TL, Chavez DJ. *SOPARNA: System for Observing Physical Activity and Recreation in Natural Areas. Description and Manual Procedures*. San Diego: San Diego State University, 2014.

39 Van den Berg F. *Instrumenten voor de beoordeling van de gemeentelijke groene/speelplekken [Tools to Assess Municipal Green Spaces/Playgrounds]*. Amsterdam: GGD Amsterdam, 2014.

40 D'Hondt E, Stevens M, Jacobs A. Participatory noise mapping works! An evaluation of participatory sensing as an alternative to standard techniques for environmental monitoring. *Pervasive Mobile Comput* 2013;9:681–94.