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A safe work environment and a successful aging-in-place. Observations and floorplan analyses in residential care provision

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Abstract

Purpose – This paper aims to explore the physical environment as a safe working environment for home- and healthcare staff in ordinary housing, and the possibilities for a successful aging-in-place for elderly residents.

Design/methodology/approach – This paper is based on observations of home environments in 20 housing units in different areas in Gothenburg, Sweden. An analysis of the spatial configurations was made according to bedroom capacity, spatial proximity and functional autonomy.

Findings – The findings show how the staff, in different ways, develop strategies for caregiving in various spatial configurations to give the best care. This paper shows that the spatial configuration of the rooms, in combination with the fittings, determine both the prerequisites for a safe working environment and the possibilities for aging-in-place for the residents.

Practical implications – The combined perspectives from architecture, nursing, and occupational therapy describe that easy access to bedroom-bathroom-entrance-kitchen is equally important for the staff, regardless of the care situation, whereas with more care needs, the resident/patient will be more limited to bedroom and bathroom. This paper shows that the home environment of the caretakers has a significant impact on staff's health and safety, prompting an adaptability from the staff to various spatial configurations.



Originality/value – The multidisciplinary approach, comprising architecture, nursing and occupational therapy, and the mixed-methods design, has allowed us to draw some conclusions and to formulate valid directions for further research.

Keywords Health and safety, Working environment, Aging-in-place, Enablers and barriers, Homecare and services, Ordinary housing

Paper type Research paper

Background

This paper focuses on:

- the physical work environment of the staff in home- and healthcare, by identifying safety issues; and
- the possibilities for remaining in their ordinary home for the residents.

In this context, staff who provide everyday care and services and medical staff are included. [blinded for review].

This paper is based on the study protocol from a study performed in 2016–2017. The study protocol has been published separately ([blinded for review]) and relates to how enablers and barriers in ordinary housing affect staffs' safety and accessibility in care-giving situations. The study identifies several risks and shows how the staff relate to different spatial configurations in relation to daily caregiving activities. Safety, for example, concerns helping the resident to move and the possibility to use assistive devices. Accessibility, for example, concerns space for walkers and wheelchairs or height-adjustable toilet seats.

In a recent study, [blinded for review], develop the three concepts of *bedroom capacity*, *spatial proximity* and *functional autonomy* to determine the potential for aging-in-place, focusing on both the resident's situation and the prerequisites for effective caregiving. The authors show that size and number of rooms are not paramount in creating good conditions for aging-in-place and for in-home care, but rather the spatial-functional organization and the connections between different spaces.

Introduction

There is an increasing demand for residential healthcare, or in-home care, for older people in Sweden. For 20 years, Swedish policies have encouraged and enabled older people to remain in ordinary housing (Ministry of Social Affairs, 2008). In parallel, efforts to avoid unnecessary hospital care are discussed worldwide (Crisp, 2020). More than 20% of the Swedish population is 65+, of which, 400.000 receive homecare; a group that by 2060 will exceed 25% (Statistics Sweden, 2023: Swedish National Board of Housing, Building and Planning, 2022). Furthermore, more and more care is provided in private homes, which has many advantages in terms of well-being and recovery, as well as for cutting costs for society.

Architectural qualities that support successful aging in ordinary housing need to be addressed (Baltes and Carstensen, 1996; Steinfeld and Maisel, 2012). When a home becomes a place for care, full of medical equipment and healthcare staff, spaces for partners and relatives can become scarce (Borgstrand and Berg, 2009). This creates problems for the families – on top of the problems related to the specific care issues. The need for an effective work environment as well as a good home environment for “aging-in-place” must be met, along with protecting the caretakers' personal integrity.

Some studies have focused on housing design in relation to the possibility to remain in ordinary housing (Currie, 2008, pp. 195–250; Gottschalk *et al.*, 2005; Lundälv *et al.*, 2019; Mnea and Zairul, 2023). Though much research has focused on older adult residents, some

studies have also focused on the residential working environment (Beer *et al.*, 2014; Lindberg, *et al.*, 2022; [blinded for review] [blinded for review] [blinded for review]), e.g. concerning bathroom space (Kalman and Andersson, 2014) and safety during the COVID-19 pandemic (Tavemark, *et al.*, 2022). Wipfli *et al.* (2012) argue for further research on how to improve care safety and prevent injuries for home- and healthcare staff. Martins *et al.* (2025) have recently investigated burnout and back pain among homecare workers. Bien *et al.* (2021) have presented a tool for assessing risks and hazards in home healthcare environments. Hazards observed outside of and within the home include uneven pavements, stairs without railings, throw rugs, unrestrained animals, dust and mold. Hignett *et al.* (2016) has made a systematic review on 42 publications, focusing on safety risks in connection with physical interactions between patients and caregivers. They found that permanent or temporary factors could imply risks in the physical home care work environment. Markkanen *et al.* (2014), describes how architectural solutions can influence the implementation of new equipment in the home environment, concerning costs, space and structural considerations. A facility management perspective on usability adapted to this context could elucidate relevant connections between the physical environment and its users (Alexander, 2006), which could be the topic for another article.

There is need for more research, especially in a Swedish context. Decision-makers, architects, planners and care providers need more knowledge about the prerequisites for aging-in-place in ordinary housing. We mean that it is crucial to map hazards in the physical work environment and create prerequisites for eliminating them as early as possible. We also assume that what supports a successful aging also supports good working conditions. Furthermore, the increasing lack of available staff within Swedish home- and healthcare (Dagens Medicin, 2023), and the subsequent increase in assistive devices and technologies, makes this research even more relevant.

Aim

The aim of this paper is to investigate the relation between the physical environment for enabling a safe working environment for home- and healthcare staff in ordinary housing, and the possibilities for aging-in-place for the residents.

Research questions

- RQ1. What enablers and barriers for safe in-home care and services for older people are observed in ordinary housing?
- RQ2. How can ordinary housing be designed or adapted to fulfill the double purpose of being both a functional home and a work environment in a care situation?
- RQ3. What kind of improvements or adaptations can be made to the existing physical environment to support home healthcare services and the possibilities for aging-in-place in ordinary housing?

Methods

This paper is based on the study protocol from a study performed in 2017–2018. The study protocol has been published separately ([blinded for review]) and relates to how enablers and barriers in ordinary housing affects staffs' safety and accessibility in care-giving situations. This paper analyzes the results from the observational field notes from care situations in the 20 housing units included in the study. In the spatial analysis of the 20 housing units, we use the three spatial qualities of *bedroom capacity*, *spatial proximity* and *functional autonomy* ([blinded for review]).

Design

Qualitative and quantitative methods were used according to a mixed-method design (Freshwater, 2012; Groat and Wang, 2013; Patton, 2002) to strengthen the scientific validity (Miles *et al.*, 2019; Onwuegbuzie and Johnson, 2006) and to grasp measurable empirical material such as layouts of the housing units as well as observations of home- and healthcare staff. Furthermore, the multidisciplinary approach in this paper is strengthened by the authors' scientific disciplines: architecture, occupational therapy, physiotherapy and care sciences.

Data collection

Observations

The observations were conducted in two city areas in Gothenburg, Sweden. Staff in homecare and home healthcare were observed: nurse assistants and unskilled homecare staff and staff from home healthcare services (i.e. nurses, occupational therapists and physiotherapists). The data collection was conducted during 2016–2017 (for a detailed description, see [blinded for review]).

Data were gathered by observations of working situations among home- and healthcare staff in 20 housing units (please see Table 1 for an overview of housing properties, participants' mobility status and level of care administration). The selection criteria have included a representative variation in housing types, sizes and standards; respondents' age and sex; and residential areas. One of the authors, an occupational therapist, performed all observations by registering staff movements within the layout of the apartments when care was performed to older adults as well as field notes of the observations, to capture home and healthcare situations in different ordinary housing. Fieldnotes were made in two forms: notes in notepads and annotations on printed-out designs of the housing units. See the study protocol presented in [blinded for review].

Analysis

The data analysis of the observation field notes was performed by use of thematic analysis (Braun and Clarke, 2012), using five steps of analysis:

- (1) Familiarization with the data by reading the whole material by reading and re-reading the data.
- (2) Coding every data item and collating all the codes and relevant data extracts.
- (3) Searching for themes and coherent and meaningful patterns in the data relevant to the research question and collating all the coded data relevant to each theme and subtheme.
- (4) Reviewing themes and relating the themes and subthemes to both the coded extracts and the full data set.
- (5) Defining and naming themes.

Preliminary findings were validated several times and finally, all the coauthors agreed on the findings. The spatial analysis is presented below, under floor plan analysis.

Findings from the observation study

The findings from the observations and observational field notes formed one overarching theme and two main themes: inadequate space leads to difficulties giving the best care, and

Table 1. Housing properties, participants' mobility status and level of care administration

Case nr.	Housing type	Rooms	Sex	Age 2017	Persons in the house-hold	Homecare per day	Health-care and rehab per week	Access to separate storage space	Accessible bathroom	Walking aid indoors
1	Apartment	2	w	84	1	3	0	0	0	walker
2	Apartment	3	w	87	2	3	1/w	0	1	walker
3	Apartment	2	w	84	2	3	0	0	0	walker
4	Apartment	3	w	71	1	2	1/d	0	1	wheelchair
5	Villa	3	w	72	2	1	0	0	1	walker
6	Villa	9	m	96	2	01	0	0	0	stick
7	Apartment	3.5	w	76	2	3	4/w	1	1	wheelchair
8	Apartment	2	w	93	1	3	0	0	1	walker
9	Apartment	1	w	0	1	5	1/m	0	1	walker
10	Apartment	2	m	90	1	4	1/m	0	0	crutch
11	Apartment	2	m	0	1	1	0	0	1	wheelchair
12	Apartment	3	w	92	1	4	0	1	1	walker
13	Villa	3	w	86	1	2	0	0	0	stick
14	Apartment	3	m	82	1	3	0	0	1	walker
15	Apartment	3	m	86	1	6	0	0	1	none
16	Apartment	3	w	86	2	5	0	0	1	walker
17	Apartment	2	w	81	1	2	0	0	1	none
18	Apartment	3	w	69	2	1	1	0	1	wheelchair
19	Apartment	3	w	78	1	4	0.5 ²	0	1	walker
20	Apartment	4	m	96	1	1	2/w	0	1	wheelchair

Note(s): ¹Cleaning help every third week; ²Twice per month

Source(s): Authors' own creation

developing strategies for handling care in residents' home. In addition, each main theme was divided into three subthemes (Table 2).

Main theme 1: inadequate space and fittings lead to difficulties giving the best care

This main theme comprised three subthemes: the rooms' size and proportion, the rooms' spatial configuration and the rooms' services facilitate or complicate care interventions. The observations identified problems with inadequate space in different rooms, and therefore, were not able to give the best care.

Subtheme 1:1: the rooms' size and proportion

The observations showed that some large bedrooms create conditions for a good working environment for the staff. For example, the space to make a transfer from a standing chair to a shower chair was sufficient when two staff performed the intervention. Another example observed was a bedroom with space for a walker and other mobility devices if this need emerged. The observations also showed that technical equipment in the bedroom is an opportunity for staff to have as good a working environment as possible. For example, a ceiling lift or a height-adjustable bed in the bedroom helps the staff when transferring the person, and removed threshold replaced with a ramp in combination with a shower chair on wheels helps the staff when transferring a person in and out of the bathroom. The observations also showed that rooms normally used to meet personal activity in daily living (ADL) are small. Bathrooms too small or incorrectly dimensioned, result in a person who needs help with ADL cannot get help in the bathroom, as there is no space for both the person and staff. For example, in the shower, there is space for the shower chair but not for staff. Another problem showed in the observations was the construction of the floor that constituted a barrier for the staff. A level difference between bathrooms and adjacent rooms constituted a problem when staff help a person to transfer. Furthermore, lack of protecting water in the shower area can cause water to run out on the floor in the bathroom. This means that the floor can become slippery, and that staff tramps around in water and needs special equipment to avoid getting wet. An assistive device that does not work as intended can also be a barrier for the staff, for example, a wedge in the bathroom is lower but lying loose and moving.

Table 2. Overarching theme, main themes and subthemes from observational field notes

	Observational field notes
Overarching theme	
	<i>Struggling to balance between safeguarding privacy and integrity and a functional working environment in ordinary housing</i>
Main themes	Sub-theme
(1) Inadequate space and fittings lead to difficulties giving the best care	1:1. <i>The rooms' size and proportion</i> 1:2. <i>The rooms' spatial configuration</i> 1:3. <i>The rooms' services facilitate or complicate care interventions</i>
(2) To develop strategies for handling care in residents' home	2:1. <i>The staff adapt based on the resident's situation</i> 2:2. <i>The staff adapts based on the conditions in the home</i> 2:3. <i>The staff adapts to the individual's wishes or needs to use the residence</i>

Source(s): Authors' own creation

Subtheme 2:2: the rooms' spatial configuration

The observations showed that how the rooms are placed in relation to each other may facilitate or complicate the work. The work was facilitated when the bathroom and bedroom were placed close to each other. This as a shorter distance facilitated transferring the person or the assistive devices. Problems arose when there was a long distance between bedroom and bathroom, then staff must pass several rooms to get to the bedroom where the person was, or when the toilet and shower are placed in separate rooms.

Another problem was when staff needs to pass several doors to get into the apartment, and when the stairs begin right next to the apartment door. Placing furnishings can also complicate staffs' interventions. For example, the observations showed that as the wedge in the hall is steep, staff must "hold back" when they transferred a person in wheelchair, and to not go into the hat shelf, where there are clothes and drawers placed underneath, which in turn resulted in a difficult transfer.

Subtheme 2:3: the rooms' services facilitate or complicate care interventions

The observations showed that placement of standard equipment such as electrical outlets may complicate the work. For example, staff must search for a socket to enable the cord to reach the bedroom. The observations also show that kitchen fittings constitute a problem for staff, for example, a low-placed sink or kitchen counter, which occurs in old homes or homes adapted to the resident. Other examples are that narrow kitchen prevents staff from helping a person with walking and transferring, but also staff's transferring, and when staff must pass the kitchen table further into the laundry room, they must go "on the side". Other examples shown in the observations was a stair lift that facilitate for the resident but constitutes but complicate for staff must walk or vacuum the stairs. A stair lift mounted in a curved staircase, and too crowded to walk next to because the stair lift takes up space. Another example shown in the observations was a stair lift that facilitate for the resident but complicate for staff who vacuum the stairs, and unsafe because the stairs are relatively steep and limited with space due to stair lifts.

The observations gave insight into the fact that inappropriate furnishings, both fixed and loose, may complicate the work. In addition, staffs' material is sometimes stored in a way that makes it look dirty in the home. For example, wall-mounted cupboards in the hall, where hand sanitizer and shoe covers are placed visible, shoe cover lies in a drawer on the floor and a stool with gloves and hand sanitizer.

A low bed, not height adjustable creates an unfavorable working position, for example, when transferring, wound care and other care interventions. Another example is a crowded bedroom that complicate for staff to have a good working position when transferring the person in and out of bed. To maintain good health for both resident and staff, appropriate hygiene routines are required. However, housing qualifications can complicate for staff to maintain good hygiene. Equipment may be missing when handling used materials and garbage. Even if staff establish strategies to take care of this as safe as possible, the handling still constitute a working environment problem. The observations showed that storage of material is not always possible close to where it is needed. For example, staff must go back and forth to the hall to pick up gloves, hand sanitizer and toilet paper which is placed on the coffee table in the living room.

Main theme 2: to develop strategies for handling care in residents' homes

The observations showed that staff developed strategies to handle the situation with poorly designed or equipped housing from a working environment perspective.

Subtheme 2:1: the staff adapt based on the resident's situation

When staff helps the resident with interventions, they may do so in an unfavorable working position. For example, sitting on a stool in front of the resident in a wheelchair at the dining table, and performing arm and hand training sitting on a chair next to the resident sitting in a wheelchair. Another example shown is staff who use a mirror to be able to see how the wrap sits on the hind of the resident's legs. Unfavorable working position was also seen, for example, helping the resident with dressing must be done with the staff squatting.

Subtheme 2:2: the staff adapts based on the conditions in the home

A home is not always equipped with appropriate work surfaces. The observations show that staff develop strategies to manage their work, but at the same time contribute to a bad working environment. An example and identified strategy involved two staff sitting on a sofa in the living room (kitchen and living room in one) and rolling up wraps that the resident should have on his legs. Another one showed that the location of the refuse dump in relation to the apartment was problematic. This since staff must transport the waste in the car and dispose of it at the common workplace.

The observations provided insight into the fact that necessary technical equipment can be helpful but also complicate the staff's work. Assistive devices implemented to facilitate for the resident can create problems for the staff in their daily work. For example, a freestanding toilet seat placed between bed and wardrobe wall must be moved to get close to the edge of the bed and to access clothes in closet through bed. Different assistive devices can increase the residents' independence in connection with, for example, toilet visits. To promote the resident's independence, the staff therefore helps to empty the urine bottle or freestanding toilet seat when they are visiting.

For various reasons, the residents' personal hygiene cannot always be maintained in an appropriate room, instead in, for example, the bedroom. The staff developed strategies to manage this and must go back and forth to bathroom to fetch water in a jar, back to the bedroom and the resident can have a wash.

Even if a bedroom can be spacious, the choice of placement of furnishings may complicate for staff. For example, a chest of drawers placed on one side and wardrobes on the other side of the bed reduces the space and possibility for two staff to assist with transferring.

Subtheme 2:3: the staff adapts to the individual's wishes or needs to use the residence

The design of the home may implicate that the resident chooses to live the life in the living room or bedroom. The staff then develop strategies that facilitate for the resident to live their life according to their own wishes. This can, for example, mean that the food is served in the living room or in the bedroom, and staff must go to the kitchen to heat food in the microwave, then to the living room where the resident eats the food sitting on the sofa.

Floor plan analysis

Based on the model developed by [blinded for review] (2021), the floor plans were analyzed and assessed according to the three spatial qualities: *bedroom capacity*, *spatial proximity* and *functional autonomy* (see [Table 3](#)).

Bedroom capacity is defined as the possibility to furnish a bedroom with a freestanding bed with equipment, passage at the foot of the bed and space for helpers on both long sides, requiring a free space of 300 × 310 cm. A room where one of these measures is less than 30 cm shorter is considered a "borderline" case. *Spatial proximity* is defined as a maximum distance of 6 m between the basic functions involved in a caregiving situation: entrance, bedroom, bathroom and storage, where the connections between entrance and bedroom, and

Table 3. Summarizing bedroom capacity, spatial proximity and functional autonomy for individual apartments

Case nr.	Building type	Apartment	Bedroom capacity	Spatial proximity	Functional autonomy	Sum potential
1	Multi-family	1 BR	1	1	1	3
2	Multi-family	2 BR	1	1	1	3
3	Multi-family	1 BR	1	1	1	3
4	Multi-family	2 BR	1.1	1	0.5	2.6
5	Private house	2 BR	1.1	1	0.5	2.6
6	Private house	BR	1.1	1	0	2.1
7	Multi-family	2.5 BR	1	0.5	0.5	2
8	Multi-family	1 BR	1	1	0	2
9	Multi-family	Studio	1	1	0	2
10	Multi-family	1 BR	1	1	0	2
11	Multi-family	1 BR	0	1	1	2
12	Multi-family	2 BR	1	0.65	0	1.65
13	Private house	2 BR	1	0.65	0	1.65
14	Multi-family	2 BR	0	1	0.5	1.5
15	Multi-family	2 BR	1	0.3	0	1.3
16	Multi-family	2 BR	0.1	1	0	1.1
17	Multi-family	1 BR	0.1	1	0	1.1
18	Multi-family	2 BR	0.2	0.8	0	1
19	Multi-family	2 BR	0	1	0	1
20	Multi-family	3 BR	0.1	0.5	0	0.6
Average			0.69	0.87	0.30	1.86

Source(s): Authors' own creation

bedroom and bathroom are given extra weight. *Functional autonomy* is defined as the possibility for a healthy partner to live an independent life in the apartment while care is given to a partner in need. This criterion is met if the second bedroom, kitchen and living room are not disturbed by caregiving activities. This quality does not apply to studio apartments.

Apartments with a total value of 3+ are considered to have very good potential for aging-in-place, apartments with a value of 2+ are considered to have a good potential, whereas apartments with a value between 1 and 2 have a limited potential, and apartments with a value below 1 are considered unsuited for aging-in-place.

The model aims to serve as design guidance when planning new housing or as a tool to assess existing apartments. Each quality is assessed independently and assigned a value between 0 (quality is missing) up to 1,3 (quality criteria are completely fulfilled), or fractions thereof. A spatial analysis of the 20 housing units was performed. We assessed the *bedroom capacity* as the possibility to use the bedrooms in a care situation. *Spatial proximity* was analyzed as the physical distance between entrance, bedroom, bathroom and storage. *Functional autonomy* was then assessed as to what extent the care can be performed without too much disturbance for other persons in the apartment, for example, for a partner.

The analysis is based on floor plan drawings and focuses completely on spatial qualities and do not include individual needs. The model was developed for new production, where accessibility standards are regulated in the Swedish building code. In the existing housing stock, bathrooms are usually a crucial function in a care giving situation, and, in the older housing stock, typically too small to function properly.

Of the 20 analyzed apartments in this paper, three scored 3 points, and an additional eight apartments scored 2+. Eight apartments scored between 1 and 2, and one apartment got a value of 0,6. In total, 55% of the apartments were considered to have good or very good potential for aging-in-place, whereas 45% were considered to have limited or very limited potential.

There was no obvious connection neither between type of residence (multifamily house or private house) and assessed potential, nor between size of the apartment and potential (see Table 4). Overall, the one-bedroom apartments got the highest average score (2,18), whereas a three-bedroom apartment got the lowest score (0,60). Spatial proximity was the least problematic category, where 14 out of 20 apartments (70%) had all distances within the limit of 6 m. In five apartments there was a long distance from entrance to bedroom, and in four cases there was a long distance from entrance to storage.

A total of 13 apartments had full bedroom capacity, and three of these also had a second bedroom almost meeting the space requirements. Four apartments had one or two bedrooms

Table 4. Summarizing bedroom capacity, spatial proximity and functional autonomy for apartment types

Apartment type, no. of bedrooms	No. of apts.	Bedroom capacity	Spatial proximity	Functional autonomy	Sum potential
Studio	1	1	1	0	2
1 BR	6	0.68	1.00	0.50	2.18
2 BR	10	0.65	0.84	0.25	1.74
2,5 BR	1	1	0,5	0,5	2
3 BR	1	0.1	0,5	0	0.6
8 BR	1	1.1	1	0	2.1
	20	0.69	0.87	0.3	1.86

Source(s): Authors' own creation

almost meeting the standards, while in three apartments there were no bedroom meeting these requirements. There was no connection between size of the apartment and bedroom capacity.

Functional autonomy turned out to be the most problematic category. This is important, not primarily from a caregiver perspective, but for the residents. In four apartments there was complete autonomy, where kitchen, living room and a second bedroom could function without being involved in the caregiving situation. In four other apartments, the second bedroom was disturbed, but kitchen and living room functioned independently. In 11 apartments, all circulation connected to the caregiving would pass through the social spaces, or in front of the second bedroom. For the studio apartment, this category does not apply as it is designed for a single person household.

Discussion

In this study, we focus on the physical environment. The observations identify a number of enablers and barriers for safe in-home care and services for older people. In the 20 floorplan analyses, we find support for the assumption that what promotes a successful aging-in-place for the residents/patients, is also enabling the staff to perform caregiving in an effective manner. From the staff's perspective, the physical properties of the home environment of the caretakers have a significant impact on their health and safety, prompting an adaptability from the staff to various spatial configurations.

Here, we discuss the possibilities for safe caregiving and the possibilities for a successful aging-in-place. In the beginning we asked three research questions. Can we provide any answers for them, and what are the implications?

What enablers and barriers for safe in-home care and services for older people are observed in ordinary housing?

The floorplan analyses of the 20 apartments shows that the number of rooms or apartment size does not singularly determine the possibilities for caregiving or for aging-in-place. This result is comparable to the results presented by [blinded for review].

How can ordinary housing be designed or adapted to fulfill the double purpose of being both a functional home and a work environment in a care situation?

It is suggested here that a crucial factor for both a well-functioning workplace and a successful aging-in-place is the *bedroom capacity*. The floorplan analysis confirms this assumption. Furthermore, it shows that the bedroom capacity is dependent on how the bed is placed, how big it is, and if it can be moved easily. The results also elucidate the bathroom capacity in relation to size, door width, shape and fittings.

This paper shows the importance of *spatial proximity* between the rooms used in a care situation. The connections between bedroom-bathroom-entrance are considered of great importance for both a well-functioning workplace and a successful aging-in-place. In addition, connections to kitchen and living room are identified as very important in the daily life actions for both residents and staff, in many cases this is complicated by spaces located on different floors.

This paper shows that *functional autonomy* is not necessarily related to size or number of rooms. More important is the spatial configuration of the rooms.

We can hereby assume that both *bedroom capacity* and *bathroom capacity* is of equal importance for a safe work environment and a successful aging-in-place. We can also assume that *spatial proximity* is of greater important to the resident, but involves safety issues, for example, in the case of solitary work, where staff has to temporarily leave the resident to collect something in a storage compartment, from the car, or from the kitchen. Another initial assumption has been that *functional autonomy* has the greatest significance for a partner who shares the housing unit with the patient. Covid has shown us that this is not necessarily true. In connection with contagious diseases, *functional autonomy* is also related to a) the

possibilities of living together without transferring the disease and b) to minimize the risk of transfer between residents and staff.

What kind of improvements or adaptations can be made to the existing physical environment to support home healthcare services and the possibilities for aging-in-place in ordinary housing?

Concerning *bedroom capacity*, we identify some measures to have as reference values for new housing production ([blinded for review]). The reality, however, are often far from these measures. In addition, how the bedroom is fitted drastically affects the usability of the room. In new production, a good bedroom capacity in a care situation should be catered for in the design of the new buildings. In an existing housing context, the primary means, by which to increase the capacity and accessibility would be to adapt the fittings or, if possible, to change bedroom.

Spatial proximity is also much dependent of the built structure. In an existing context, you are directed to changes in the use of the spaces, e.g. to change bedroom, change floor or make minor constructional changes.

Good possibilities for *functional autonomy* should be catered for in new production, thereby increasing the possibilities for aging-in-place as well as improving the hygiene standard, e.g. in a pandemic situation. In an existing housing unit, the possibilities are also dependent on the built structure. The actions would be similar to those proposed under *spatial proximity*, but there can also be possibilities to make a subdivision in a bedroom or living room, e.g. by curtains or furniture.

Conclusions, strengths and weaknesses

We see that *bedroom capacity*, *spatial proximity* and *functional autonomy* are crucial for both residents and staff in creating a safe and effective work environment and possibilities for aging-in-place, respectively. We also see that the significance for residents and staff differs, and that the staff develop strategies to fill the gap between a perfect workplace and the reality.

In a care situation where the resident/patient is reasonably mobile and not bedbound, his/her access to the kitchen and living room are equally important as to bedroom-bathroom-entrance. In a situation with more severe care needs, the resident/patient will to a higher extent be limited to bedroom (bed)-bathroom. But for the staff, easy access to bedroom-bathroom-entrance-kitchen is equally important, regardless of the care situation.

The multi-disciplinary approach, in combination with a mixed-methods design, has allowed us to draw some conclusions and to formulate directions for further research. The thick descriptions (Geertz, 1973) from the observation study have been combined with the quantifiable results from the floorplan analyses.

One weakness with the presented results is the relatively small sample. Another is that the most information is obtained from assistant nurses and less from nurses, occupational therapists and physiotherapists. However, results with focus group interviews of these categories are published previously ([blinded for review]).

This paper does not present any ideal solution in the form of tables and layouts. It rather points at a number of problems and, to some extent, how to deal with them. One example of the construction of a tool, or method, is the aforementioned paper by [blinded for review], on which this paper draws many of its conclusions. Nordin, et al. (2015) and Nordin et al. (2016) describe the adaptation of an existing measurement tool to a national context, concerning residential care facilities, but partly transferable to this context.

Implications for further research

This paper suggests that there is need to further study spatial qualities regarding caregiving in ordinary housing environments. A further study of bathroom capacity is called for in terms of place for transitions and medical equipment.

More studies could be done to establish sustainable strategies for adapting existing housing environments in relation to *bedroom* and *bathroom capacity*, *spatial proximity* and *functional autonomy*. The staff in in-home care and services can, to a greater extent, be used as guides to these adaptations, both taking into consideration how they develop special strategies and/or how this situation can be handled.

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