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Review Article

A scoping review of public building accessibility

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ABSTRACT

Background: The built environment needs to be designed so that all people can participate in the activities they want and need to do. Yet, accessibility is difficult to put into practice, and accessibility issues tend to be overlooked in the building and planning processes.
Objectives: The aim of this scoping review was to summarize the research front in the area of accessibility to public buildings. Specific aims were to identify knowledge gaps, to identify access activities in relation to environmental features and to link to predominant activities in terms of the International Classification of Functioning, Disability and Health (ICF).
Methods: A literature search was performed in PubMed, PsycINFO, Inspec, Embase and Cochrane databases. Articles in English based on original empirical studies investigating accessibility of public buildings for adults aged ≥18 years with functional limitations were considered.
Results: Of the 40 articles included, ten involved study participants, while 30 only examined buildings using instruments to assess accessibility. In addition, the psychometric properties were only tested for a few of them. All articles concerned mobility and several visual limitations, while few addressed cognitive or hearing limitations. Ten main access activities were identified, from using parking/drop-off area to exiting building.
Conclusions: By using the ICF and theoretically relating the accessibility problems to activities, the results revealed that there are large knowledge gaps about accessibility to public buildings for older people and people with functional limitations and that there is a need for more methodological considerations in this area of research.

Accessibility to the built environment has a major impact on citizens' possibilities to participate; that is, the design of the environment either supports or restricts people in the performance of activities they want or need.[1,2] However, the environmental features that cause accessibility issues may differ depending on which functional limitations a person has. For example, environmental features such as steps and stairs are barriers for people using a wheelchair,[3] whereas this is usually not the case for people with hearing impairments. In contrast, people with hearing impairments experience other features of the environment as barriers, such as lack of visual information when only auditory information is available.[4] In other words, accessibility is relative and defined in the literature as the relationship between the person's functional capacity and the demands of the physical environment.[5]

People's functional capacity might vary during the course of life and normally declines with age, when functional limitations become more common.[6] Functional limitations signify restrictions in the capacity to perform fundamental physical and mental actions used in daily life and indicate a reduction in overall abilities of body and mind to perform purposeful tasks. Another concept to describe reduced functional capacity is impairment, notably used by the International Classification of Functioning, Disability and Health (ICF).[7] According to the ICF, impairments are problems in body function or structure such as a significant deviation or loss. On the one hand, functional limitations are more complex and more analytically applicable than impairments. On the other hand, the ICF provides a taxonomy of body functions, activities and participation that can be used to better understand complex

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person-environment relationships.[8] For example, in a study by Slaug, Schilling, Iwarsson and Carlsson (2015),[9] the ICF constituted a platform for the development of a typology, which highlights how relations between aspects of functioning and physical environmental barriers generate typical accessibility problems.

Countries have their own legislation to ensure accessibility for people with functional limitations, e.g. the Swedish Building Act and the Americans with Disabilities Act (ADA).[10,11] Yet, accessibility is difficult to put into practice, and accessibility issues tend to be overlooked in the building and planning processes.[12] Moreover, professionals struggle with how to practically deal with the complexity associated with the design of an accessible environment.[13] As in the examples mentioned earlier, even one environmental feature (e.g. lack of a ramp, visual information, or hearing loops) is sometimes enough to limit a person's activity.[3] To achieve the goal of an activity may also involve a series of tasks, where each step is important. In a recent paper activities to evacuate from a building were identified and classified within different phases with specific egress accessibility issues (locating exit signs, finding exit pathways, using exit doors, etc.) at each phase, providing a temporal dimension to the issues under study.[14] Correspondingly, activities related to access of services could be identified in a time-framed manner, from a starting point such as using a route from the entrance to the finishing point of exiting the building, to better understand the context and significance of different issues.

In the literature, participation restrictions due to inaccessible environments are reported in public buildings as well as in outdoor environments and transport.[15,16] In a narrow sense, the physical environment might hinder a person from entering a building, but inaccessibility can also have more far-reaching and profound consequences and cause social exclusion, isolation or less physical activity than recommended.[15,17] Accessibility issues of different kinds may thereby affect individuals' health and well-being.[18,19] Public buildings, i.e. facilities that the public has access to,[10] should be possible to visit by people with different functional capacities. Usually when accessibility issues are investigated, the main focus is on independent access without considering assistance (e.g., in a nursing home[20]). Therefore, we will also focus on access without assistance. There is a societal responsibility to ensure access for all, which means that extra low environmental demands are required for visitors in these buildings, compared to private buildings that are not open for the public. Hence, to achieve a more sustainable development for all citizens as outlined by the United Nations,[21] accessibility issues related to public buildings need to be vigorously addressed. A number of initiatives to assess accessibility in public buildings have been taken by researchers with a focus on the issues associated with different functional limitations or types of facilities, e.g. fitness and recreational sport centers,[22–24] public buildings[25] and restaurants.[26] Despite these efforts, there is still no gold standard to assess or address accessibility issues. The overarching aim of this review was to summarize the research front in the area of accessibility to public buildings for adults with functional limitations. Specific aims included: 1) to identify access activities in relation to environmental features of public buildings, 2) to link access activities with functional limitations and predominant activities in terms of the ICF, 3) to identify knowledge gaps with regard to accessibility issues across access activities in different public buildings.

Methods

A scoping review was conducted by an interdisciplinary research group (epidemiology, fire engineering, occupational therapy, public health and psychology) in the area of accessibility to public buildings. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines,[27] served as a guide through the process.

Literature search

Identification: The literature search was performed in PubMed, PsycINFO, Inspec, Embase and Cochrane databases by a librarian along with two of the authors (LN and GG) on March 25, 2019. The search terms included *built environment*, *disability* or *older age*, and *accessibility*; based on the thesaurus used by each of the databases, similar terms with some slight differences were also included. The details of the search strategies for each of the databases are reported in Appendix 1. During the search, four review articles were identified that were screened for eligible studies.[2,22,25,28]

Eligibility criteria

Articles were included in this review if they were based on original empirical studies on accessibility, were relevant to or conducted with adults aged ≥18 years with functional limitations, were written in English and investigated the physical environment of public buildings. As public buildings we considered buildings that are open for the public, not targeting a specific group (such as students) and where people usually are expected to access services without assistance. Articles were therefore excluded if they focused on residential facilities, nursing homes, hospitals, or schools. Articles were also excluded if they were policy documents, reviews, expert opinions, commentaries, conference abstracts, or theses.

Article selection

Screening: Two of the authors (LN and GG) independently screened the titles and/or abstracts of the original articles and the reference lists of the four reviews for eligible studies, as defined above; duplicates were removed. Upon disagreement, the two reviewers discussed the titles and/or abstracts, and upon remaining disagreement or doubt, they examined the full text. Eligibility: After finalizing the list of potentially eligible articles from the original search and the reviews, two of the authors (LN, GG) screened the full texts for eligibility. Articles with no full text, not relevant according to eligibility, or no data on accessibility features, were excluded. Included: LN extracted the data from the eligible articles. Two other authors (GC and BS) validated the extracted data and harmonized the terminology together with a co-author (SS) who is a native English speaker. See Fig. 1 for an overview of the article selection.

Data extraction and synthesis procedure

The data extracted included the first author, publication year, study design, data collection method, instrument used, data source, geographic location of the study, type and number of public buildings, number of study participants, their age, type of functional limitations considered (i.e., mobility, vision, hearing, cognition) and environmental features addressed. For articles primarily investigating buildings, information about the functional limitations considered was extracted to the extent it was clearly described. That is, as compliance of the building design to requirements defined by the instrument at use (such as certain design of doors, pathways, stairs, etc.), considering the needs of individuals with specific functional limitations. For instance, if the instrument at use included a requirement of visual contrasts on stair treads, we interpreted it as visual limitations were considered. A procedure including several steps was adopted to present the extracted data and reveal potential knowledge gaps (see Fig. 2). The

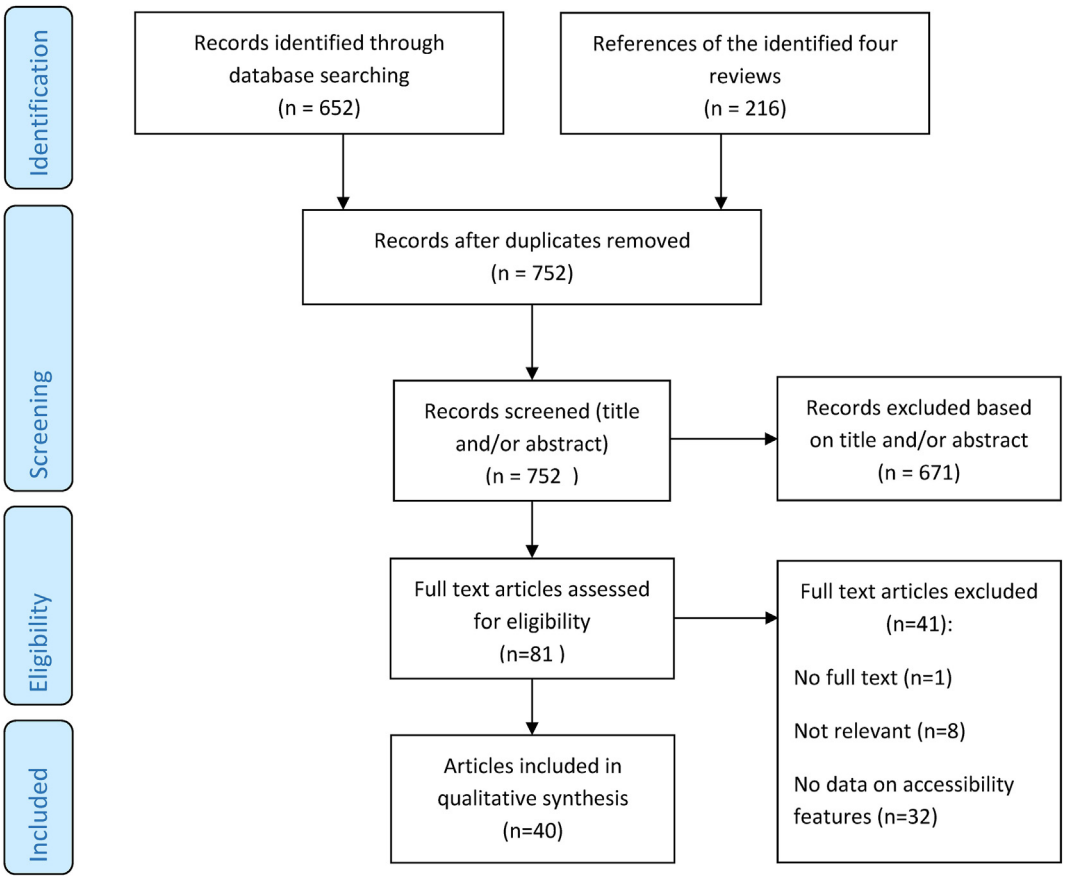

Fig. 1. PRISMA flow chart of the selection of included articles.

environmental features were assigned and sorted into access activities (e.g., parking/drop off area, route to entrance), to provide information about the environmental context where accessibility issues were found and place them within a chain of activities performed when accessing a service. Thereafter, the extracted environmental features and functional limitations of interest were linked to the activity implied—in terms of ICF—by two of the authors (BS and GC). In case more than one activity was implied, the predominant activity was identified. For instance, using stairs implies both walking and changing body position, but walking can be considered the predominant activity. The ICF level of block was used, which is the level beneath chapter. For example, *Walking and*

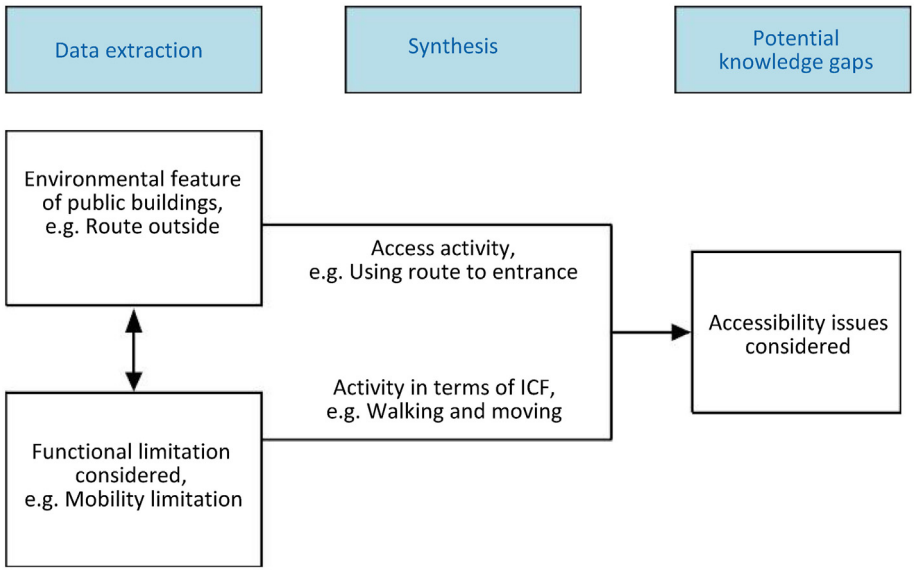

Fig. 2. Flow chart of the data extraction and synthesis procedure. ICF: The International Classification of Functioning, Disability and Health.[9]

moving and *Changing and maintaining body position* are blocks of activities, and both are in the ICF chapter on Mobility. During the process, all authors had recurrent meetings to discuss upcoming issues and to reach consensus on the extraction and synthesis of data.

The data were extracted and managed in a spreadsheet format. The characteristics of the included articles were presented with descriptive statistics, using the SAS software (SAS Institute Inc., Cary, North Carolina, USA) version 9.4.

Results

The database search resulted in 652 peer-reviewed articles, with an additional 216 references from four potentially relevant review articles, resulting in 868 records. Duplicates were removed, and then 752 articles were screened. After excluding 671 articles based on title and/or abstract, the full text screening excluded one article due to the absence of full text, eight articles lacking relevant information and 32 articles without data on accessibility components. This resulted in a selection of 40 original articles for the analysis, published between 1980 and 2018 (see Table 1[29–31,4,32–48,26,49–57,24,58–65]).

The focus of the articles

In 14 of the included articles, the type of public buildings were unspecified; seven articles focused on fitness facilities; and six articles focused on health provider facilities (health care centers, dental care facilities etc.). Two thirds (n = 2988) of the total of 4518 buildings studied were health provider facilities. For further details, see Table 2.

Thirty articles examined buildings using only instruments/checklists to assess accessibility, while the remaining ten involved study participants (Table 3). All of the 40 articles concerned mobility and 14 of them also addressed visual limitations, while few addressed cognitive or hearing limitations. Consequently, all of the ten articles with study participants also focused on mobility limitations. Additionally, three of them addressed visual limitations, one hearing limitations and one cognitive limitations. Four were from North America, two from South America, three from Asia and one from Europe. Taken together, there were 794 participants, and based on the available data from seven of these articles, the participants were mainly in the age range of 16–64 years.

Instruments used

A mix of instruments was used to assess accessibility issues (see Table 1). In six of the articles, an instrument originally focusing on food store accessibility was used,[26] but in some instances, modified versions of the same instrument were employed for other types of facilities. Moreover, the Assessment of Physical Fitness Facilities developed by Figoni and colleagues (1998)[39] was essentially based on the McClain and Todd instrument. The Assessment of Physical Fitness Facilities was also used in a study by Cardinal and Spaziani (2003)[33] and later by Dolbow and Figoni (2015)[35] with some further additions. Three articles[24,32,58] utilized the Accessibility Instruments Measuring Fitness and Recreation Environments (AIMFREE) developed by Rimmer, Riley, Wang and Rauworth (2004).[24] These instruments all referred to guidelines of the Americans with Disabilities Act (ADA)[11] at the time and reported psychometric testing. AIMFREE is the one that has undergone most tests such as unidimensionality of constructs, which showed adequate to good fit to the Rasch model, internal consistency (0.70–0.90), test-retest reliability (0.70–0.97)[24] and inter-rater reliability (0.83–0.92).[58] Another eleven articles reported studies where data was collected with instruments that in some way were based on the ADA or on recommendations from the American National Standards Institute before ADA was launched.

Furthermore, 15 articles referred to study specific checklists, and 12 of them did not refer to any country-specific regulation. Accessibility issues were also assessed by means of the Mobility Device User Work Survey in one article.[41] Finally, guided walks developed by Dischinger (2000)[66] were used in one article.[4]

Access activities and environmental features

Ten main access activities were identified among the accessibility issues described. They were: *Using parking/drop-off area, Using route to entrance, Entering building, Using inside pathways, Using elevator, Using stairs inside, Using service desk, Using service, Using hygiene facilities* and *Exiting building*. In total, a large number of environmental features were addressed on a detailed level but were summarized into 31 main environmental features that may be encountered when accessing a service, such as using a fitness facility or buying food in a shop, from the parking/drop-off area to services inside, and to emergency exit. Environmental features addressed in most articles concerned parking/drop-off area (32 articles), entrance area (27 articles) and restroom/toilet (32 articles). For further details, see Table 4.

Functional limitations and predominant activities

Most of the accessibility issues identified were related to mobility limitations, and all 40 articles addressed such issues. There were also 14 articles addressing issues related to visual limitations. The predominant activities in terms of ICF that were identified were: *Walking and moving*, *Changing and maintaining body position*, *Purposeful sensory experience* and *Applying knowledge*. Of the access activities identified, all included issues related to *Walking and moving*, except *Using hygiene facilities* (considering *Changing and maintaining body position* and *Purposeful sensory experiences*). Issues related to *Purposeful sensory experiences* were identified in all ten of the access activities, and issues related to *Applying knowledge* were found in four of the access activities (i.e., *Using route to entrance*, *Using elevator*, *Using service inside* and *Exiting building*).

Discussion

This scoping review aimed to summarize the research front on accessibility to public buildings for older people and people with functional limitations. It included 40 eligible articles published between 1980 and 2018. This overview revealed that existing research was largely concentrated around the following access activities: using parking/drop-off area, route to entrance and pathways inside the building. A limited body of research concerned the use of different kinds of service desks inside the building and using emergency exits. Moreover, the articles were mainly focused on mobility and visual limitations and the predominant ICF activities of *Walking and moving*, *Changing and maintaining body position* and *Purposeful sensory experiences*. Research on accessibility issues in public buildings related to cognitive limitations and the predominant ICF activity of *Applying knowledge* was also scarce.

Validity and reliability

Several of the articles not including study participants were conducted in different phases of instrument development (e.g. the McClain and Todd questionnaire, the Assessments of Physical Fitness Facilities and the AIMFREE), but strikingly only a few included psychometric testing. This is in line with a previous

Table 1
List of included articles.

#	Author	Year	Country	Instrument/checklist	Type of buildings	No of buildings	No of participants
29	Ahn et al.	1994	USA	Study specific checklist	Shopping mall/stores	250	–
30	Al-Mansoor	2016	United Arab Emirates	Checklist based on country specific regulations	Mosques	*Not stated*	–
31	Alagappan, Hefferan & Parivallal	2018	India	Checklist based on country specific regulations	Bus terminal	1	–
4	Andrade & Ely	2012	Brazil	Assessment based on spatial accessibility (Dischinger, Bins Ely & Piardi 2009) and guided walks (Dischinger 2000)	Public buildings, unspecified	2	8
32	Arbour-Nicitopoulos & Ginis	2011	Canada	AIMFREE (Rimmer et al., 2004)	Fitness facilities	44	–
33	Cardinal & Spaziani	2013	USA	Asessment of Physical Fitness Facilities (Figoni et al., 1998)	Fitness facilities	50	–
34	Crowe, Picchiarini & Poffenroth	2004	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Public buildings, unspecified	122	–
35	Dolbow & Figoni	2015	USA	Asessment of Physical Fitness Facilities (Figoni et al., 1998)	Fitness facilities	10	–
36	Dos Santos & Carvalho	2012	Brazil	Checklist based on country specific regulations	Hotels/conference centers	17	–
37	Doshi et al.	2014	Brazil	Study specific checklist	Hotels/conference centers	36	–
38	Evcil	2009	Turkey	McClain and Todd questionnaire (1990)	Public buildings, unspecified	26	–
39	Figoni et al.	1998	USA	Asessment of Physical Fitness Facilities (Figoni et al., 1998), developed from the McClain and Todd questionnaire (1990)	Fitness facilities	34	–
40	Graham & Mann	2008	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Health provider facilities	68	–
41	Gray et al.	2014	USA	Mobility Device User Work Survey (MWS)	Work environments, offices	*Not stated*	132
42	Hamzat & Dada	2005	Nigeria	ADA Accessibility Guidelines Checklist for Buildings and facilities (1992)/prior recommendations from American National Standards Institute (1980)	Public buildings, unspecified	38	–
43	Iezzoni et al.	2010	USA	Study specific checklist	Health provider facilities	*Not stated*	20
44	Kim, Lee, Kwon & Chung	2014	South Korea	Study specific checklist	Public buildings, unspecified/Ramps	15	30
45	King et al.	2011	Canada	Study specific checklist	Public buildings, unspecified	1	1
46	Leal Rocha et al.	2015	Brazil	Study specific checklist	Health provider facilities	89	204
47	Martin	1987	USA	Study specific checklist	Public buildings, unspecified	13	–
48	McClain	2000	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Shopping mall/stores	3	–
26	McClain & Todd	1990	USA	McClain and Todd questionnaire (1990)	Grocery/convenience stores	40	–
49	McClain et al.	1999	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Shopping mall/stores	1	–
50	McClain et al.	1993	USA	McClain and Todd questionnaire (1990)	Restaurants	120	–
51	Meyers et al.	2002	USA	Study specific checklist	Public buildings, unspecified	*Not stated*	28
52	Mojtahedi et al.	2008	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Grocery/convenience stores	82	–
53	Moyo et al.	2000	Zimbabwe	McClain and Todd questionnaire (1990)	Public buildings, unspecified	20	–
54	Mudrick et al.	2012	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Health provider facilities	2389	–
55	Mulazadeh & Al-Harbi	2016	South Africa	ADA Accessibility Guidelines Checklist for Buildings and facilities (1992)/prior recommendations from American National Standards Institute (1980)	Public buildings, unspecified	13	–
56	Nary, Froehlich & White	2000	USA	McClain and Todd questionnaire (1990)	Fitness facilities	8	–
57	Reich	1980	USA	Study specific checklist	Shopping mall/stores	*Not stated*	297
24	Rimmer et al.	2004	USA	AIMFREE (Rimmer et al., 2004)	Fitness facilities	35	–
58	Rimmer et al.	2017	USA	AIMFREE (Rimmer et al., 2004)	Fitness facilities	227	–
59	Rivano-Fischer	2004	United Arab Emirates	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Public buildings, unspecified	17	–
60	Sá et al.	2012	Portugal	Study specific checklist	Public buildings, unspecified	11	24
61	Saigal & Narayan	2014	India	Study specific checklist	Work environments, offices	*Not stated*	50
62	Sanchez et al.	2000	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Health provider facilities	40	–

(*continued on next page*)

Table 1 (*continued*)

#	Author	Year	Country	Instrument/checklist	Type of buildings	No of buildings	No of participants
63	Seliger	1981	USA	Study specific checklist	Health provider facilities	402	–
64	Useh, Moyo & Munyonga	2001	Zimbabwe	McClain and Todd questionnaire (1990)	Public buildings, unspecified	20	–
65	Zissermann & Tumiel	1989	USA	ADA Accessibility Guidelines Checklist for Buildings and Facilities (1992)/prior recommendations from American National Standards Institute (1980)	Public buildings, unspecified	274	–

Note: All 40 articles reported non-intervention studies of cross-sectional design.

review of measurement properties of instruments that assess inclusive access to fitness and recreational sport centers,[22] where the authors also identified only a few instruments that were psychometrically evaluated. Scientifically robust instruments that are easy to administer are necessary to validly assess the accessibility of public buildings, and this finding suggests further efforts of psychometric testing are urgently needed.

The review showed that studies that included participants mostly had the aim of evaluating whether certain facilities were accessible for specific groups, such as people using mobility devices, which gave them a bit narrow scope. In order to meet the needs of all people who wish to use the public buildings, the diversity of people's functional capacity needs to be addressed,[23] not just some specific groups. The three largest studies,[41,46,57] which represent 80% of the total number of participants in this review, also used different, study-specific instruments, which makes comparisons difficult. Moreover, the level and scope of problematic issues under study differed widely, which prevented quantification of the accessibility problems. Further, all of the included studies were cross-sectional, and many of them aimed to extract qualitative data on the accessibility problems encountered without quantifying how severe the problems were in different types of buildings or for different groups of people. Thus, the types of studies identified for this scoping review demonstrate that there is a need for further instrument development and psychometric testing. In addition, studies should focus on enabling empirical evaluation and quantification of problems caused by different combinations of building features and functional limitations. Intervention studies with a before and after analysis are also lacking, which could give guidance on the impact of typical measures to improve accessibility.

Public buildings

A variety of public buildings were examined, but health care and fitness facilities predominated. The most common environmental features studied were the parking/drop-off areas, entrance areas and hygiene facilities. However, even if fitness centers have been addressed in several studies, the accessibility remains poor.[22] Notably lacking were buildings related to vital societal services such as court houses, police stations and bank offices. A recent study[23] suggested that some of these facilities may present even more accessibility issues for people with functional limitations compared to commercial facilities like shopping centers and restaurants. Among other issues, this may be linked to the specific types of environmental barriers that may be present due to security requirements in such buildings. Facilities related to cultural activities such as theaters, museums, libraries, concert halls and movie theaters were also lacking to a great extent in the included articles. When accessibility is investigated, the compliance with legislation in different areas of the facilities are usually compared.[25] However, in order to be able to use the facilities and participate in the activities incorporated in a single facility, such as shopping, eating, listen to a concert or getting a passport, accessibility in the entire

Table 2
Public buildings[a] studied.

Article	Type of buildings	No of articles	No of buildings studied (%)
Alagappan et al. (2018)	Bus terminal	1	1 (<0.1)
Arbour-Nicitopoulos et al. (2011), Cardinal & Spaziani (2003), Dolbow & Figoni (2015), Figoni et al. (1998), Nary, Froehlich & White (2000), Rimmer et al. (2004), Rimmer et al. (2017)	Fitness facilities	7	408 (9.0)
McClain & Todd (1990), Mojtahedi et al. (2008)	Grocery/convenience stores	2	122 (2.7)
Graham & Mann (2008), Iezzoni et al. (2010), Leal Rocha et al. (2015), Mudrick et al. (2012), Sanchez et al. (2000), Seliger (1981)	Health provider facilities	6[a]	2988 (66.1)
Dos Santos & Carvalho (2012), Doshi et al. (2014)	Hotels/conference facilities	2	53 (1.2)
Al-Mansoor (2016)	Mosques	1	*Not stated*
Andrade & Ely (2012), Crowe et al. (2004), Evcil (2009), Hamzat & Dada (2005), Kim et al. (2014), King et al. (2011), Martin (1987), Meyers et al. (2002), Moyo et al. (2000), Mulazadeh & Al-Harbi (2016), Rivano-Fischer (2004), Sá et al. (2012), Useh, Moyo & Munyonga (2001), Zissermann & Tumiel (1989)	Public buildings, unspecified[c]	14 [d]	572 (12.7)
McClain et al. (1990)	Restaurants	1	120 (2.7)
Ahn et al. (1994), McClain (2000), McClain et al. (1990), Reich (1980)	Stores, shopping malls	4 [d]	254 (5.6)
Gray et al. (2014), Saigal & Narayan (2014)	Work environments, offices	2	*Not stated*
	Total	40	4518 (100.0)

[a] Public buildings are defined as buildings that the public has access to (SFS 2010:900). [b] No of buildings stated in 5 of 6 articles. [c] In one article (Kim et al., 2014), only ramps to 15 buildings were assessed. [d] No of buildings stated in 13 of 14 articles. [e] No of buildings stated in 3 of 4 articles.

Table 3
Study participants, functional limitations considered.

Article[a]	Country	No of study participants	Age Mean (SD)	Functional limitation			
				Visual	Hearing	Mobility	Cognitive
Andrade & Ely (2012)	Brazil	8	*No info*	X	X	X	X
Gray et al. (2014)	USA	132	46.3 (10.8)	–	–	X	–
Iezzoni et al. (2010)	USA	20	*No info*	–	–	X	–
Kim et al. (2014)	South Korea	30	25.4 (2.1)	–	–	X	–
King et al. (2011)	Canada	1	25	–	–	X	–
Leal Rocha et al. (2015)	Brazil	204	39.8 (22.7)	X	–	X	–
Meyers et al. (2002)	USA	28	47.0 (14.7)	–	–	X	–
Reich (1980)	United Arab Emirates	297	Range 16–64[b]	–	–	X	–
Sá et al. (2012)	Portugal	24	*No info*	–	–	X	–
Saigal & Narayan (2014)	India	50	Range 25–60[b]	X	–	X	–
Total		794		3	1	10	1

[a] 30 articles did not have study participants, only examined public buildings in relation to instruments/checklists.
[b] Range is only information provided.

building is necessary. Social aspects, including personal interactions between visitors and people working in the buildings are also of importance. In some accessibility assessments,[24,28] such aspects are touched upon. For instance, AIMFREE includes assessments of the professional and supportive behavior of the staff in fitness facilities.

Functional limitations and predominant activities

All of the included articles considered mobility and several visual limitations, a few articles addressed cognitive limitations, and only one was about hearing limitations. The reports of accessibility problems are thereby incomplete. For example, in the recent study by Slaug, Jonsson and Carlsson (2019)[23] —where a limited number of public buildings was studied—the results demonstrated a variety in accessibility problems depending on the functional limitations concerned. In terms of the ICF, *Walking and moving* was the predominant activity that was most reported in the articles included in the current review, followed by *Purposeful sensory experiences* and *Changing and maintaining body position*. In a study by Bukvić, Carlsson, Gefenaite, Slaug, Schmidt and Ronchi (2020)[14] investigating functional limitations and evacuation performance, it was noted that other predominant activities were also addressed, for instance *Communicating, carrying, moving and handling objects*, and *fine hand use*. The probable reason is that studies in evacuation performance also address other environmental features.[67] Nevertheless, in the research area of evacuation performance the target groups are rarely involved in the studies while the buildings are mostly under scrutiny.[68,69] A methodological challenge is to address accessibility problems at the right level. When for example stairs and ramps were addressed in the articles included, environmental details such as handrails were not always discussed in depth. If handrails were not specifically mentioned, they were handled in this review as part of *Walking and moving* and not categorized as *Handling and manipulating objects.* This might be a limitation, but also highlights the need of making environmental design details more obvious. To enhance the activity level including physical as well as social aspects in the older adult population, environmental design considerations are of utmost importance.[70]

Access activities and how to assess accessibility problems

The ten access activities (*Using parking/drop-off area*, *Using route to entrance*, *Entering building*, *Using inside pathways*, *Using elevator*, *Using stairs inside*, *Using service desk*, *Using service inside*, *Using hygiene facilities*, *Exiting building*) identified in this study are general level sub-categories to activity and participation when visiting a public building. All of these need to be considered because daily activities such as buying food, visiting a museum, studying at the university or working, require full physical accessibility to their associated environments. Otherwise the activities might not be possible at all to perform. This implies that environmental barriers and accessibility issues cannot be isolated when the environmental design is considered, but need to be related to the performance of an activity in order to be meaningful for an individual.[71] In addition, the social environment is of utmost importance for participation.[15,72] However, these aspects regarding accessibility were beyond the scope of the current review.

As elaborated in this article, the environmental features that cause accessibility issues may differ depending on which functional limitations a person experiences; for instance a blind person does not experience the same accessibility problems as a person using a wheel-chair. There is a large diversity in people's capacity to overcome different barriers and what they perceive as obstacles, and accessibility is just about the compliance with legislation, which means that accessibility of facilities does not per se guarantee that a person finds the facility useable.[5] By systematically evaluating accessibility, related activities and other available resources, the knowledge can increase and ultimately improve usability of facilities. With solid evidence, accessibility can be addressed at societal level and may increase the possibilities for participation by all people regardless of their age, ability or disability. In that way, it is instrumental in supporting the sustainable development goals outlined by the United Nations, that is, to reduce inequalities (Goal 10), enable good health and well-being (Goal 3) as well as approaching the achievement of sustainable cities and communities (Goal 11).[21]

Study limitations

Since the literature search was conducted, additional studies may have been published that could have been included. Nevertheless, the current review provides a broad overview of the literature, spanning over 40 years of research. Although we only had one author initially extracting the data, we believe the procedure applied with two other authors reviewing and validating the extracted data minimized the risk for bias. Many articles in this review included very detailed information on design features of public buildings, such as door widths and presence of high thresholds etc., generating accessibility issues, which is not fully conveyed by this review. By synthesizing and linking information of sections of the environment (such as parking area, route outside

Table 4
Access activities, from drop-off area to use of service and exit from building.

Access activity	Environmental feature	Public building	Predominant activity in terms of ICF[b]	Number of papers considering related issues[a]			
				Functional limitation			
				Visual	Hearing	Mobility	Cognitive
Using parking/drop-off area	Parking/drop-off area	Fitness facilities, Grocery/convenience stores, Health provider facilities Hotels/conference facilities, Mosques, Public buildings/ unspecified, Restaurants, Stores/shopping malls, Work environments/offices	Walking and moving			31	
Using route to entrance	Route outside	Bus terminal, Fitness facilities, Grocery/ convenience stores. Health provider facilities, Hotels/conference facilities, Mosques, Public buildings/unspecified, Stores/shopping malls	Walking and moving Purposeful sensory experiences Applying knowledge	2	1	16	1
	Entrance area outside	Fitness facilities, Grocery/convenience stores, Health provider facilities, Hotels/conference facilities, Mosques, Public buildings/unspecified Stores/shopping malls	Walking and moving Purposeful sensory experiences Applying knowledge	3	1	27	1
	Ramp outside	Bus terminal, Fitness facilities, Grocery/ convenience stores, Health provider facilities, Public buildings/unspecified, Restaurants, Stores/shopping malls	Walking and moving Purposeful sensory experiences	1		24	
Entering building	Entrance door	Bus terminal, Grocery/convenience stores, Health provider facilities, Mosques, Public buildings/unspecified, Stores/shopping malls	Changing and maintaining body position Walking and moving Purposeful sensory experiences	1		13	
Using inside pathways	Ramp inside	Health provider facilities	Walking and moving			1	
	Route inside	Bus terminal, Fitness facilities, Grocery/ convenience stores, Health provider facilities, Public buildings/unspecified, Ramps, Restaurants	Walking and moving Purposeful sensory experiences	4		17	
	Floor surface	Hotels/conference facilities, Mosques, Public buildings/unspecified, Work environments/ offices	Walking and moving Purposeful sensory experiences	1		4	
	Orientation/information signage	Fitness facilities, Health provider facilities, Hotels/conference facilities, Mosques, Work environments/offices	Walking and moving Purposeful sensory experiences	7		3	
Using elevator	Elevator	Bus terminal, Fitness facilities, Health provider facilities, Public buildings/unspecified, Restaurants, Stores/shopping malls, Work environments/offices	Walking and moving Purposeful sensory experiences Applying knowledge	7	5	23	1
Using stairs inside	Stairs inside	Bus terminal, Health provider facilities, Hotels/ conference facilities, Public buildings/ unspecified	Walking and moving Purposeful sensory experiences	3		7	
Using service desk	Service desk	Fitness facilities, Grocery/convenience stores, Hotels/conference facilities, Public buildings/ unspecified, Stores/shopping malls	Walking and moving Purposeful sensory experiences	1		9	
Using service inside	Acoustics inside	Hotels/conference facilities	Purposeful sensory experiences		1		
	Dining area	Restaurants, Public buildings/unspecified, Stores/shopping malls, Work environments/ offices	Walking and moving Purposeful sensory experiences	1		5	
	Dressing room	Public buildings/unspecified, Stores/shopping malls	Changing and maintaining body position			4	
	Drinking fountains	Fitness facilities, Health provider facilities, Public buildings/unspecified, Stores/shopping malls	Walking and moving Changing and maintaining body position			11	
	Exercise and safety equipment	Fitness facilities, Health provider facilities, Public buildings/unspecified	Walking and moving Purposeful sensory experiences	2	1	10	
	General interior environment	Health provider facilities, Hotels/conference facilities, Public buildings/unspecified, Stores/shopping malls, Work environments/offices	Walking and moving Purposeful sensory experiences Applying knowledge	4	2	10	1
	Health care service room	Health provider facilities	Walking and moving Changing and maintaining body position			4	
	Hotel room	Hotels/conference facilities, Public buildings/ unspecified	Walking and moving Purposeful sensory experiences	1		1	
	Induction/hearing loop	Hotels/conference facilities	Purposeful sensory experiences		1		
	Lighting inside	Hotels/conference facilities	Purposeful sensory experiences	1			
	Locker room	Fitness facilities, Public buildings/unspecified	Changing and maintaining body position	1		8	

Table 4 (*continued*)

Access activity	Environmental feature	Public building	Predominant activity in terms of ICF[b]	Number of papers considering related issues[a]			
				Functional limitation			
				Visual	Hearing	Mobility	Cognitive
	Office computer	Work environments/offices	Walking and moving Purposeful sensory experiences	1		1	
	Seats inside	Health provider facilities, Mosques, Public buildings/unspecified	Changing and maintaining body position			3	
	Shopping basket	Grocery/convenience stores	Walking and moving			1	
	Swimming pool, showers and sauna	Fitness facilities, Public buildings/unspecified	Walking and moving			5	
	Telephone	Fitness facilities, Grocery/convenience stores, Health provider facilities, Hotels/conference facilities, Public buildings/unspecified, Stores/shopping malls	Walking and moving Purposeful sensory experiences		3	17	
	Waiting and other rooms inside	Fitness facilities, Health provider facilities, Hotels/conference facilities, Public buildings/unspecified, Stores/shopping malls, Work environments/offices	Walking and moving Purposeful sensory experiences	1		7	
Using hygiene facilities	Restroom/Toilet	Bus terminal, Fitness facilities, Grocery/convenience stores, Health provider facilities, Hotels/conference facilities, Mosques, Public buildings/unspecified, Restaurants, Stores/shopping malls, Work environments/offices	Purposeful sensory experiences Changing and maintaining body position	3		32	
Exiting building	Emergency exit	Health provider facilities, Public buildings/unspecified, Work environments/offices	Walking and moving Purposeful sensory experiences Applying knowledge	2	2	2	1

[a] Total number of papers included is 40, the same paper can consider more than one issue.
[b] The International Classification of Functioning, Disability and Health (ICF).[9] Linking to ICF at block level.

etc.) to a chain of access activities, we instead provide a context that aims to make it more comprehensive and still reflect the overall research front in the area. Finally, our results indicate that research on accessibility issues in public buildings related to cognitive limitations was scarce. In future studies, search terms specifically related to cognition and applying knowledge might be added to further explore this finding.

Conclusions and implications

To foster development in practice when public buildings are built or renovated as well as further research on public building accessibility, a synthesis of extracted data from the literature was conducted. That is, data on environmental features of public buildings as well as functional limitations were linked to predominant activities in terms of ICF, and ordered to reflect a chain of activities performed when accessing a service. The results of this scoping review demonstrated that fitness facilities and health provider facilities are mainly addressed in cross-sectional studies, often without study participants. This review also revealed that existing research is largely concentrated around the access activities of using parking/drop-off areas, route to entrance and hygiene facilities. A variety of instruments are used, but psychometric testing is rare. Further, the articles were mainly focused on mobility and visual limitations. In terms of the ICF, the predominant activities identified were mainly *Walking and moving*, *Changing and maintaining body position* and *Purposeful sensory experiences*. The types of studies identified demonstrate that there is a need for further research enabling empirical evaluation and quantification about 1) the features of buildings that cause accessibility problems; 2) access activities and how people experience the accessibility problems; and 3) which combinations of building features and functional limitations that lead to accessibility problems in areas with identified knowledge gaps. Users of public buildings have knowledge about barriers through their own experience. However, for different professionals, such as architects and engineers at building and construction companies, it can be a challenge to design public buildings to be flexible and useable to the greatest possible extent by all people. Reviews like the present study add a new perspective to the knowledge base by providing a summary of available evidence, which may be of most practical use for professionals and policy makers.

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Conflicts of interest

The authors have no conflicts of interest to report.

Supplementary material

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Authors' contributions

All authors participated in designing the study. Enrico Ronchi secured acquisition of financial support for the project leading to this publication. Lizette Norin and Giedre Gefenaite conducted the literature search and data extraction. Gunilla Carlsson and Björn Slaug performed the data analysis and all authors contributed to the synthesis of data. Giedre Gefenaite, Gunilla Carlsson and Björn Slaug drafted the initial manuscript. In an iterative process, all authors provided critical intellectual input to the evolving draft of the manuscript, and they all read and approved the final manuscript.

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