Fire safety in planning of elderly residential facilities: a case study from Korea
Nahyang Byun

Department of Architecture, Chungbuk National University, Cheongju, South Korea

ABSTRACT
In line with the global phenomenon of population aging, Korea is rapidly becoming an aged society. This research focuses on the lack of residential facilities for elderly people in Korea. It aims to explore the plans and current situation of elderly residential facilities and to identify the relevant challenges and issues. The case study of elderly residential facilities consists of three methodologies: the type of facility and physical evacuation conditions, the planning and usage of the facility, and interviews with relevant parties. The case study reveals fire safety issues by the degree of obsolescence and the size of the facility. It was found that the general response to obsolescence was unprofessional compared to the increase in remodelling demands. In terms of evacuation conditions, the facilities complied with the requirements for evacuation instruments, yet generally were lacking in proper instructions or concrete evacuation plans. The status of this was worse for smaller facilities. This research discusses specific issues with the floor plans, and interview records. Based on the analysis data, it suggests directions for future enhancement of the highlighted fire safety issues in the planning of elderly residential facilities, and the relevant institutional support plans as research outcomes.

1. Introduction
1.1. Background and purpose of research
Korea is experiencing rapid aging while undertaking fewer trials, errors, and experiences related to societal change and relevant policies than other nations. The Welfare of Elderly Persons Act, requiring the establishment of elderly welfare facilities, has applied the same classifications and standards for a long time. The number, and poor environment, of residential welfare facilities particularly illustrates the institutional limitations of merely supplying and managing facilities. Compared to medical and leisure welfare facilities, the supply of which has exceeded demand, residential welfare facilities suffer from a problem of polarization and do not fulfil their primary purposes and functions (Kwon, Kim, and Kim 2017; Kwon 2012).

Meanwhile, safety issues are important in elderly people's lives, and issues in the physical living environment of elderly people can be resolved by relevant education in the areas of facility plans, usage, and management (D’Orazio et al. 2014; Fonad et al. 2006; Walker et al. 1992; Lina and Catharina 2019). Most of all, fire safety issues need to be addressed including not just fire prevention but also physical condition—layout of floor and exit routes. However, while the number of elderly residential facilities in Korea over the last 10 years has increased, and the safety plans for daily living and evacuation of buildings are inadequate. Only regular inspection of fire, gas, and electricity is provided.

Under these circumstances, the following research questions are raised: 1) How can the fire safety of the senior lives in Korean elderly residential welfare facilities be improved? 2) How can the elderly facilities plan be improved? 3) What are the institutional bases or planning aspects for this? The aims of this research are to explore the plans and current situation of elderly residential facilities, and to identify the relevant challenges and issues. This research applies the case study method. It begins with a literature review on fire safety issues in elderly residential facilities and analyses the development status of Korean facilities. Subsequently, it designates the research subjects, data collection methods, and the content. For the case study, in-depth analysis is performed of nine facilities via field studies, analysis of spatial planning, and interviews. Finally, based on the analysis results, there is a discussion of the associated fire safety issues and physical planning and suggestions for the direction and details of future execution plans.

1.2. Previous studies
Most of the studies in regard to fire safety in Korea have been mainly conducted through the simulation analysis method, and available studies on the elderly facilities are insufficient. This is because the behavior of elderly people was determined by weight rather than reflected in most cases, and academic interest was also low due to the inability to supply and operate elderly residential welfare facilities.
The previous studies on fire safety in elderly facilities in Korea are as follows. Lee and Kim (2004) proposed a ramp which was possible for training, user recognition, and core and vertical movement as a result of the evacuation simulation analysis and field survey conducted for welfare centers and nursing homes. However, the arrangement of spaces within the facility was not addressed in detail. Kang, Seo, and Yang (2011) emphasized the appropriateness of two-way evacuation by comparing the evacuation time and distance according to the double-loaded /central-corridor type and hall type for the small elderly residential facilities. The result of this study is worth noting because it points out the blind spot in the system as the current law does not mandate two-way evacuation in the case of small-scale facilities, and it clearly carries implications for the plan, which divides the type of space layout. In addition, it was found that the exit sign has an absolute effect on evacuation among various physical elements of the facility environment (Jeon et al. 2019).

As the existing studies dealt only with medical, leisure, and residential parts of the elderly welfare facilities, there was a lack of research focused on residential facilities. The evacuation routes in case of fire were also addressed by simplifying the layout of the facility. This study is different in that it examines the fire safety conditions in detail through the in-depth interviews and the analysis of facility floor plans for the elderly residential facilities and deals with evacuation routes.

2. Type of elderly residential facilities and fire safety regulation

2.1. Type of elderly residential facilities and its current state

Korea establishes and operates elderly welfare facilities in accordance with the Welfare of Older Persons Act (2019). These facilities can be classified as “residential”, “medical”, “leisure”, “home care”, or “job support facilities”. Of these, there are three types of elderly residential welfare facilities: “institutions for elderly persons (aka nursing homes)”, “communal living homes for elderly persons (aka group homes)”, and “welfare house for elderly persons”. There is an insufficient number of elderly residential welfare facilities in Korea and a lack of comprehensive facility information management. This research referred to the list of 427 elderly residential welfare facilities announced by the Ministry of Health and Welfare in 2017, and gathered building register data from the Electronic Architectural Administration Information System (E-AIS) from the Ministry of Land, Infrastructure, and Transport.1 The size range of facilities was aligned with mandatory installation criteria for hand held sprinklers (total area of over 300m$^2$). The ages of the facilities were examined via 10-year safety inspection periods.

Results revealed that most of the elderly residential welfare facilities are small, run by individuals, and vulnerable in terms of facility safety and response to fire. Seventy percent of group homes are under 300m$^2$, while most of the nursing homes are over 300m$^2$. That is due to the fact that the facilities can be situated either in detached houses or apartment buildings. The apartment buildings, especially, encounter greater difficulties in quickly responding to fire than is the case with other facilities. The decrepitude of facilities was examined by 10-year safety inspection periods. Most of them were under 20 years old, and half of the group homes were in the age range of between 10 and 20 years. (Table 2).

2.2. Fire safety regulation

Among the fire safety standards, the facility planning, which is the main focus of this study, is related to firefighting facilities, evacuation routes, and evacuation stairs. Residential welfare facilities fall as “the aged and children” under the [Building Act]. Article 15(6) of the [Act on Fire Prevention and Installation, Maintenance, and Safety Control of Fire-Fighting Systems, 2019] strengthens the standards for firefighting facilities for the installation of simple sprinkler facilities, automatic re-detection facilities, and single-alarm detection facilities only for “the aged and children”. Article 4 (Fire Safety Regulation of Evacuation Device) in the National Fire Safety Code (NFSC) 301 specifies the types of evacuation devices and the criteria for their installation. In the case of elderly residential facilities, it is mandatory to stall the devices for every 500m$^2$ of floor area. In particular, the openings of evacuation devices have been prescribed to be at least 0.5 m wide and 1 m long at “an appropriate distance from stairs or exit stairs”. In addition, the evacuation devices and the openings are required to be installed at a position not in the same straight line. Table 1 shows the evacuation devices according to the installation location of firefighting systems, and “the facilities for the aged and children” are as follows.

3. Analysis method

3.1. Selection of the cases and data collection

Research data was collected primarily from various sources-statistics report, facility homepage and Electronic Architectural Administration Information System. The research subject case studies consisted of nine facilities

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1The Ministry of Health and Welfare publishes a facility condition report every year. The Electronic Architectural Administration Information System (E-AIS) is an electronic system for processing civil affairs and licensing. It was established by the Ministry of Land, Infrastructure, and Transport (MOLIT). [https://www.eais.go.kr](https://www.eais.go.kr).
including four nursing homes, four group homes, and one welfare house for elderly persons. The size (number of persons within a home), operating body (individual, corporation), and location (urban, non-urban) of the facilities were considered in the selection process (Figure 1).² The nursing homes included facilities run by individuals and located in a planned management district (A1, A2), and those run by corporations and located in a general residential district (A3, A4). Most of the group homes were located in urban areas. The cases included those in existing detached houses and run by individuals (B1, B3), one newly built by a religious corporation (B3), and one linked to an elderly care organizations (B4). The welfare houses for elderly persons (C) constituted the first model established as public rental housing by a local government.

All of the cases varied in location conditions by the facility. The cases of nursing homes were in a third-class general residential district (A1), a first class general residential district (A2), and a planned management district (A3 · 4). A1 · 2 were located in a general residential area and had easy access to public transportation and were close to public facilities and convenience facilities. A3 · 4 in the planned management district had level differences between the road and facility sites, resulting in sloped access. The group homes were in the second and third class residential districts, in detached houses (B1 · 3), a remodelled

| Type of Residential Welfare Facilities for Elderly Persons | Definition |
|----------------------------------------------------------|-------------|
| An institution for older persons | An institution intended to provide older persons admitted thereto with meals and other conveniences necessary for their daily life |
| A communal living home for older persons | An institution intended to provide older persons with home-like residential circumstances, meals and other conveniences necessary for their daily life; guidance of life and advice, and safety management through a lease of a residential institution to older persons |
| A welfare house for older persons | An institution intended to provide conveniences necessary for their daily life, such as convenient residence, through a lease of a residential institution to older persons. |

Source: WELFARE OF OLDER PERSONS ACT, Article 32

Table 2. Current state of residential welfare facilities for elderly persons in Korea.

| Item | Institution for Elderly Persons | Communal Living Home for Elderly Persons | Welfare House for Elderly Persons |
|------|---------------------------------|----------------------------------------|---------------------------------|
| Facility Size GFA (m²) | Number of Facilities | Ratio (%) | Number of Facilities | Ratio (%) | Number of Facilities | Ratio (%) |
| Overall | 258 | 100 | 131 | 100 | 31 | 100 |
| Less than 300 | 22 | 8.5 | 70 | 53.4 | 0 | 0 |
| 300–600 | 53 | 20.5 | 38 | 29.0 | 2 | 6.5 |
| 600–900 | 159 | 61.6 | 16 | 12.2 | 28 | 90.3 |
| More than 900 | 24 | 9.4 | 7 | 5.4 | 1 | 3.2 |
| Total | 258 | 100 | 131 | 100 | 31 | 100 |
| Facility Deduction (years) | 28 | 10.9 | 65 | 49.6 | 8 | 25.8 |
| Less than 10 | 112 | 43.4 | 61 | 46.6 | 17 | 54.8 |
| 10–20 | 97 | 37.5 | 66 | 50.4 | 13 | 41.9 |
| 20–30 | 29 | 11.2 | 43 | 3.0 | 1 | 3.3 |
| More than 30 | 23 | 8.9 | 10 | 0 | 0 | 0 |
| Total | 258 | 100 | 131 | 100 | 31 | 100 |
| Operating Body | | | | | | |
| Social Welfare Foundation | 103 | 39.9 | 12 | 9.2 | 7 | 22.6 |
| Incorporated Foundation | 27 | 10.5 | 7 | 5.3 | 1 | 3.2 |
| Corporation | 0 | 0.0 | 0 | 0.0 | 16 | 51.6 |
| Private | 117 | 45.3 | 110 | 84.0 | 5 | 4.5 |
| Other | 10 | 3.9 | 2 | 1.5 | 0 | 16.1 |
| Missing | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 |
| Total | 258 | 100 | 131 | 100 | 31 | 100 |

Source: Ministry of Health and Welfare (MOHW) 2017 Status of Elderly Welfare Facilities. 2016.12.31. Sejong-si, Korea. pp. 65–96; 427 Residential Welfare Facilities, Building Register. E-AIS Homepage. Retrieved 1 June 2017 from www.eais.go.kr

Figure 1. Analysis process of the cases.

²The number of elderly residential welfare facilities in Korea has been decreasing in recent years compared to other types of welfare facilities. Most communal living homes for elderly persons, a form of group home, have been discontinued in Seoul.
neighbourhood living facility (B4), or newly built elderly welfare facility (B2). Case C was located in a second class general residential district near the public housing area of a new town. It included a walkway and outdoor space in front of the facility.

3.2. On-site survey

The aim of the site survey was to explore the physical environment of the facility in order to diagnose the facility plan and spatial status in terms of fire safety, while examining evacuation conditions. Evacuation conditions can be divided into evacuation spaces and evacuation routes. Evacuation spaces refer to balconies, including the evacuation safety area, rooftop, and outdoor space. Outdoor space is divided with access methods for instruments such as ones used for descending or using stairways. The evacuation route takes into account distance and directions as to whether a two-way evacuation is available.

3.3. Analysis of spatial planning

Spatial planning of facilities is closely related to moving flow and method, escape route, and evacuation planning. The aim of analysing spatial planning was to understand the actual spatial use and emergency response scenarios in order to suggest improvements. Based on floor plans for each case, this was analysed in parallel with a field study. Firstly, this spatial analysis identified the zones separating the living space and the space to move. Secondly, it analysed the location of evacuation spaces such as the rooftop of each floor, outdoor areas, balconies, and evacuation space including designated safe areas such as the path from each living space or a living room to the evacuation space (rooftop, balcony, exit and rescue device), and the route direction of each floor. Third, based on the second step, it analysed the layout of room and pathway and the location of building the core. For improving the evacuation route, it might be physical condition including layout.

3.4. Interview with the operator and manager of facilities

The interview procedure aimed to identify the challenges either occurring in or faced by the facilities. It was conducted in 1:1 interviews with the representative or manager of each facility. The questionnaires consisted of 3 parts: overall facility operation, facility status and spatial using problems, and fire safety. The status and problems included the location, spatial organization, the propriety of each space, ages, urgent maintenance, legal criteria, and actual facility installation. The safety component considered safety management and inspection of the facility.

4. Result

4.1. Characteristics of spatial planning and layout

Spatial planning and layout analysis can be distinguished by the location of bedrooms, corridors, halls, cores and stairs in the plane. The spatial planning can be divided into the double-loaded/corridor structure (A1, A4, B1, B2), single-loaded corridor (A2, C) and the other (A3, B3, B4). In addition, it is divided if the core is located in the center of the building (A1, B2, A4, C) one-sided (A2, B3, B4), or one-story building (B1, A3). Depending on the type of building and the location of the core, there are differences in access to the bedroom and in the horizontal path of travel.

The difference between the evacuation route and the total distance according to the overall structure and core layout of these spaces is caused to the segregated layout of the top floor bedrooms and offices rather than the corridor structure and the position of the core located at the end of the corridor in the cases of A1 and A2 where the total evacuation distance is more than 40 m. Despite the fact that A1 and A2 are two-way evacuation in the form of a rectangular building, isolated space is inevitably created. On the other hand, although the case C is a rectangular single-corridor structure, the average evacuation distance is short for each floor because each bedroom has a balcony. Except in the case of C, there are no cases where bedrooms and balconies are connected, but if you have more than three floors. However, in the case of three floors or higher, balcony planning is required to secure the shortest distance. If this is applied to other facilities in common, not only the evacuation route but also the environment of the bedroom can be improved.

A3 and B1 are small facilities with an average evacuation distance of less than 10 m. The distance from the entrance to each bedroom is within a relatively short radius. The A3 is a unique structure with an office in the center of the plane, designed to make it easier for the elderly to enter each bedroom. In this case, the two-way evacuation is possible with stairs at the entrance and behind the building, but the stairs have

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3Escape plans include 1. Fire alarm method and tools, 2. Number of persons to evacuate from each floor, 3. Persons who will experience difficulty evacuating independently, 4. Evacuation route from each living room to outside (rooftop or safe area), 5. Method and route of evacuation for persons who support with number 3, 6. Facility for evacuation, fire prevention area, and etc. based on Article 14-4 of the ENFORCEMENT RULE OF THE FIRE PREVENTION AND INSTALLATION, MAINTENANCE, AND SAFETY CONTROL OF FIRE-FIGHTING SYSTEMS ACT.

The following are the schedules of the site visit and interview: A4 and C on July 6, 2017, B4 and B3 on July 7, 2017, A2 and A1 on 10 July 2017, B1 and B2 on July 19 2017, A3 on 22 August 2017.
narrow passageways. It has the difficult spatial structure to be seen from elsewhere and secure vision. In this case, there is a need to improve the evacuation route by adjusting the office wall where the core is located or by ensuring sufficient passage to the stairs. That is, in the case of a small facility, the layout of the building, where the living room or the hall is centered, makes it easier to recognize the evacuation route at a short distance.

On the other hand, throwing fire extinguishers are usually installed in small-scale facilities instead of other evacuation devices. In the case of A3, A4, B1, and B3, the throwing fire extinguishers are located at the entrance. It is installed for easy checking during regular fire checks. Even if the evacuation distance is short, it is necessary to install it in the bedroom or kitchen with a distance from the entrance.

4.2. Characteristics of physical condition for fire evacuation

Figure 2, 3 and 4, Table 3 and 5 show physical condition in facility planning for evacuation. Table 4 and 6 are an analysis of escape distance from each room to the exit, evacuation space on the floor, and rescue device by case. These are related to meet fire safety requirement in the planning aspect.

All the nursing homes, A1 to A4 had the same structure whereby an aisle was situated in the middle of the bedrooms. This long aisle enlarged the vertical and horizontal distance for movement. Although the bedrooms, toilets, and bathrooms were arranged as units, the dining rooms, living rooms, and program rooms were separated as a certain designated floor or isolated within the same floor. It should be noted that
some of the elderly could not lead independent lives, which may have had an effect on the evacuation.

Most of the elderly experienced difficulties using elevators and stairways in B1 to B4. The communal living homes for the elderly were as small as a detached house, with fewer people than the nursing homes, although it was hard to verify this exact information. If staff do not provide such information, rescue workers cannot identify the number of people in each bedroom or each individual’s health status in order to decide the priority and method of rescue. However, this information was not systematically managed.

Case C featured a welfare support center, administrative office, program room, a dining room, and a grocery store on its lower floors (first and second floor) while the third to 14th floors were residential facilities with rooms, toilets, and kitchens for cooking. The balconies in the residential facilities were linked to the evacuation space, and each household had a fire alarm and a sprinkler. Evacuation rooms had been installed to use a lift-type evacuation instrument, linked to the corridor and easily accessible on each floor. The evacuation room was separated from the lower floors, main entrance, and the core, and connected to the outside of the building.

### 4.3. Fire safety issues based on the interview results

The first issue was the safety aid facility installation for responding to emergency situations and preventing incidents. Although firefighting items such as evacuation instruments were installed on each floor, the guidance, education, and training for these instruments were found to be insufficient. Although the evacuation instruments were installed, there was a lack of any staff demonstrations or training for the elderly. As the installation space was insufficient, fire extinguishers in the small existing space reduced the basic living space. Although the fire extinguishers were situated at prominent points in the building, the elderly people or facility staff did not possess any detailed information about them.
| Floor Installation Location | Basement | 1st Floor | 2nd Floor | 3rd Floor | 4th Floor or higher 10th Floor or lower |
|----------------------------|----------|-----------|-----------|-----------|----------------------------------------|
| Facilities for the aged and children | Evacuation Traps | Escape Slide · Rescue Bag · Evacuation Bridge · Multi person evacuation device · Evacuation lift | Escape Slide · Rescue Bag · Evacuation Bridge · Multi person evacuation device · Evacuation lift | Escape Slide · Rescue Bag · Evacuation Bridge · Multi person evacuation device · Evacuation lift | Evacuation Bridge · Multi person evacuation device · Evacuation lift |
Table 4. Case outline.

| Facility Type | Case | GFA (m²) | Building Stories | Residents/Full-time Staff (No. of Persons) | Establishment (Date) | Operating Body | Location (City) |
|---------------|------|----------|------------------|-------------------------------------------|---------------------|----------------|-----------------|
| A Institution | A1   | 1606.3   | 1 basement, 3 stories | 64/15 | 1982.04 | Social Welfare | Seoul |
|               | A2   | 782.8    | 1 basement, 3 stories | 22/7  | 1998.11 | Incorporated Foundation | Seoul |
|               | A3   | 396.1    | 1 story           | 11/5  | 2006.11 | Private          | Sejong |
|               | A4   | 306.2    | 2 stories/1 basement, 3 stories | 29/5  | 2013.04 | Private          | Sejong |
| B Communal Living | B1   | 204.4     | 1 basement, 2 stories | 7/3  | 2005.01 | Private          | Daejeon |
| Home          | B2   | 539.9    | 1 basement, 3 stories | 9/4  | 2005.10 | Incorporated Foundation | Daejeon |
|               | B3   | 210.6    | 1 basement, 2 stories | 5/2  | 2007.07 | Private          | Daejeon |
|               | B4   | 490.3    | 1 basement, 3 stories | 6/3  | 2015.06 | Incorporated Foundation | Daejeon |
| C Welfare House | C    | 40,874.9 | 1 basement, 20 stories | 100/4 | 2014.11 | Social Welfare | Sejong |

Source: Ministry of Health and Welfare (MOHW) (2018) Status of Elderly Welfare Facilities. 2016.12.31. Sejong-si. Korea. pp. 65–96; 9 Cases from the Building Register. E-AIS Homepage. Retrieved 5 June 2017 from www.eais.go.kr

Table 5. Condition of facility planning for fire evacuation.

| Items                        | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | C |
|------------------------------|----|----|----|----|----|----|----|----|----|
| Evacuation space            |    |    |    |    |    |    |    |    |    |
| Balcony                     | ●  | X  | X  | X  | X  | X  | X  | ●  | ●  |
| Access to balcony           | ●  | ●  | X  | X  | X  | ●  | ●  | ●  | ●  |
| Rooftop                     | ●  | ●  | X  | X  | X  | ●  | ●  | ●  | ●  |
| Access to roof floor        | ●  | ●  | X  | X  | X  | ●  | ●  | ●  | ●  |
| Exterior                     |    |    |    |    |    |    |    |    |    |
| Using instrument            |    |    |    |    |    |    |    |    |    |
| Through staircase           |    |    |    |    |    |    |    |    |    |
| Evacuation route            |    |    |    |    |    |    |    |    |    |
| Distance                    |    |    |    |    |    |    |    |    |    |
| Within 50m                  |    |    |    |    |    |    |    |    |    |
| Direction                   |    |    |    |    |    |    |    |    |    |
| One way                     |    |    |    |    |    |    |    |    |    |
| Two way                     |    |    |    |    |    |    |    |    |    |
| Fire Prevention             |    |    |    |    |    |    |    |    |    |
| Fire Partition              |    |    |    |    |    |    |    |    |    |
| Fire Door, Shutter, Wall    |    |    |    |    |    |    |    |    |    |
| Planning of Fire Partition  |    |    |    |    |    |    |    |    |    |
| Change of Boundary and Partition Wall |    |    |    |    |    |    |    |    |    |
| Interior                    |    |    |    |    |    |    |    |    |    |
| Finishing Materials         |    |    |    |    |    |    |    |    |    |
| Exterior                    |    |    |    |    |    |    |    |    |    |

*Applicable (●), Partially Applicable (○), NA (X)

Table 6. Analysis of fire evacuation distance.

| Total distance from room to exit using stairs(m) | From room to balcony (or roof top) (m) | Form room to rescue and descent device (m) | Cases | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. |
|-------------------------------------------------|----------------------------------------|-------------------------------------------|-------|------|------|------|------|------|------|------|------|
| A1                                              | 26.0                                   | 4.8                                       | 46.4  | 9.2  | 2.4  | 13.2 |        |      |      |      |      |      |
| A2                                              | 27.3                                   | 3.6                                       | 49.2  | 15.1 | 3.6  | 25.6 | 11.8  | 2.4  | 21.6 |      |      |      |
| A3                                              | 16.0                                   | 12.2                                      | 19.4  | -    | -    | -    | -     | -    | -    | -    | -    | -    |
| A4                                              | 8.1                                    | 2.4                                       | 12.0  | -    | -    | -    | 11.8  | 2.4  | 21.6 |      |      |      |
| B1                                              | 18.3                                   | 7.2                                       | 29.2  | -    | -    | -    | 15.4  | 2.4  | 21.6 |      |      |      |
| B2                                              | 7.7                                    | 2.4                                       | 13.2  | -    | -    | -    |        |      |      |      |      |      |
| B3                                              | 8.1                                    | 2.4                                       | 12.0  | -    | -    | -    | 6.6   | 2.4  | 9.6  |      |      |      |
| B4                                              | 18.3                                   | 7.2                                       | 12.0  | -    | -    | -    | 6.6   | 2.4  | 9.6  |      |      |      |
| C                                                | 27.3                                   | 12.2                                      | 49.2  | 15.1 | 3.6  | 25.6 | 15.4  | 2.4  | 21.6 |      |      |      |

Although handles had been installed on the living room walls, they were removed for flame-resistance, firefighting equipment installation, and wallpaper. (B1 manager)

Although the borough office recommended that we repair stairs and install an elevator, it is impossible to do that with the present areas. The sprinkler equipment was installed in the small existing area. (B3 operator)

The emergency bell is located in the middle of the bedroom walls, where people can reach it while standing. However, people often cannot stand in a situation when they need to use an emergency bell. It should be relocated in a lower and more easily accessible position. (C general secretary)

The second issue was the living safety management for elderly people. The safety management for elderly residential welfare facilities must consider their lives aside from the facilities because improvement can be derived from their lifestyles and conditions. Systematic management to record the place, reason, and victim of accidents requires individual recording. In addition, detailed contact, coping strategies, and support plans are needed to respond to an individual’s physical status in an emergency situation.
5. Discussion: how to improve fire safety for the elderly in a residential welfare facility

First, Elderly residential welfare facilities need to secure safe two-way evacuation routes by installing evacuation instruments and identifying the appropriate evacuation route in the case of emergencies. The small communal living homes for the elderly especially had problems with two-way evacuation. Facility was not planned considering two-way evacuation and it is not a legal obligation.

To enable two-way evacuation, it is necessary to plan balconies in the bedroom area. Existing large-scale facilities have a spatial structure that forms a long rectangular corridor, and the evacuation distance is bound to be long even if a core is installed in the center or an evacuation device is installed at the end of the corridor. In case of fire from the outside, access to each bedroom is limited to windows, and it is practically limited for the elderly to evacuate on their own. Not planning to have balconies in elderly residential facilities in Korea often creates inconvenience because the elderly who actually use the building are in worse health condition than the condition prescribed by the law, and they find it difficult to freely move around. There is a prejudice that the balcony space may present safety issues rather than improve the living environment. Above all, the initial facility installation criteria applied as the nursing homes had been built on a large scale has been maintained for a long time.

Secondly, Small facilities require facility planning to arrange bedrooms with a common space such as a living room or hall as the center. Elderly living families often operate in old detached houses as small facilities, and the layout where the living room is in the center makes it easy to secure a route to exit. On the other hand, there is a problem of going from room to room. The grid layout also has the problem of changing the direction 2–3 times in the case of evacuation.

Lastly, small-size facilities require separate management. Among the nursing homes, group homes, and welfare houses for elderly persons, small facilities such as communal living homes for elderly persons were more vulnerable to safety issues due to their old facilities, lack of personnel, and reduced numbers of residents. According to the on-site survey, the residents in communal living homes for elderly persons have difficulties moving and thus spend most of their time lying down. Safety information sharing between the local community, residents, and facility managers is insufficient. Safety instruments are old and inoperative.

The data of this study have the following limitations. First, the analysis of the periphery of the facilities was excluded. It did not cover the separation distance from adjacent buildings and the access to fire trucks. Next, fire safety issues deal with evacuation routes, firefighting equipment (fire extinguishers) and evacuation rescue equipment (rescue bags) that are part of firefighting facilities. Firefighting facilities such as evacuation guidelines, evacuation exit guide lights, and guide signs, etc., are also closely related to the facility planning, and further analysis should be conducted.

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