



Developing a matrix and manual for mapping access to outdoor environments for older adults and care workers at residential care facilities

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ABSTRACT

Although quantitative and qualitative tools exist for assessing environments for older adults and care workers at residential care facilities (RCFs), a method for mapping quantitative accesses to physical outdoor environmental aspects, such as windows, entrances, balconies, patios, gardens, parks, and squares is lacking. The aim of this study is to develop a matrix and manual for quantitatively mapping the existence of access to physical environmental aspects of outdoor environments for older adults and care workers at RCFs. The matrix and manual are developed through an interdisciplinary approach involving healthcare science, architecture, and landscape architecture, and included a ten-step process comprising the identification of a theoretical basis, definition of physical environmental aspects, construction of the matrix, development of a manual, a pilot study, iterative revisions, and quality assurance. The matrix and manual are developed for use at a national level, but can also be applied locally, for example within a single municipality. The matrix comprises 26 physical environmental aspects, and the manual describes how to carry out the mapping. By using the matrix and the manual, insights can be gained into physical environmental conditions for outdoor environments as part of everyday life and arenas for person-centred care and rehabilitation. Insights from such research can contribute to a broader understanding of how to meet the needs and wishes of older adults and care workers related to outdoor environments at RCFs and in similar healthcare settings, both nationally and internationally.

1. Introduction

The use of outdoor environments for health-promoting purposes in care and rehabilitation has historical roots (Dushkova and Ignatieva, 2020; Korsgaard, 1989; McCauley and Hayes, 2021). However, this potential seems to be underutilized at residential care facilities (RCFs) for older adults across Europe—including Austria, Germany, Norway, Poland, Romania and Slovenia (Artmann et al., 2017)—as well as in Sweden. Two national quality follow-ups conducted by the Swedish National Board of Health and Welfare, distributed to all older adults living at Swedish RCFs and managers, indicated that the older adults and managers perceived that outdoor environments were not leveraged to their full potential (The Swedish National Board of Health and Welfare, 2024a, 2024b, 2024c).

Contact with nature and spending time outdoors (hereafter referred to as outdoor stays) are basic human needs (Kaplan, 1995; Ottosson,

2007; Ulrich et al., 1991) that improve older adults' physical and mental health and maintain self-identity (Ng et al., 2023). Recent studies have highlighted that access to outdoor environments seems to benefit not only older adults but also care workers at RCFs (Joseph et al., 2016; Liljegren et al., 2024a, 2024b; van der Velde-van Buuringen et al., 2021; Young Lee et al., 2024). International recommendations advise the general public, including older adults and care workers at RCFs, to spend at least two hours outdoors per week (White et al., 2019). Older adults with cognitive decline at RCFs would benefit from a minimum of 30 min of outdoor stays each day (van der Velde-van Buuringen et al., 2021). Previous research has also underscored the need for effective interventions that would enable older adults to spend more time outdoors (van der Velde-van Buuringen et al., 2024). To meet these needs, access to outdoor environments is required.

The physical environments at RCFs are complex because they constitute both a living environment for older adults as well as a

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working environment for care workers. A supportive physical environment contributes positively to both quality of life in older adults and to the quality of care worker interaction, while a hindering environment contributes negatively to the older adults quality of life and thereby makes the work of care workers more challenging (Lee et al., 2016). More specifically, previous research has shown that outdoor environments can facilitate activities for older adults by compensating for their impairments and helping them actively utilize their body functions (Xie and Yuan, 2022).

To support the assessment of outdoor environments at RCFs, qualitative or quantitative evidence-based tools can be used. Four such tools are particularly relevant for evaluating the design and content of these environments. The first tool, the Seniors' Outdoor Survey (SOS), has been reliability and validity tested and evaluates how well outdoor environments support older adults' preferences and outdoor usage (Bardenhagen and Rodiek, 2015; Bardenhagen et al., 2018; Rodiek et al., 2016). The second tool, the Swedish version of the Sheffield Care Environment Assessment Matrix (S-SCEAM), has also been reliability and validity tested and addresses various domains and locations within RCFs. Although the S-SCEAM tool primarily evaluates indoor environments, some items specifically assess outdoor environments (Nordin et al., 2015). The third tool, the Quality Evaluation Tool (QET), includes 19 health-promoting design qualities and focuses on two design concepts for outdoor environments in healthcare settings: comfort and stimulation (Bengtsson and Grahn, 2014; Nordregio, 2024). The fourth tool, Is your garden dementia friendly? highlights seven important aspects to assess gardens at RCFs, health centres and hospitals (University of Worcester, 2021). The third and fourth tools have not yet been tested for reliability and validity.

To address the needs and wishes for contact with nature and outdoor stays, the authors have identified four important knowledge areas: (1) older adults' needs and wishes for contact with outdoor environments, (2) care workers' reflections on using outdoor environments for care and rehabilitation, (3) health-promoting design qualities of outdoor environments, and (4) access to outdoor environments in terms of health-promoting physical environmental aspects such as windows, entrances, balconies, patios, gardens, parks, open green spaces and squares. Previous research has provided insights into the first (Dahlkvist et al., 2016; Liljegren et al., 2024b; Murrioni et al., 2021; Zhang et al., 2017), second (Liljegren et al., 2024a; Morris et al., 2022; van der Velde-van Buuringen et al., 2021), and third areas (Bardenhagen et al., 2018; Bengtsson, 2015; Lee et al., 2021; Nordin et al., 2015; van den Berg et al., 2020; Xie and Yuan, 2022). To our knowledge, only one study has assessed the fourth area by exploring access to gardens and found that 4 of 20 RCFs (20 %) lacked such access (Nordin et al., 2017).

One reason some RCFs lack access to their own gardens may be the absence of a national guideline for open space, similar to the 30–40 square meters per child recommended for preschool and school gardens (The Swedish National Board of Housing Building and Planning, 2021). Without such a guideline, there is a risk that preschools and/or schools may be given priority when sharing the same plot (Nordin et al., 2024), as sometimes occurs in Sweden, though this situation may be less common in other countries. Previous research also asserts that when clear regulatory requirements—such as minimum outdoor space standards—are lacking, outdoor environments tend not to be prioritized in community planning (Nilsen and Hågerhäll, 2012). Although several tools exist for assessing outdoor environments, none of them focus primarily on quantitatively mapping the existence of access to different physical environmental aspects of these environments (e.g., number of entrances, presence of balconies and gardens, as well as proximity of parks in the surroundings). Thus, the aim of this study was to develop a matrix and manual for quantitatively mapping the existence of access to physical environmental aspects of outdoor environments for older adults and care workers at RCFs. The matrix and manual are developed for use at a national level, but can also be applied locally, for example within a single municipality.

2. Method

The study adopted an interdisciplinary research approach to address the complexity of the physical environments at RCFs. Experts from the disciplines of healthcare science, architecture, and landscape architecture formed the research group and consisted of three researchers, two research assistants and one doctoral student.

2.1. Development of the matrix and manual

The development of the matrix and manual is outlined as a process consisting of ten steps (Fig. 1), with each step concisely described. As this section provides a concise description, the steps will be further reflected and discussed in the Discussion section.

- Step 1: Identifying a theoretical basis

The principled model of four zones of contact with the outdoors (Bengtsson, 2015) was chosen as the theoretical basis for the study. It is a *principled guiding model* rather than a formal theory, developed to provide a structured framework for understanding how the physical environments at RCFs can promote health and to guide the mapping of different forms of contact with outdoor environments. Furthermore, this model is informed by previous research examining how outdoor environments can affect the health and well-being of older adults and care workers, based on their experiences of these environments. The model was developed within the fields of landscape architecture and environmental psychology and organizes access to the outdoor environment into four different zones. Contact with the outdoors ranges from visual access from inside a building to being outdoors at varying distances from the building. Each zone provides unique qualities that can contribute to different health benefits for older adults and care workers, as detailed in Step 3. The respective zones are described as follows:

- Zone 1: Visual access from inside a building through windows.
- Zone 2: Access to transitional spaces between indoors and outdoors, such as balconies, patios, conservatories, greenhouses and roof terraces.
- Zone 3: Access to gardens and courtyards on the property.
- Zone 4: Access to surrounding green and blue spaces beyond the property.
- Zone 0: Represents indoor spaces without window access and thus offers no contact with the outdoors (excluded)

Zones 1–4 can potentially be health-promoting resources for persons regardless of physical capacities and/or their need for care and rehabilitation (Bengtsson et al., 2018) (Fig. 2). So far, the model has been used mainly in research-practice collaboration in landscape architecture (Bengtsson et al., 2025; Bengtsson et al., 2024).

- Step 2: Identifying sources for data collection

Sources identified for data collection were architectural drawings and online map services. In Sweden, architectural drawings for RCFs are public documents and can be acquired from the respective municipality's building permit unit.

- Step 3: Identifying and defining physical environmental aspects

Health-promoting aspects, ranging from inside the building to the surroundings, were identified through a review of relevant literature on the health effects of contact with the outdoors and outdoor stays for both older adults (appendix A) and care workers (appendix B). The identification of aspects also included insights from the author's experiences of RCFs in terms of walking interviews (Liljegren et al., 2024a, 2024b) and



Fig. 1. The ten steps in the mapping process. Illustration: M. Liljegren.

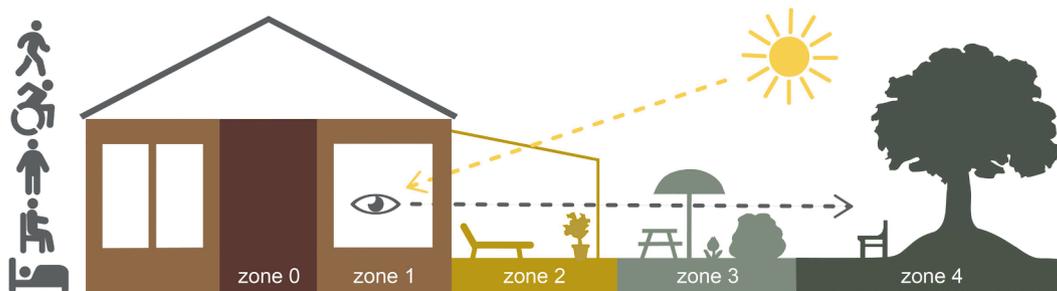


Fig. 2. The principal model of four zones of contact with the outdoors. Illustration: A. Bengtsson.

practical experiences from care workers and designers of RCFs. Table 1 presents the identified aspects for each zone based on the literature and lived experiences.

To increase understanding of each physical environmental aspect, it was defined using international sources and illustrated by photos from the Swedish context of RCFs (Table 2 and Figs. 3-15).

- Step 4: Developing a matrix based on physical environmental aspects

A matrix was built up in Microsoft Excel based on the zone model, which meant a deductive approach was adopted. The aim of the matrix was to establish an approach for mapping the existence of access to the different types of physical environmental aspects in Zones 1–4 at RCFs.

For each zone and identified environmental aspect, variables were formulated as questions with predetermined numerical answer options to enable descriptive statistics calculations and relationships across the entire dataset (Norman and Streiner, 2008). The purpose of the descriptive statistics was to generate results for each variable, thereby providing insight into the presence or absence of outdoor environment access in each zone, as well as identifying any noteworthy relationships between variables. Fig. 16 presents a fictitious example illustrating how the matrix was structured in Microsoft Excel. It includes the municipality name, RCF name, address, background variables, and variables for Zone 1. The figure also shows response options for one of the variables as well as fictitious results from the data extraction to demonstrate how the data were input.

Table 1
Identified aspects based on research literature and experiences of RCFs.

Zone	Identified health-promoting physical environmental aspects based on research literature	Identified aspects of importance based on experiences of RCFs
Zone 1	<ul style="list-style-type: none"> Window (Alerby and Engström, 2021; Aries et al., 2015; Lottrup et al., 2015; Musselwhite, 2018; Sugiyama et al., 2022; Ulrich, 1984; Zadeh et al., 2014) 	<ul style="list-style-type: none"> French balcony
Zone 2	<ul style="list-style-type: none"> Entrance (Gonzalez and Kirkevold, 2016) Balcony (Narsakka et al., 2022; Tabrizi et al., 2023) Patio (Narsakka et al., 2022; Tabrizi et al., 2023) Greenhouse (Detweiler et al., 2012; Gonzalez and Kirkevold, 2016; Hernandez, 2013; Narsakka et al., 2022; Oher et al., 2024) Roof terrace (Bolleter et al., 2024) 	<ul style="list-style-type: none"> Glazed balcony Conservatory/freestanding conservatory Orangery Freestanding patio
Zone 3	<ul style="list-style-type: none"> Garden in ground floor in direct connection to the RCF within the plot (Artmann et al., 2017; Cordoza et al., 2018; Eren et al., 2021; Gonzalez and Kirkevold, 2015; Narsakka et al., 2022; Oher et al., 2024; Ottosson and Grahn, 2013; Petersson Troije et al., 2021; Tsai et al., 2020; van der Velde-van Buuringen et al., 2021; Xie and Yuan, 2022) Courtyard (Narsakka et al., 2022) 	<ul style="list-style-type: none"> Shared garden No garden Closed courtyard
Zone 4	<ul style="list-style-type: none"> Green space such as park, nature area, and cemetery as well as green space within 300 m from RCF (Konijnendijk, 2023; Mainuddin Patwary et al., 2023; Nieuwenhuijsen et al., 2022; Nordh et al., 2022; Nordh et al., 2023; Petersson Troije et al., 2021; Stoltz and Grahn, 2021; Söderlund et al., 2023; Taylor et al., 2015; Zhang et al., 2020; Zheng et al., 2024). Blue space such as lake, sea and stream (Britton et al., 2020; Wang and Md Sani, 2024) 	<ul style="list-style-type: none"> Buildings Open land Cultivation land High vegetation Industrial and commercial area Transport infrastructure Community features Public area Square

• Step 5: Developing a manual for the matrix

A manual was created to guide the research assistants in extracting data from architectural drawings and online map services as well as entering data into the matrix. The manual was developed by documenting the process in a Microsoft Word document, structured into four phases encompassing a total of 56 steps: Phase 1.) Before the review (Steps 1–10), Phase 2.) Conducting the review (Steps 11–52), Phase 3.) After the review (Steps 53–55), and Phase 4.) Random checks (Step 56). The manual described each step in detail to ensure consistency in the assessments. To illustrate the manual, an example is provided below showing how the assessment of the first variable for Zone 1 was formulated: “Column P: Are windows/French balconies in contact with the outdoor environment in the common rooms (e.g. activity room, meeting room, therapy room, café, spa or library)? Information from drawings. Note the occurrence/absence, and enter answers based on the specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No common rooms and X = Information is missing”. Similar information was available for all variables that were to be assessed.

• Step 6: Pilot study

To test the matrix and manual on a small scale, a pilot study was conducted. Drawings were requested from a municipality for which the research group had no pre-knowledge of either the RCFs or of the

Table 2
Definitions and comments of the identified physical environmental aspects.

Zone	Health-promoting environmental aspects	Definitions	Experienced-based comments
1	Window	“A space usually filled with glass in the wall of a building..., to allow light and air in and to allow people inside the building to see out” (Cambridge Dictionary, 2024f)	Usually the windows can be opened, but there are also non-openable ones at RCFs.
	French balcony	“A floor-to-ceiling window that you can open fully. It normally has a... safety railing in front of it” (Origin Architectural, 2024).	French balconies usually open inward into the room.
2	Entrance	“A door or other opening that you use to enter a building or place” (Cambridge Dictionary, 2024c).	Entrances at RCFs usually have high accessibility, such as automatic door opening and absence of level differences in the ground surface (threshold).
	Balcony	“A platform that is built on the upstairs outside wall of a building, with a wall or rail around it. You can get out onto a balcony from an upstairs room” (Oxford Learner’s Dictionaries, 2024).	Balconies can be both open and glazed. The passages between indoor environments and balconies often consists of a single door with a threshold in the door frame or by glazed sliding doors on rails. Access to automatic door openers is unusual.
	Patio	“An area outside a house with a hard floor, where people can sit to eat and relax” (Cambridge Dictionary, 2024e).	Patios can be linked to the building or freestanding in the garden. The passages between indoor environments and patios often consist of a single door with a threshold in the door frame or by glazed sliding doors on rails. Access to automatic door openers varies.
	Conservatory	“A room with glass walls and glass roof, usually connected to a house, used for growing plants or for relaxing in” (Cambridge Dictionary, 2024a).	Conservatories can be linked to the building or freestanding in the garden. The passages between the environment and the conservatories often consist of a single door with a threshold in the door frame. Automatic door openers are unusual.
	Greenhouse	“A building with a roof and slides made of glass, used for growing plants that need warmth and protection” (Cambridge Dictionary, 2024d).	The passages into the greenhouse often consist of a single or double door with a threshold in the door frame and access to automatic door openers is unusual.
	Orangery	“Building with glass walls and roof which is used for growing orange trees and other plants which need to be kept warm” (Collins Dictionaries, 2024).	The passages into the orangeries often consist of a single door with a threshold in the door frame and access to automatic door openers are unusual.
	Roof terrace	“An architectural element of a building	Roof terraces have limited accessibility and

(continued on next page)

Table 2 (continued)

Zone	Health-promoting environmental aspects	Definitions	Experienced-based comments
		that sits on the roof of the building and is arranged as a terrace to be used as a living or leisure space. A roof terrace can be treated as a garden (sometimes only vegetated) or it can consist of open-air parts and built elements” (Condolegal, 2024).	are therefore considered supplementary areas i.e., not included in the open space (The Swedish National Board of Housing Building and Planning, 2021). The passages between the indoor environments and the roof terraces often consists of a single door with a threshold in the door frame and usually with access to automatic door openers. RCFs can have an own garden, share with other organizations or lack access to a garden. Openings in the boundaries to the surroundings are often constituted by gates. The surface materials often link together, for example patios, paths in gardens and the paths in the surroundings.
3	Garden	“A piece of ground adjoining a building, often with grass, flowers, trees, etc., and generally used for recreation” (Oxford English Dictionary, 2024).	RCFs can have an own garden, share with other organizations or lack access to a garden. Openings in the boundaries to the surroundings are often constituted by gates. The surface materials often link together, for example patios, paths in gardens and the paths in the surroundings.
	Open and closed courtyards	“An area of flat ground outside that is partly or completely surrounded by the walls of a building” (Cambridge Dictionary, 2024b).	The passages between the indoor environments and the courtyards often consists of a single door with a threshold in the door frame and access to automatic door openers.
4	Surroundings/ Neighbourhood	“Near or around a particular place” (Longman Dictionary of Contemporary English, 2024) respectively “a section of a town or city” (The Britannica Dictionary, 2024).	The surroundings and thus the access to these places is determined by the location of the building. Physical aspects in the surroundings are : Enclosed buildings: Land with multi-floor buildings in enclosed blocks - High-rise buildings: Land with detached buildings with multi-family buildings with several floors (three or more) - Low-rise buildings: Land with buildings in planned blocks, with detached one and two-family villas, terraced houses and multi-family houses with one or two floors - Sparse buildings: Land with sparse buildings - Open land – park: Open land in a built-up area, e. g. parkland or sports ground with grassy areas - Open land – nature: Natural open land, unclaimed or extensively claimed land - Cultivation land: Fruit cultivation or arable land - High vegetation: Land with deciduous forest or

Table 2 (continued)

Zone	Health-promoting environmental aspects	Definitions	Experienced-based comments
			coniferous trees, or mixed trees in built-up or undeveloped areas, including wooded parkland - Water contact: Feature of visible water, e.g. lake, sea or watercourse - Industrial and commercial area: Land on which mainly industrial or commercial activities are conducted - Transport infrastructure: Heavy transport infrastructure such as multi-lane highway, communication hubs with railways, buses and/or train station - Community features: Cemetery, health centre and school etc.
	Public space/place within approx. 300 m	“A space that is generally open and accessible to people” (Wiktionary, 2024).	Public spaces are part of the surroundings, and it is of importance for older adults that they be within close proximity of RCFs. Physical aspects within 300 m are : Public open space: Green space, park, cemetery (excluding schoolyards) - Public area intended for physical activity: Training ground or sports ground (excluding schoolyards) - Public area with high vegetation: Green space, park, forest with high vegetation, natural land if there are paths - Public area with water contact: Public area with visible water, e.g. lake, sea or watercourse - Squares: Open usually hard surface area in a built-up area intended for public events, temporary trade, and as a meeting place (including pedestrian streets)

building permit unit. The results of the pilot study, which included eight RCFs, pinpointed that some questions were difficult to assign numerical options based on the information available. Therefore, some variables were deleted, and new ones were added to increase clarity. The manual was simultaneously updated with the new information.

- Step 7: Identifying addresses for RCFs and building permit unites

To carry out a full-scale national mapping, access to architectural drawings and online map services were needed. In Sweden, it is possible to obtain these drawings and online maps for RCFs if their addresses are known, which the Swedish National Board of Health and Welfare was able to provide.

After adjusting in terms of removing duplicates and completing some



Fig. 3. Window view of garden from common dining room. Photo: M. Liljegren.



Fig. 6. Open balcony furnished with outdoor furniture. Photo: M. Liljegren.



Fig. 4. View from an apartment via French balcony and windows. Photo: M. Liljegren.

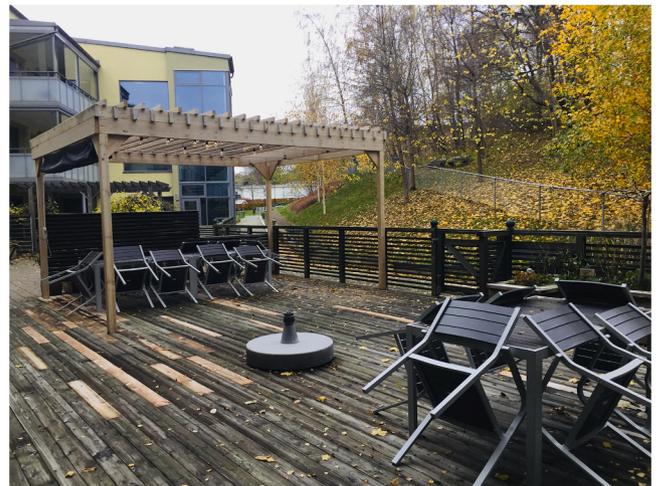


Fig. 7. Patio with pergola and outdoor furniture. Photo: M. Liljegren.



Fig. 5. Entrance to an RCF. Photo: M. Liljegren.



Fig. 8. Conservatory directly connected to the building. Photo: M. Liljegren.

address details, an address list of 2036 RCFs was obtained. Furthermore, all Swedish municipal building permit units ($n = 290$) needed to be

contacted to obtain the architectural drawings. An email list was compiled based on information from the municipalities' websites and request for the drawings was sent digitally. The data collection continued throughout 2022, and 262/290 (90.3 %) municipalities



Fig. 9. Free standing greenhouse in the garden. Photo: M. Liljegen.



Fig. 12. Newly established garden in ground level. Photo: M. Liljegen.



Fig. 10. Orangery with furniture and oranges. Photo: M. Liljegen.



Fig. 13. Open courtyard with fence and gate. Photo: M. Liljegen.

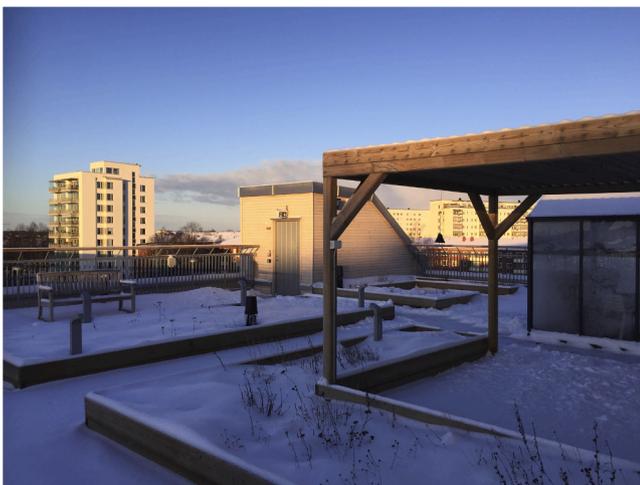


Fig. 11. Snowy roof terrace with pergola and handrails. Photo: M. Liljegen.



Fig. 14. Park in the surroundings. Photo: M. Liljegen.

contributed drawings. In total, drawings for 1811/2036 (88.9 %) RCFs had been obtained.

- Step 8: Adaptations of matrix and manual

The data extraction was initially carried out by one research assistant in collaboration with the authors. During the process, continuous adjustments were made to the matrix and the manual to provide clarifications and simplifications. A critical point arose sometime after the



Fig. 15. Square as a public space. Photo: M. Liljegren.

pilot study was conducted, when the authors became aware that several of the variables for Zones 3 and 4 were too difficult to obtain data for based on the planned approach. The data-extraction process was changed to only include drawings for Zones 1–2 and to clarify the data extractions for Zones 3–4 by using a more advanced public online map service (Geographic Information System data, GIS data) from the Swedish Land Survey. This map service has supplementary information concerning type of buildings, vegetation, transport infrastructure, community features, and public areas, but requires proficiency in GIS (The Swedish Land Survey, 2023). To show the data extraction procedure, drawings that were used for Zones 1–2 and online maps for Zones 3–4 are presented in Fig. 17.

Based on the first 200 RCFs of the national study, adjustments to the matrix and manual needed to be made to ensure robustness. Examples of adjustments included whether platforms resembling balconies with stairs between floors should be assessed when there was also information indicating that they served as fire escape routes. Another example was the approach used to carry out measurements in Zones 3 and 4.

- Step 9: Quality assurance

After the final adjustments of the matrix, a statistician reviewed all variables and their possible answer options to ensure that they were correctly entered into the Excel file and that all formulas worked as intended. This verification ensured that the resulting dataset was accurate and ready for statistical calculations. To further ensure the quality of the data extraction from the drawings and online maps, a procedure

for random checks for every 200 RCF was added to the manual.

- Step 10: Complete national mapping

To test whether the final versions of the matrix and manual could generate data for access to outdoor environments at RCFs, the research group mapped the access to all four zones in the zone model on a national level (i.e. in the Swedish context). At this stage, the research assistants were also instructed to document interesting design solutions for each zone in order to showcase various examples.

2.2. Ethical considerations

The study has received ethical approval for the study from the Swedish Ethical Review Authority, diary number: 2022–02682–02.

3. Results

The results of this study consist of two parts: (1) the final version of the matrix, and (2) the final version of the manual, each described below:

3.1. Final version of the matrix

The first result consists of the final version of the matrix and how each variable relates to the zone model and the health-promoting environmental aspects as well as to aspects of importance based on experiences from RCFs. The final version of the matrix includes 26 variables which are divided into the four zones: Zone 1 ($n = 7$), Zone 2 ($n = 6$), Zone 3 ($n = 9$), and Zone 4 ($n = 2$). It also includes background variables describing the characteristics of RCFs, as these influence contact with the outdoor environments and outdoor stays ($n = 2$) (Table 3).

3.2. Final version of the manual

The second result is the finalized version of the manual, which comprises an introduction and detailed steps for each phase: Phase 1: Before Mapping, Phase 2: Data Extraction, Phase 3: After Mapping, and Phase 4: Random Checks. Given its comprehensive nature, the manual is included as an appendix (Appendix C).

4. Discussion

The aim of this study was to develop a matrix and manual for quantitatively mapping the existence of access to physical environmental aspects of outdoor environments for older adults and care

	A	B	C	D	E	N	O	P	Q	R	S	T	U	V	W	X	Y		
1	RESIDENTIAL CARE FACILITY					BACKGROUND		ZONE 1											
	Municipality	Residential care facility	Street	Postal code	City	How many floors are in the building?	How many assisted living apartments are in the building?	Are there windows/French balconies in contact with the outdoor environment in the common rooms (e.g., activity room, meeting room, therapy room, café, spa, library)?	Are there windows/French balconies in contact with the outdoor environment in dining areas and living rooms/day rooms?	Are there windows/French balconies in contact with the outdoor environment in the apartments?	Are there windows/French balconies in contact with the outdoor environment in the conference rooms?	Are there windows/French balconies in contact with the outdoor environment in the care workers' dining rooms?	Are there windows/French balconies in contact with the outdoor environment in the offices?	Are there windows/French balconies in contact with the outdoor environment in the care workers' relaxing rooms?	0 = No 1 = Yes 2 = Partial (available in some, but not all) 3 = No relaxing room X = Information is missing				
2																			
3	1	A	...	...	...	5	75	1	1	1	1	2	1	1			
4	1	B	...	...	...	2	49	1	1	1	1	0	1	0			
5	1	C	...	...	...	1	33	2	1	1	0	1	2	3			

Fig. 16. Example of how the matrix was structured in Excel, highlighting variables for background questions and Zone 1.

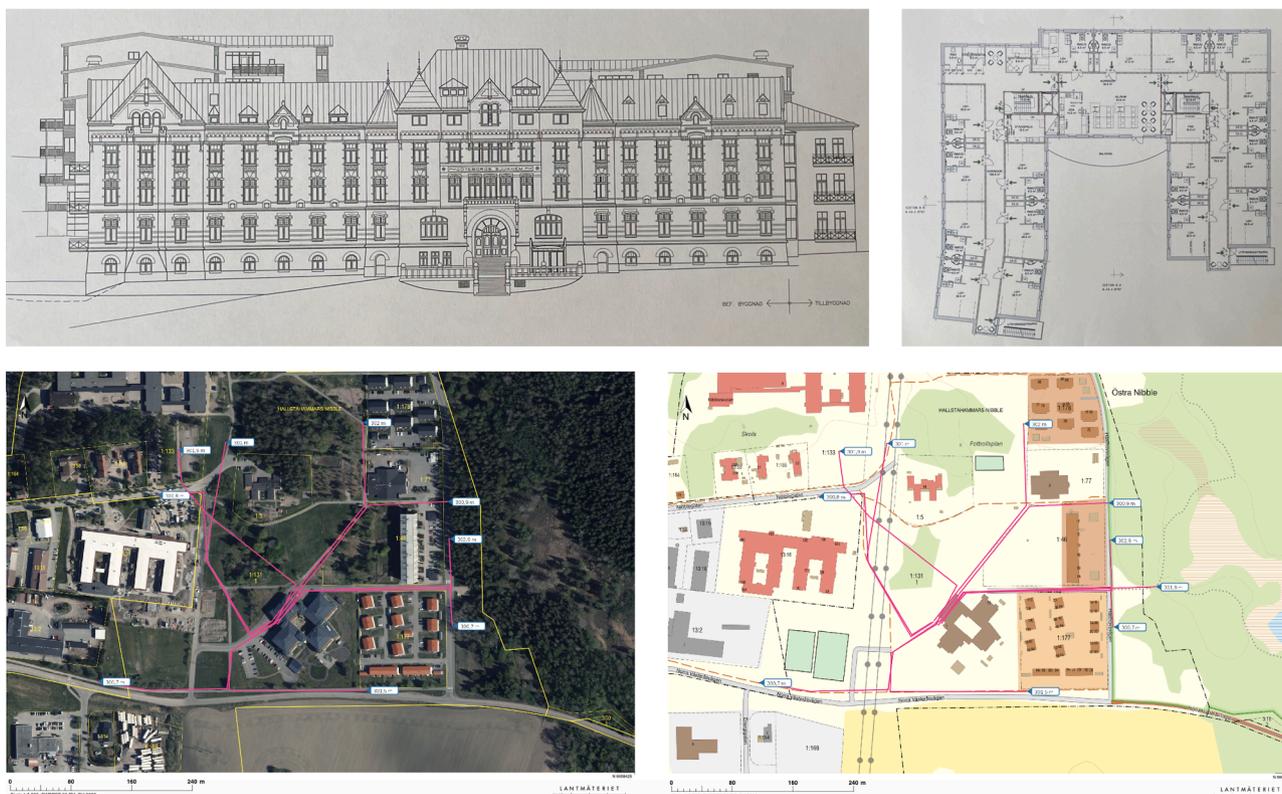


Fig. 17. Example of drawings (top two: façade and floor plans) and online maps (bottom two: aerial and map views) used for the data extraction of Zones 1–4. Photo drawings: M Liljegren. Maps: The Swedish Land Survey, permission not necessary.

workers at RCFs. As a theoretical basis, the zone model was used (Bengtsson, 2015). The authors deemed the zone model to be suitable due to its concrete applicability to the physical environment. Practically, the zone model was used to structure the matrix, facilitating the input of data. The study contributes a viable matrix and manual for mapping access to outdoor environments at RCFs, which can be used by researchers both nationally and internationally. Additionally, the matrix and manual can be applied in similar healthcare settings beyond RCFs. The matrix and manual complement existing tools such as S-SCEAM (Nordin et al., 2015), SOS Tool (Bardenhagen and Rodiek, 2015; Bardenhagen et al., 2018; Rodiek et al., 2016), QET (Bengtsson and Grahn, 2014; Nordregio, 2024), and Is your garden dementia friendly? (University of Worcester, 2021) by introducing a new approach for assessing outdoor environments. This new addition provides a matrix and manual specifically designed to map access to physical environmental aspects related to Zones 1–4 at RCFs.

Initially in the study, there was a general idea of the steps included in the mapping process, but the specifics were developed iteratively during the study. The final version of the process consisted of ten steps, each outlining how they should be implemented to enable the mapping of outdoor environments, representing an initial step toward the long-term goal of developing an evidence-based tool. A strength of the process is its clear structure for developing both the matrix and the manual.

However, despite this strength, some limitations have been identified such as the considerable time required for collecting drawings and performing the data extraction. Collecting drawings and performing data extraction required substantial time. It took approximately one year before all drawings were available, during which parallel mapping was carried out as new RCFs became available. Mapping Zones 1–2 took around two years for one full-time research assistant, while Zones 3–4 required about one year for another full-time assistant. With the recent development of AI-based tools, future mappings could benefit from automated image analysis of drawings and digital maps, potentially

reducing time and effort. These limitations can be overcome if, for example, an authority is the custodian of the drawings for healthcare buildings and ensures they are kept up to date. Additionally, to avoid misunderstanding, it is important to highlight, that the final step in the process involves conducting a national mapping, the results of which are presented elsewhere (Liljegren et al., 2025).

4.1. Physical environmental aspects as mapping variables in Zones 1–4

The variables in the matrix were carefully considered by the research group based on prior research on health-promoting physical environmental aspects and the group's experiences from RCFs. The interdisciplinarity of the group was thus essential to these decisions. For example, healthcare scientists contributed knowledge about older adults' and care workers' needs. The architect provided insights into building features that affect outdoor access and advised on what aspects could realistically be mapped in Zones 1–2 based on the information available from drawings. The landscape architect contributed knowledge of outdoor environments, such as patios, gardens, and surrounding spaces, and guided what could be mapped in Zones 3–4 using digital mapping services. This collaboration ensured that both indoor and outdoor aspects were appropriately captured in the matrix. Such an interdisciplinary approach, emphasized in previous studies (Alves et al., 2024; Xie and Yuan, 2022), is invaluable for accurately capturing environmental features, which can later be combined with person-related data to explore person-environment interactions.

For the Zone 1 mapping variables concerning access to windows, the research group considered that the most appropriate approach was to use architectural drawings rather than conducting field visits to the 2036 RCFs, as field visits would involve significant time and high travel costs. Mapping window access using drawings was considered feasible based on the pilot study findings that indicated the drawings were of sufficient quality to clearly differentiate between windows, walls, and

Table 3
The final version of the matrix.

Zone	Variables
Back-ground	How many floors are there in the building?
1	<ul style="list-style-type: none"> • How many assisted living apartments are there in the building? • Are there windows/French balconies in contact with the outdoor environment in the common rooms (e.g., activity room, meeting room, therapy room, café, spa, library)? • Are there windows/French balconies in contact with the outdoor environment in dining areas and living rooms/day rooms? • Are there windows/French balconies in contact with the outdoor environment in the apartments? • Are there windows/French balconies in contact with the outdoor environment in the conference rooms? • Are there windows/French balconies in contact with the outdoor environment in the care workers' dining rooms? • Are there windows/French balconies in contact with the outdoor environment in the offices? • Are there windows/French balconies in contact with the outdoor environment in the care workers' relaxing rooms?
2	<ul style="list-style-type: none"> • Are there entrances to the outdoor environment (excluding delivery entrances/entrances to garbage rooms)? • How many balconies/patios/conservatories for older adults are there in direct connection to the building? • How many apartments per balcony/patio/conservatory are there? • How many balconies/patios/conservatories for care workers are there in direct connection to the building? • How many greenhouses/orangeries/independent conservatories are there? • How many roof terraces are there?
3	<ul style="list-style-type: none"> • How many square meters does the plot make up (including the building/s)? • Based on the previous variable, what is the plot-size range (including building/s)? • Is there an outdoor environment on the ground floor in direct connection to the RCF within the plot? • How many square meters of the plot constitute an outdoor environment with vegetation rounded to tens of square meters (including enclosed courtyards, excluding parking space and traffic routes)? • What is the size of the outdoor environment with vegetation (e.g. garden) per apartment? • How many buildings are there on the plot (both connected and unconnected, excluding pavilions, sheds etc.)? • How many enclosed courtyards are there on the plot? • How many open courtyards are there on the plot? • How many courtyards are there on the plot in total (both enclosed and open courtyards)?
4	<ul style="list-style-type: none"> • What kind of environment surrounds the RCF? • Enclosed buildings? • High-rise buildings? • Low-rise buildings? • Sparse buildings? • Open land – park? • Open land – nature? • Cultivation land? • High vegetation? • Water contact? • Industrial and commercial area? • Transport infrastructure? • Community features? • Is there a public outdoor environment in the immediate surroundings within a radius of approx. 300 m distance from main entrance? • Public open space? • Public area intended for physical activity? • Public area with high vegetation? • Public area with water contact? • Square?

entrances.

For the Zone 2 mapping variables regarding entrances, patios, balconies, conservatories, greenhouses, orangeries, and roof terraces, architectural drawings were also considered the most appropriate approach for mapping access rather than conducting field visits. Initially, some variables were formulated at a high level of detail but

required simplification based on insights from the pilot study and the mapping of the first 200 RCFs. For example, the variable concerning entrances was originally formulated based on the number of entrances accessible to older adults and care workers. However, this was later simplified to only indicate the presence of entrances as it was challenging to determine whether certain entrances were exclusively used for receiving goods. Mapping access to balconies, conservatories, greenhouses, orangeries, and roof terraces proved relatively straightforward as these places were clearly marked on the drawings. However, it should be noted that some outdoor structures meeting Zone 2 criteria, such as greenhouses, may have been constructed after the original building plans were created and therefore might not be reflected in the drawings. This represents a potential limitation in accurately capturing all accessible outdoor environments. Patios were more challenging to map. This difficulty arose because some drawings indicated the presence of doors leading from dining rooms, activity rooms, or apartments to patios, but they lacked exterior markings to corroborate their existence. While all Zone 2 variables enable outdoor stays for older adults and care workers, roof terraces require particular attention. Previous research highlights that roof terraces provide minimal nature contact (only 8 %) as they primarily consist of hard surfaces (Bolleter et al., 2024). Furthermore, the Swedish National Board of Housing, Building and Planning (2021) emphasizes that roof terraces at preschools and schools are considered as supplementary areas, and are not included in the open space at ground floor (gardens). Roof terraces should remain a mapping variable due to the growing trend of incorporating them in new RCFs in urban areas with limited land availability (Nordin et al., 2024). However, it is essential to recognize that they cannot serve as a substitute for open ground-level spaces.

For the Zone 3 mapping variables, regarding gardens and courtyards, the research group initially considered using drawings and simple online map services as the most appropriate approach for mapping access. However, the pilot study and the mapping of the first 200 RCFs revealed that these sources did not provide sufficiently reliable data. As a result, the research group decided to ignore the drawings and instead use a more advanced online mapping service. This updated approach provided higher-quality data and proved to be a more suitable alternative.

For the Zone 4 mapping variables, regarding surroundings/neighbourhoods as well as public spaces/places within approximately 300 m, the authors needed to consider what aspects had available data at the national level. While previous research highlights the health benefits of access to green and blue spaces, the research group also prioritized aspects derived from the experiences of RCFs. These aspects were considered important because they influence the perception of the environments both positively and negatively. As with the mapping of variables in Zone 3, simple online map services were initially used to map variables in Zone 4. However, results from the pilot study and the mapping of the first 200 RCFs highlighted the need for more reliable data, prompting the transition to more advanced online map services.

4.2. Architectural drawings and online map services as data sources

Using drawings to map access to Zones 1 and 2 worked satisfactorily for the majority of variables but proved more challenging for some others (patios). It became apparent that not all building permit offices had complete drawings for their respective RCFs, an issue that must be addressed if the study is to be replicated. Furthermore, another challenge identified was that some municipalities charged fees for processing public drawings, while the majority handled them free of charge. One of the major difficulties in using online map services to analyse access to Zones 3 and 4 was the discrepancy between the address data of the RCFs and the address data in the Swedish land registry's search engine. To yield search results, addresses had to be entered exactly as they appeared in the search engine, and when discrepancies arose, time-consuming manual handling of each address was required. Furthermore, measuring outdoor areas in Zone 3 based on the land registry's data was

particularly challenging. Random checks revealed significant deviations, largely due to the insufficient resolution of the aerial images. Additionally, the property boundaries in the Swedish land survey's mapping data are not legally binding, meaning that the measured results for usable land area should be regarded as indicative rather than precise.

4.3. Generalizations and implications

Concerning the generalizability of the matrix and manual, the authors believe it has potential for broader application, such as mapping access to outdoor environments at RCFs in other countries and within other healthcare contexts. While the matrix and manual have potential for application in other countries and healthcare contexts, it should be noted that availability of architectural drawings and online mapping services differs internationally. In contexts where such data are limited, mapping may require on-site visits or alternative data sources. To ensure feasibility, it is essential to first identify the types of data available at local or national levels. The matrix could also be used at the municipal level to inventory access to the zones through on-site visits to the RCFs. The matrix currently does not include variables that specifically map transitions between zones. While it captures the presence of physical environmental aspects within each zone, aspects such as thresholds or gates, are not yet mapped. Including such variables in future versions could improve the understanding of how older adults navigate and access outdoor environments. The matrix can also support urban planning and design by providing a structured overview of which physical environmental aspects are present or missing in each of the four zones. By highlighting gaps—such as the absence of windows, balconies, or gardens—planners and designers can identify opportunities to improve health-promoting aspects for older adults and care workers. A general limitation of the matrix and manual is that they do not assess the qualitative aspects of outdoor environments, such as design qualities that support comfort, familiarity, cognitive stimulation, or physical support. As briefly noted in the Introduction, such qualities are addressed in tools like the QET, which includes 19 health-promoting design qualities and focuses on comfort and stimulation in outdoor environments for healthcare settings (Bengtsson and Grahn, 2014; Nordregio, 2024). The present matrix and manual were developed to complement such tools by focusing solely on the existence of access to physical environmental aspects.

4.4. The mapping in a more robust way next time

To strengthen the quality of the mapping, the matrix should be transformed into an evidence-based tool (tentatively referred to as The Four Zone Mapping Tool 1.0) through reliability and validity testing. It should be noted that the national mapping was not conducted as a validation study but as an initial empirical application intended to identify practical challenges and guide further refinement of the matrix and manual. We plan to carry out reliability and validity tests in forthcoming national mappings. A relevant reliability test to assess the absence of measurement errors could be a test-retest analysis. To examine validity, a content validity test can be conducted to determine whether the variables accurately measure what they are intended to. The advantage of this quality assurance process is the inclusion of an expert panel whose expert knowledge about outdoor environments in healthcare contexts can provide valuable insights. Additionally, calculating both the content validity ratio and the content validity index will further strengthen the quality (Streiner and Norman, 2014). Furthermore, the original version of the manual used by the research assistants would need to be developed into a user-friendly guide for practitioners. Future versions of the tool could consider access that improves connection to natural environmental aspects, such as openable windows or balconies with views of greenery.

It is advantageous to include further variables in the matrix to gain additional insights into the outdoor environments at RCFs and the

physical environmental conditions for outdoor stays for both older adults and care workers. For Zone 1, it may be relevant to split questions concerning access to windows in activity rooms, meeting rooms, therapy rooms, cafés, spas, and libraries to ensure that rooms with different functions are not grouped together. A variable that should be included is whether trees are visible via windows from inside the buildings. This addition is inspired by a Norwegian study showing that trees were visible from all apartments in 51 % of the RCFs included (Gonzalez and Kirkevold, 2016). Mapping the visibility of trees aligns with the urban planning rule 3–30–300, which stipulates, among others, that it should be possible to see at least three trees from one's residence or workplace (Konijnendijk, 2023; Nieuwenhuijsen et al., 2022). For Zone 2, a variable should be included that maps access to patios, balconies or conservatories on each floor since these are described as facilitators for outdoor stays (The Irish Department of Health, 2023). Additional variables should measure the size of balconies, patios, and conservatories to obtain information concerning the number of older adults and care workers who are able to use these places simultaneously. For Zone 3, a variable should assess whether RCFs have elevators providing direct access from wards to the gardens. Furthermore, for Zones 3–4, the qualitative design qualities in the QET (Bengtsson and Grahn, 2014; Nordregio, 2024) should be transformed into quantitative variables. Selected variables from tools such as S-SCEAM (Nordin et al., 2015), the SOS Tool (Bardenhagen and Rodiek, 2015; Bardenhagen et al., 2018; Rodiek et al., 2016), and the Is your garden dementia friendly (University of Worcester, 2021) would also be beneficial to include. To expand the mapping further and account for ongoing climate change, variables addressing air pollution, noise, and radiation temperatures (heat stress) at RCFs could be interesting to include. For example, the previously mentioned 3–30–300 rule stipulates that there should be at least 30 % tree canopy coverage in the surrounding environment and access to a green space within a maximum of 300 m (Konijnendijk, 2023; Nieuwenhuijsen et al., 2022). While the current matrix includes the 300-meter variable, incorporating 30 % tree canopy coverage is equally relevant. This variable could replace the “high vegetation” variable, which does not differentiate between a single tree, multiple trees, or a forest. For Zone 4, physical environmental aspects of age-friendly environments should be further examined and included as these significantly impact the physical, mental, and social health of older adults (Bhuyan and Yuen, 2022).

To streamline future mapping, it would be advantageous for an authority or organization with access to updated address registers for all RCFs along with information on planning permission changes implemented in the environments since the last mapping, to take responsibility for this task. Alternatively, an interdisciplinary research group or universities could be commissioned by the government to oversee and carry out the work.

5. Conclusion

A matrix and manual were developed through an interdisciplinary research approach to map access to outdoor environments for older adults and care workers at RCFs. By using the matrix and manual, detailed and structured data were obtained concerning access to outdoor environments at RCFs. The matrix and manual are developed for use at a national level, but can also be applied locally, for example within a single municipality. In turn, obtaining information about access contributes to insights regarding the physical environmental conditions necessary to meet the basic human need for contact with the outdoors and outdoor stays. In future studies, the matrix needs to be tested for reliability and validity, and the manual needs to be converted into a user-friendly guide for practitioners.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used ChatGPT in order to improve texts. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Ethics statement

Ethical approval for the study was obtained from the Swedish Ethical Review Authority (Diary number: 2022–02682–02).

CRediT authorship contribution statement

Madeleine Liljegren: Writing – original draft. **Anna Bengtsson:**

Writing – review & editing, Supervision. **Göran Lindahl:** Writing – review & editing, Supervision. **Helle Wijk:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices

A. Identification of health-promoting aspects in contact with the outdoors related to older adults (with and without dementia), persons in need of care and rehabilitation and, for some aspects, generally.

Views from inside the building and natural daylight

- Window view: Positively affects recovery after surgery in terms of reduced use of painkillers, shorter hospital stays, improved well-being, and fewer complications such as headaches and nausea (Ulrich, 1984).
- Window view: May protect against older adults' stress increase and improve quality of life (Sugiyama et al., 2022).
- Window view: Enjoyment of observing a motion-full, ever-changing world outside, which allows immobile older adults to engage, find meaning, and feel connected to their surroundings despite their limited mobility (Musselwhite, 2018).
- Window view: Trees outside hospital windows fosters a sense of togetherness and friendship that can alleviate feelings of loneliness (Alerby and Engström, 2021).
- Daylight through window: Promotes health by providing access to daylight (Aries et al., 2015).

Outdoor environments between indoors and outdoors

- Spaces "in-between": Establish a sense of place, promoting the restorative merits of the natural setting and offering a greater meaning to the healthcare setting (Montgomery, 2017).
- Entrance (direct): Supports easy access from indoor to outdoor environments (Gonzalez and Kirkevold, 2016).
- Balcony and patio: Increases exposure to nature and green space, which has positive effects on health and helps sharpen attention among older adults living in ordinary housing (Tabrizi et al., 2023).
- Balcony, patio, greenhouse: Promote physical activities (Narsakka et al., 2022).
- Greenhouse: Extends the outdoor season, keeps the older adults warm and protected from wind and rain (Detweiler et al., 2012; Gonzalez and Kirkevold, 2016; Hernandez, 2013).
- Greenhouse: Facilitates connections with nature, offering views of the sky and garden while allowing both sunlight to stream in and sounds of rain pattering on the windows. In Sweden, access to greenhouses is essential for outdoor healthcare interventions due to the country's seasonal variations (Oher et al., 2024).
- Roof terrace: Provides minimal access to greenery although challenges are vegetated surfaces and lack of trees; therefore most of the surface are hard made (Bolleter et al., 2024).

Outdoor environments belonging to the building on the plot

- Garden: Empowers older adults to shift from being passive recipients to active contributors, fostering a sense of purpose, belonging, and ownership within the local landscape at RCFs (Tsai et al., 2020).
- Garden: Encourages older adults at RCFs to visit gardens, which improves their well-being, and contentment, sleep and sleep patterns as well as their balance and mobility (Gonzalez and Kirkevold, 2015).
- Garden: Encourages physical activity, recreation, and social interaction, particularly when the RCFs have their own gardens (Artmann et al., 2017).
- Garden: For older adults at RCFs, positively affects concentration, blood pressure and pulse rate after rest in gardens (Ottosson and Grahn, 2013).
- Garden: Improves wakefulness during the day, reduces agitation, fosters new positive habits, and improves reminiscence among older adults at RCFs, especially those persons with dementia (van der Velde-van Buuringen et al., 2021).
- Garden: Contributes to a sheltered feeling, which in turn contributes to a private social community and a sense of "us" and "ours" in younger persons with dementia (Oher et al., 2024).
- Garden: Facilitates outdoor activities by compensating for impairments and enabling utilization of remaining body functions among older adults at RCFs (Xie and Yuan, 2022).
- Garden and courtyard: Promotes physical activities (Narsakka et al., 2022).
- Own garden: RCFs with access to own gardens are highly aware of the benefits urban green spaces provide (Artmann et al., 2017).
- Garden: Satisfaction with the garden leads to improved psychosocial well-being among older adults at RCFs (Eren et al., 2021).

Outdoor environments in the surroundings

- Green space: Encourages regular use, improves physical, mental, and social well-being when having access to public green spaces within 300 m of one's home (Konijnendijk, 2023; Nieuwenhuijsen et al., 2022).
- Green space: Contributes to health and well-being through access to high-quality green spaces in cities and communities (Zhang et al., 2020; Zheng et al., 2024).

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- Promotes mental and physical health to visit outdoor environments designed based on the eight perceived sensory dimensions (Stoltz and Grahn, 2021).
 - Green space: Promotes lower rates of antidepressant use when street tree density is higher (Taylor et al., 2015).
 - Green space: May reduce the need for healthcare and prescription medications (Mainuddin Patwary et al., 2023).
 - Green space in cemetery as recreational landscape: benefits both mourners and recreational visitors (Nordh et al., 2022; Nordh et al., 2023)
 - Blue space: Contributes to health, especially psychosocial well-being and mental health among older adults (Britton et al., 2020; Wang and Md Sani, 2024).
-

B. Identification of health-promoting aspects in contact with the outdoors related to care workers and office workers as care workers also perform some office-related tasks.

Views from inside the building and daylight

- Daylight through window: Decreases medication errors and reduced feelings of sleepiness among acute-care nurses (Zadeh et al., 2014).
 - Window view: Improved work ability and job satisfaction among office workers (Lottrup et al., 2015).
- Outdoor environments between indoors and outdoors
- Greenhouse: Extends the outdoor season, keeps care workers warm and protected from wind and rain (Detweiler et al., 2012; Gonzalez and Kirkevold, 2016; Hernandez, 2013).
- Outdoor environments belonging to the building
- Garden: Improves relationships and communication with older adults with dementia at RCFs through daily garden use while also promoting relaxation (van der Velde-van Buuringen et al., 2021).
 - Garden: Reduce burnout for nurses who work in hospitals and take daily garden breaks (Cordoza et al., 2018).
 - Garden: Contributes to a sense of well-being, supports recovery, promotes autonomy, improves communication and social relations between office workers when the workplace moves outdoors to courtyards (Petersson Troije et al., 2021).
- Outdoor environments in the surroundings
- Green space: Contributes to a sense of well-being, supports recovery, promotes autonomy, improves communication and social relations between office workers when the workplace moves outdoors to nearby parks (Petersson Troije et al., 2021).
 - Green space: May promote work-related well-being by providing positive experiences in the outdoor work environment among office workers (Söderlund et al., 2023).
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C. Manual for mapping access to outdoor environments

For research assistants: Introduction to mapping outdoor environments at RCFs

This manual describes four phases: 1) Before the review; 2) Conducting the review; 3) After the review and 4) Random checks. The overall principle is that all data included must be clear. In the case of doubt, the data should be excluded. Before starting the review, one must ensure that one has the following documents: the manual, the matrix, drawings (on a USB flash drive), the document 'Kommungruppsindelning 2023' (the Swedish municipal group classification from 2023) and a template to document interesting design examples. Should any questions occur, please feel free to contact the research group.

Phase 1: Before the review (Steps 1–10)

1. Open Outlook and go to the aldreboende@slu.se mailbox. The mailbox contains folders for all municipalities (290), sorted in alphabetical order. The RCF drawings are presented at the municipal level. If drawings for an RCF are sent in a single email, it is placed in a subfolder with the name of the RCF. When the drawings of several RCFs were sent in a joint email, they were placed in a subfolder called 'Boenden' (RCFs). When the drawings for one or several RCFs were sent using a cloud service, they were downloaded to the USB flash drive that you received. In the mailbox, this is noted by adding 'USB' to the subfolder named 'Boenden', that is 'Boenden – USB'. In each municipal folder, there is also a subfolder named 'Övrigt' (Other). Here, all email conversations with the municipality are saved. If you believe information is missing, check the subfolder 'Övrigt'. In some cases, the municipalities named the RCF according to its property designation. We only have access to the names and addresses for each RCF. In these cases, a translation table has been provided so we know which RCF belongs to which property designation. These emails are marked with a red flag, so they can be easily found in each municipality's folder.
2. Identify the municipality with which you will work.
3. Once you have identified which municipality you will work with, write your initials beside the municipality's name in capital letters, so other people in the project will know that you are reviewing this municipality. Hence, the duplication of work will be minimized.
4. Start by creating an overview of the RCFs in the municipality. How many RCFs are there? How many drawings/other documents did we receive per RCF? Note! Some municipalities have sent many drawings per RCF with several hundred documents. Skip reviewing these initially, they will be reviewed at a later stage. Write a comment about this in the matrix for the first RCF in the municipality (Column F), so the information is easy to find.
5. Identify the drawings of the RCF to examine.
6. Work with one RCF at a time. Check the drawings. If you find words such as 'äldreboende', 'särskilt boende', 'älderdomshem' or 'vård- och omsorgsboende' (different Swedish terms for RCFs), the drawings should be included. If you find words such as 'gruppboende' (group accommodation) or 'vårdcentral' (healthcare centre), make a note in the matrix. We will discuss whether they are relevant. If you realise upon review that you have not received complete documentation from the municipality, you should not contact them to supplement the material. Instead, the questions that cannot be answered in the matrix should be marked with an 'X', meaning information is missing.

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7. To investigate if the buildings in the drawings are RCFs, check hitta.se and Google Maps to compare their shapes. If the shapes do not look the same, make a note in the matrix, and we will discuss the drawings. Note! We only review drawings with the correct address and/or property designation. In case of doubt, the address is checked first and then we check which drawings have been sent to us. A search is made on the Internet for "name of RCF" and "city", then it is settled if we have received correct material. In addition, if the number of buildings on the plot differ between the drawings and the online map services (hitta.se or Google Maps), the information from hitta.se and Google Maps is prioritised, and the drawings cannot be used in the review. In such cases, only Hitta.se and/or Google Maps is used for the review, and only Zones 3 and 4 are completed in the matrix. If you find that an address is incorrect and does not belong in the matrix (i.e. it is not an RCF for older adults), write a comment about it in Column F. Interesting design examples that somehow stand out are collected in the document 'Interesting examples'.

8. Select relevant drawings, usually termed '*situationsritning*' (situation drawing), '*planritning per våningsplan*' (floor plan drawing), '*fasadritning*' (facade drawing) and '*bygglovsritning*' (building permit drawing). This review is primarily digital. If the drawings are difficult to interpret digitally, they are printed (A3 format) and reviewed via hard copy. Be observant of whether building extensions have been completed. If so, it is necessary to review both the original drawings and extension drawings. That is, it is insufficient merely to review the latest version of drawings as, for example the main building may not be included. Use at most five minutes per RCF to investigate if the drawings are correct, readable and useful. If more than one building is on the plot, use a maximum of 10 min to sort drawings. If you need more time, make a note, and we will discuss it later.

9. Sort the drawings based on floor plan so the review can be carried out smoothly.

10. If you think the review will be facilitated by marking on drawings (hard copy or digital), it is fine.

Phase 2: Conducting the review (Steps 11–52)

11. If the drawings are printed, the review is facilitated by placing them on a large table so several drawings can be viewed simultaneously.

12. Open the review matrix in Excel. The matrix contains the variables for which the drawings will be examined. Initially, the assessment concerns background information. Subsequently, the review is categorised based on the model of four zones of contact with the outdoor environment. There are several answer options for each column. It is important that the available options are used correctly.

Starting

13. Column A (name of municipality): Locate the municipality you will review. Column A is preloaded and does not require processing.

14. Column B (name of RCF): Find the right row for the RCF in the matrix. Addresses for all RCFs are preloaded in columns C–E.

15. Column F (map): Visit the website www.hitta.se, and find the RCF on the map. Enter the name and city for the RCF in the search field. Copy the weblink showing the location of the RCF and insert it in Column J. Purpose: To facilitate review during the procedure, note the appearance of the plot and the location of the building(s).

16. Column G (map): Visit the website www.googlemaps.com, and find the property on the map. In the search bar, type the name and city of the property. Copy the link showing the location of the property and insert it in Column H. Purpose: To facilitate review during the procedure, take a digital walk around the plot to get a better idea of the building and its location.

17. Column H: Comments are used to write special circumstances regarding the drawings. For example, some drawings are missing/large number of drawings/the address is not an RCF.

18. Columns I–J (municipal grouping classification) are pre-loaded and do not need further processing. Use the Excel file *Kommungruppsindelning 2023* and register options for each municipality.

19. Column K (organiser) is information obtained via the Swedish National Board of Health and Welfare.

20. Column L (approved building permit year): Note which year the building permit was approved (i.e. the year indicated in the drawing). If there are different drawings with different years, pick the latest year indicated.

21. Column M (approved building permit decade): This number is based on the previous data and is calculated automatically via formula.

Background questions

22. Column N: How many floors are in the building? Enter the number of floors in the RCF building. Usually, the basement and the attic are excluded, unless they include apartments, common rooms, dining rooms or living rooms that belong to the RCF. The same goes for hillside houses. All floors with apartments, common rooms, dining rooms or living rooms that belong to the RCF count. The information is gathered from drawings, hitta.se or Google Maps. Fill in the answers based on the specified options. Available options: 1 = 1 floor, 2 = 2 floors, 3 = 3 floors etc. and X = Information is missing.

23. Column O: How many assisted living apartments are in the building? Count the number of apartments according to the drawings. (Note that an apartment counts as one, even if there is more than one person living in it.) Information from drawings. Fill in the answers based on the specified answer options. Available options: 1 = 1 apartment, 2 = 2 apartments, 3 = 3 apartments etc. and X = Information is missing.

Zone 1

24. Column P: Are windows/French balconies in contact with the outdoor environment in the common rooms (e.g. activity room, meeting room, therapy room, café, spa or library)? Information from drawings. Note the occurrence/absence, and enter answers based on the specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No common rooms and X = Information is missing.

25. Column Q: Are windows/French balconies in contact with the outdoor environment in dining areas and living rooms/day rooms? Information from drawings. Note the occurrence/absence, and enter answers based on the specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No dining areas and living rooms/day rooms and X = Information is missing.

26. Column R: Are windows/French balconies in contact with the outdoor environment in the apartments? Information from drawings. Note the occurrence/absence, and enter answers based on specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all) and X = Information is missing.

27. Column S: Are windows/French balconies in contact with the outdoor environment in the conference rooms? Information from drawings. Note the occurrence/absence, and enter answers based on specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No conference room and X = Information is missing.

28. Column T: Are windows/French balconies in contact with the outdoor environment in the care workers' room/dining rooms? Information from drawings. Note the occurrence/absence, and enter answers based on specified alternatives.

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Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No care workers' room/dining room and X = Information is missing.

29. Column U: Are windows/French balconies in contact with the outdoor environment of the offices? Information from drawings. Note the occurrence/absence, and enter answers based on specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No office and X = Information is missing.

30. Column V: Are windows/French balconies in contact with the outdoor environment in care workers' relaxing rooms? Information from drawings. Note the occurrence/absence, and enter answers based on specified alternatives. Available options: 0 = No, 1 = Yes, 2 = Partial (available in some, but not all), 3 = No relaxing room and X = Information is missing.

Zone 2

31. Column W: Are there any entrances to the outdoor environment (excluding delivery entrances/entrances to garbage rooms)? Information from drawings, hitta.se or Google Maps. Note the occurrence/absence, and enter answers based on specified alternatives. Available options: 0 = No, 1 = Yes and X = Information is missing.

32. Column X: How many patios/balconies/glazed balconies/glazed conservatories for older adults are directly connected to the building? Information from drawings, hitta.se or Google Maps. Zone 2 on the ground floor is counted a) When there is a door and a marking on the ground with the label 'uteplats' (patio), b) When there is a door and an area right outside the door with a clear framing (e.g. hedges) or c) If there is a patio door between the indoor and outdoor environment, then we assume that there is some form of useful outdoor environment outside. Balconies are counted when there is a door leading to a clearly framed area. The label 'balkong' (balcony) is not necessary. In some RCFs, there are balconies with fire ladders. If the site looks as if it is used as a balcony, include it in the review; if not, exclude it. Fill in the answers based on the specified options. Available options include the following: 1 = 1 patio/balcony/glazed balcony/glazed conservatory, 2 = 2 patios/balconies/glazed balconies/glazed conservatories, 3 = 3 patios/balconies/glazed balconies/glazed conservatories etc. and X = Information is missing.

33. Column Y: How many apartments per patio/balcony/glazed balcony/glazed conservatory are there? The answer is based on columns O and X and is calculated automatically via the formula.

34. Column Z: How many patios/balconies/glazed balconies/glazed conservatories for care workers are directly connected to the building? Information from drawings, hitta.se or Google Maps. Zone 2 on the ground floor is counted a) When there is a door and a marking on the ground with the label 'uteplats' (patio), b) When there is a door and an area right outside the door with a clear framing (e.g. hedges) or c) If there is a patio door between the indoor and outdoor environment, then we assume that there is some form of useful outdoor environment outside. Balconies are counted when a door leads to a clearly framed area. The label 'balkong' (balcony) is unnecessary. Some RCFs have balconies with fire ladders. If the area seems useable as a balcony, include it in the review; if not, exclude it. If the patios/balconies/glazed balconies/glazed conservatories relate to a door to conference room, office, staff room/dining room or relaxing room, we consider them useful for just the staff. Fill in the answers based on the specified options. Available options include the following: 1 = 1 patio/balcony/glazed balcony/glazed conservatory, 2 = 2 patios/balconies/glazed balconies/glazed conservatories, 3 = 3 patios/balconies/glazed balconies/ glazed conservatories etc. and X = Information is missing.

35. Column AA: How many greenhouses/orangeries/independent conservatories are there? Information from drawings, hitta.se or Google Maps. Note the number based on the answer options specified. Available options: 1 = 1 greenhouse/orangery/independent conservatory, 2 = 2 patios/balconies/glazed balconies/ glazed conservatories, 3 = 3 patios/balconies/glazed balconies/ glazed conservatories etc. and X = Information is missing.

36. Column AB: How many roof terraces are there? Information from drawings, hitta.se or Google Maps. Note the number based on specified answer alternatives. Available options: 1 = 1 roof terrace, 2 = 2 roof terraces, 3 = 3 roof terraces etc. and X = Information is missing.

Zone 3

37. Column AC: How many square metres are in the plot (including the building/s)? Information from eniro.se. Note the plot size in square metres. X = Information is missing.

38. Column AD: Based on the previous column, what is the plot size range (including building/s)? The answer is based on Column AC and is calculated automatically using the formula.

39. Column AE: Is an outdoor environment on the ground floor directly connected with the RCF on the plot? Information from eniro.se and/or lantmateriet.se. Note if there is an outdoor environment on the ground floor directly connected to the RCF on the plot or if the building covers the entire property designation area (i.e. plot size area and lacks its own defined Zone 3), if the RCF lacks its own defined Zone 3 (i.e. is in Zone 4, e.g. on public land) and if the property is shared with other/s (i.e. if the plot is shared with companies or other kinds of facilities that are registered on the address, including schools, healthcare facilities etc.). Note the occurrence/absence or combinations and fill in answers based on the specified alternatives. Available options: 0 = No* Building covers the entire property designation area, that is plot size area (and is without its own defined Zone 3). 1 = No* Building covers all the property designation area, that is plot size (and lacks its own defined Zone 3) AND the property (address/building) is shared with other/s** (e.g. school, healthcare facilities etc.) – there are two or more companies registered on the address according to eniro.se. 2 = No* The RCF is in Zone 4, for example on public land (and is without its own defined Zone 3). 3 = No* The RCF is in Zone 4, for example on public land (and lacks its own defined Zone 3) and the address/building is shared with other/s** (e.g. school, healthcare facilities etc.) – there are two or more companies registered on the address according to eniro.se. 4 = Yes*. 5 = Yes*; however, the property is shared with other/s** (e.g. school, healthcare facilities etc.) – there are two or more companies registered on the site according to eniro.se. X = Information is missing. Information from *Lantmateriet.se and/or eniro.se and **Information only available at eniro.se.

40. Column AF: How many square metres of the plot constitutes an outdoor environment with vegetation (e.g. a garden) rounded to tens of square metres, (including enclosed courtyards, excluding parking space and traffic routes)? Information from lantmateriet.se. Note the area of the yard, including courtyards (not roof terraces), but excluding hardscapes, such as parking areas and roads. Only measure areas of plots under 1 ha square metres (<10,000 square metres) according to Column AC and only for RCFs with answer Option 4 in Column AD (i.e. with a dedicated Zone 3 on the plot that is not shared with others). Enter square metres in numbers (rounded to the nearest tens). X = Information is missing. Z = Not measured – plot size exceeds 10 square metres (column AC) or the plot has no dedicated outdoor environment (according to the result in Column AE). Save the measurement as pdf - filename = 'line number column letters'.

41. Column AG: What is the size of the outdoor environment with vegetation (e.g. garden) per apartment? Based on columns O and AF, it is automatically calculated via the formula.

42. Column AH: How many building/s are on the plot (both connected and unconnected, excluding pavilions, sheds etc.)? Information from lantmateriet.se. Note the total number of building/s on the plot (both connected and unconnected), excluding pavilions, sheds etc. Fill in based on the specified answer alternatives. Available options: 1 = 1 building, 2 = 2 buildings, 3 = 3 buildings etc. and X = Information is missing.

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43. Column AI: How many enclosed courtyards are on the plot? Information from lantmateriet.se. Note the number of enclosed courtyards based on the specified answer alternatives. Available options: 1 = 1 enclosed courtyard, 2 = 2 enclosed courtyards, 3 = 3 enclosed courtyards etc. and X = Information is missing.

44. Column AJ: How many open courtyards are on the plot? Information from: lantmateriet.se. Note the number of open courtyards based on the specified answer alternatives. Available options: 1 = 1 open courtyard, 2 = 2 open courtyards, 3 = 3 open courtyards etc. and X = Information is missing. Guiding rules are to include courtyards with house angles that are closed >85 degrees, for example with openings shaped similar to C, E, F, G, H, U and V. However, disregard house angles that are L shaped or more open (90 degrees and more).

45. Column AK: How many courtyards are on the plot (both enclosed and open courtyards)? The answer summarises the results of columns AI and AJ. The result is calculated automatically using the formula.

Zone 4

46. Column AL: What kind of environment surrounds the RCF? Information from lantmateriet.se. Note the type of environment/settings that surround the RCF (beside the property designation area). Fill in the answers in columns AM–AW based on specified alternatives for built-up area/surrounded by enclosed building blocks, built-up area/surrounded by high building, built-up area/surrounded by low buildings, built-up area/sparsely populated area, beside open land/park (developed area, including sport facilities), beside farmland/agricultural landscape, beside developed or natural landscape with high vegetation, that is high bushes and trees, beside water (sea, lake, river or canal), beside industrial and/or commercial area, beside heavy transport infrastructure (e.g. multi-lane highway, communication hubs with railways, bus and/or train station etc.) and beside a public building, societal function (e.g. care facilities, schools, graveyards etc.). Available options: 0 = No, 1 = Yes and X = Information is missing.

47. Column AY: Is there a public outdoor environment in the immediate neighbourhood within a radius of approximately 300 m from the main entrance? Information from lantmateriet.se. Identify the occurrence of specific visiting points (supporting different types of experiences) in the closest environment. State for each category if it is present within 300 m walking distance from the RCF. A distance of 300 m is estimated using the measuring tool on the property map. Fill in the answers in columns AZ–BD based on specified alternatives for public open space (including cemeteries, disregarding schoolyards), public areas intended for physical activity (disregarding sport areas in schoolyards), public areas with high vegetation (park, path and forest), public areas with water contact and a square (clear square/path that is marked on the map). Available options: 0 = No, 1 = Yes and X = Information is missing.

Ending

48. Column BE (property designation): Information from lantmateriet.se. Register 'Fastighetsbeteckning' (the Swedish property designation code) for the property/plot where the RCF is located.

49. Column BF (search link): Information from lantmateriet.se. Copy and paste the link to the search hit at minkarta.lantmateriet.se.

50. Column BG (save verified address): Information from lantmateriet.se. Copy and paste the address row from the search hit on the map.

51. Column BH (national county division): Information from Statistics Sweden (link: <https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/lan-och-kommuner/lan-och-kommuner-i-kodnummerordning/>). Add information about which Swedish county the municipality belongs to.

52. Column BI (climate zones): Information from Impecta (link: <https://www.impacta.se/sv/zonkarta>). Add information about which climate zone to which the respective county belongs. If a county is divided into two or more climate zones, choose the option that represents the largest area.

Phase 3: After the review (Steps 53–55)

53. Review of new RCF begins according to the procedure described in the manual.

54. The review of a new municipality begins according to the procedure described in the manual.

55. When all municipalities and RCFs have been reviewed, send the matrix and the document with interesting design examples to the research group.

Phase 4: Random checks (Step 56)

To ensure the quality of the assessments of access to the outdoor environment at RCFs, the research group decided to perform random checks of the data. This section describes how the process works. Two research assistants in the study were responsible for assessing access to outdoor environments. Random checks were conducted by other persons in the research group who had not performed the assessments. The assessments' results were compared with the random checks' results. In this way, the quality assurance of the assessments took place and any ambiguities or mistakes were caught. Interval: Random checks were taken for every 200 RCF. Instructions: A) Go to the matrix and find the specific RCF, B) Obtain current drawings and online maps, C) Carry out the sampling based on the process described above, D) Compare the results of the assessments with the results of the random check, E) In the case of similarities, no action needs to be taken, F) If there are a few differences (2–3 pcs), they are within the margin of error and contributed by the human factor. Thus, no measures need to be taken. If differences concern a specific variable in the matrix, appropriate measures are taken to avoid systematic errors in the ongoing assessments, G) If there are several differences, the research assistants and control persons will be asked to redo the current assessment/random checks. If the differences persist, the whole research group will be invited to a meeting to discuss whether the questions' wording is ambiguous or whether there are mistakes in the assessments. If differences concern a specific variable in the matrix, appropriate action is also taken, and H) Appropriate measures are decided upon with the research group.

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