

## Article

# Apartment Space Planning Directions for Infectious Disease Prevention and Management: Insights Based on Residents' Experiences

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**Abstract:** The COVID-19 pandemic has raised people's interest in pandemic-safe housing. This study aims to present insights into apartment housing space design to prevent and manage infectious diseases based on the actual living experiences of apartment residents. The relevant literature was reviewed, and overall satisfaction was assessed through a questionnaire targeting apartment residents in South Korea. Finally, using the photovoice method, residents' space needs were identified. By applying a mixed-use methodology and identifying the needs of residents, the following two recommendations were derived: (1) a flexible space plan to support multifunctional use while securing work efficiency and privacy in the living room, bedroom, and space for hobbies/work/learning; (2) a facility for removing contaminants at the entrance with sufficient storage space. The residents emphasized the importance of non-structural changes to the space and the convenience of use to increase actual space utilization. When planning future pandemic-safe apartment housing spaces, it is important to consider structural aspects like functionality and facilities. Convenience of use and methods of supporting family members' privacy should also be taken into account.

**Keywords:** residential apartment living experience; residential preference; residents' spatial needs; pandemic-safe space planning; prevention and management of infectious disease



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## 1. Introduction

COVID-19 has brought significant changes to people's daily lives. Owing to the level of social separation it required, the pandemic has posed more social, mental, and psychological challenges to residents' lives [1]. In particular, external activities such as working, studying, and entertainment have been added to the functional needs of residential buildings [2]. Social distancing and self-quarantine have allowed residents to rethink housing design and layout. Various functional, structural, and cultural aspects of housing significantly impact resident health through the prevention and management of infectious diseases [3,4]. Many patients infected with COVID-19 overwhelmed the capacity of hospitals and quarantine institutions; therefore, households operated their homes as places of self-isolation [5].

Accordingly, efforts are being made to examine the layout and design of residential spaces from a new perspective and to suggest future design directions for a more effective response to the prevention and management of infectious diseases. Architecture has long been responsive to pandemics and health threats in innovative and adaptive ways [6]. Regarding the implications of stay-at-home requirements, many useful yet insufficient studies in multiple disciplines, including architectural design, environmental psychology, building science, engineering, urban planning, and healthcare, have been undertaken to determine the modifications necessary to make homes more adaptable to the new norm [5–10]. Scholars have introduced several factors that must be considered when designing the interiors of residential buildings. Tokazhanov et al. [2] introduced the four

categories of “health and safety”, “environmental resource consumption”, “comfort”, and “sustainable use of building services” as pandemic-resilient criteria.

Moreover, they specifically suggested various items such as natural light, temperature and humidity, greenery and gardens, activity/sports spaces, separate toilets for the infected, natural ventilation, space adjustability, personal space, acoustics, and urban farming, regarding the four main categories. Al-Qaisi [4] introduced critical considerations for post-pandemic housing characteristics, such as low-population-density areas, flexibility, pliability and adaptation, and private and removable walls and screens, based on a literature review [11–13]. Molaei et al. [14] and Aydin and Sayar [15] emphasized the importance of semi-open spaces for resting, leisure time, socializing with neighbors, and getting fresh air. Hajjar [16] argued that securing natural elements such as garden space, sunlight, air, and a view of food production helps overcome the negative psychology of residents following the spread of infectious diseases. Millán-Jiménez et al. [17] introduced findings that university students’ preference for open space and flexible space use increased in terms of health and comfort after lockdown.

Bettaieb and Alsabban [3] introduced flexibility as an essential concept in housing after quarantine. They mentioned that the inside–outside relationship through windows and openings, various daily life activities, and changes in behavior in terms of privacy and comfort effected significant changes in spatial composition. To summarize the arguments in the literature, providing a flexible layout and multifunctional space using semi-open spaces and gardens to prevent and manage infectious diseases after COVID-19 effectively has become increasingly imperative.

However, this concept of flexibility requires a structurally removable wall and presents a problem regarding the accessibility of natural light, ventilation, and the outside view, according to each space division. Furthermore, although theoretical guidelines have been presented, their uniform application to individual residential spaces is limited because the lifestyles and needs of residents differ by country and region. Residential buildings play a significant role as spaces where residents mainly stay during self-isolation periods owing to infectious diseases [18]; therefore, it is critical to understand their lifestyles and needs and reflect them in the design of their space. Several authors have outlined the advantages of planning processes involving users [19–23]. In particular, Correia and Willis [24] explained that individuals have different characteristics, vulnerabilities, motivations, and ways and degrees of understanding. They asserted that people look at and respond to the present and future based on their past experiences when faced with a specific situation. For this reason, they emphasized the importance of understanding the individual’s experience to improve the management of future public health issues. In addition, Hartig and Lawrence [25] argued that residence is a concept that includes people, place, activity, and time, and among them, how people act and behave in their residence has a great impact on their health. These articles suggest that understanding people’s behavior-based experiences can provide critical insights to improve the quality of residential spaces in terms of health.

Heydarian et al. [26] stressed that it is critical to apply user-centered design to reflect end users’ needs, requirements, and preferences in building design. Nevertheless, many building industries fail to collect accurate information from users to better understand their needs and behaviors. Consequently, residents’ needs have not been detailed, and the same standards and principles have been continuously applied to building construction, ignoring regional, national, and cultural differences.

As special needs, such as the prevention and management of infectious diseases and social distancing, have emerged due to COVID-19, these characteristics should also be considered in planning residential spaces. To understand residents’ needs, collecting users’ opinions from various perspectives is necessary. Applying a mixed-use methodology is more effective than relying on one quantitative or qualitative research method, including surveys, interviews, observations, and site visits. Quantitative research effectively identifies the majority’s general opinions and preferences. In contrast, qualitative research helps draw in-depth conclusions about latent needs by observing and analyzing the behaviors

of a few representative users from various angles. For example, Cuervo-Vilches et al. [27] described how the Spanish population perceived lockdown, how they related habitability and health aspects to housing, and how they have withstood the COVID-19 pandemic by using a survey and a photovoice method. They explained that it is useful to enrich the understanding of the topic in two aspects, quantitative and qualitative, through the mixed method.

Therefore, this study aims to identify the problems of the current residential spaces and suggest future space design directions by collecting and analyzing residents' living experiences during the COVID-19 period, in order to prevent and manage infectious diseases effectively. The participants in this study were apartment residents living in a metropolitan area of South Korea. The study examined their living experiences when quarantine was strictly enforced due to the COVID-19 pandemic. This study is divided into three stages: literature review, survey, and photovoice. It uses mixed-use methods to identify residents' vivid living experiences during the pandemic and offers practical design directions for pandemic-safe residential space plans based on user perspectives.

## 2. Materials and Methods

### 2.1. Literature Review for Identifying Planning Guides to Prevent and Control Pandemic Disease in Residential Apartments

We examined the trends and guides discussed in the literature regarding space planning in residential apartments to prevent and manage infectious diseases. A literature review was conducted using the methodology introduced by Snyder [28]. The search strategy followed the PRISMA guidelines [29] to select search terms and electronic databases, and we include an explanation of the inclusion and exclusion criteria.

#### 2.1.1. Search Strategy

The three most used and valuable electronic databases were utilized to search academic papers comprehensively: Google Scholar, Web of Science, and Scopus [30]. For search terms, "apartment housing", "pandemic disease prevention and control", "COVID-19 pandemic", "space planning", and "residential space" were chosen as keywords. A cross-search was conducted by expanding the scope to words with meanings similar to residential apartments. The languages included both English and Korean to avoid excluding Koreans' residential experiences and needs.

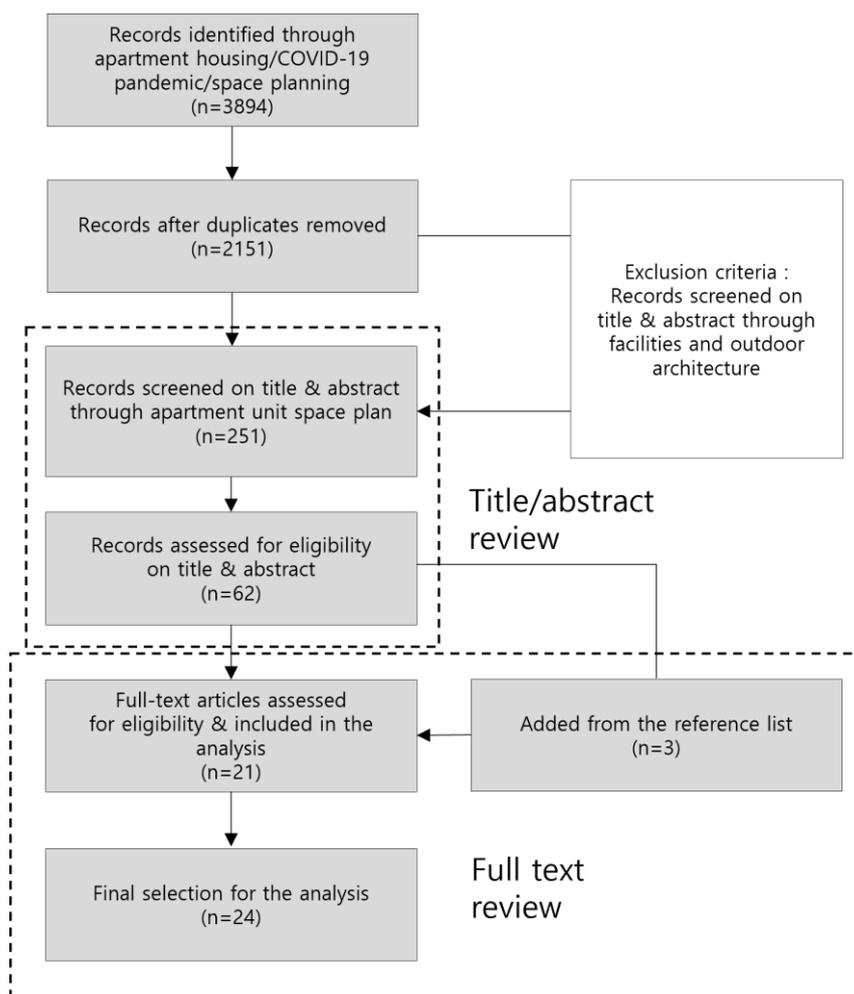
#### 2.1.2. Study Selection

From the literature search results of the three databases selected, a total of 3894 papers were searched. Among them, 251 papers were selected after reviewing the title and abstract of 2151 records, excluding redundant papers. The inclusion criteria included studies targeting apartment unit space and the exclusion criteria included studies dealing with the subjects of facilities, and architecture, building, and indoor environment requirements. As a result of assessing the relevance of the topic, 62 papers were selected, and their eligibility was closely evaluated through a full-text review. In this process, 3 papers were added from the reference list, and finally 24 papers were selected for analysis. The flow diagram of the literature review is shown in Figure 1. The final list of selected studies for review is provided in Appendix A.

### 2.2. Online Survey to Understand Residents' Overall Residential Experiences during the COVID-19 Pandemic

During the COVID-19 pandemic, we conducted an online survey to understand the overall residential experience of Seoul residents. The survey was conducted from 28 June to 2 July 2022 and targeted 201 adults who experienced self-quarantine during the pandemic. The participants were recruited by snowball-targeting Seoul residents. After developing the questionnaire using Google Forms, the survey link was delivered to the participants through text messages. The initial questionnaire was revised and finalized after a pilot test with researchers and ten Seoul residents who had experienced self-isolation.

The questionnaire comprised 23 items: 7 items for sociodemographic characteristics and residence type; 5 items for self-quarantine experience; 8 items for living experience during the pandemic; and 3 items for resident preference for pandemic-safe housing (Table 1 shows the items without sociodemographic characteristics). Two hundred thirty questionnaires were sent to the participants, and two hundred and one responses were received. For the data analysis, frequency analysis was conducted using SPSS version 25.0. The questionnaire obtained ethical approval from the ethics committee of Chungbuk National University in June 2022.



**Figure 1.** Flow diagram of the literature review.

### 2.3. In-Depth Analysis of Apartment Residents' Living Experiences during the Pandemic

At this stage, the photovoice technique was used to examine the living experiences of apartment residents more deeply. Photovoice is an effective method for direct interviews when dealing with sensitive or complex topics among participants by sharing one's experiences with others through photography [31]. Additionally, this method can ensure active participation in the entire process, as it can be conducted online without meeting in person [32].

In this study, to collect and analyze the residential experience during the pandemic more vividly through the voices and gazes of users, the photovoice method was divided into three stages: preliminary preparation, data collection, and data analysis.

**Table 1.** Questionnaire for the survey.

| No. | Criteria  | Questionnaire  |
|-----|---|--|
| 1   | Self-quarantine experience                      | Have you experienced self-quarantine during the COVID-19 pandemic? If yes, how long have you been in self-quarantine?      |
| 2   |   | Where did you spend most of your time within your apartment dwelling during self-quarantine?                               |
| 3   |   | What activities did you mainly perform during self-quarantine?   |
| 4   |   | What was the most uncomfortable aspect of living during self-quarantine?   |
| 5   |   | During the self-quarantine period, what were you most dissatisfied with regarding the structure and function of each room? |
| 6   | Residential experience during the pandemic      | Which areas of your residential space should be changed to prevent and control pandemic disease?                           |
| 7   |   | Which spaces were remodeled, restructured, or rearranged to meet the needs of residential space during the pandemic?       |
| 8   |   | What problems do you face with your residential space in the context of the prevention and management of pandemics?        |
|     |   | 8-1. entrance  |
|     |   | 8-2. living room   |
|     |   | 8-3. kitchen and dining  |
|     | 8-4. bedroom                                    |  |
|     | 8-5. bathroom                                   |  |
|     | 8-6. balcony                                    |  |
| 14  | Residents' preference for pandemic-safe housing | Where is the best place to store disinfection items such as hand sanitizer and masks?                                      |
| 15  |   | What is the most preferred method of improving residential space to prevent and control pandemics?                         |
| 16  |   | What aspects should be considered most important in residential spaces to prevent and control pandemics?                   |

First, photovoice participants were recruited in the preliminary preparation stage, and data collection and analysis methods were specified. In this study, families with elementary school children, who experienced the most significant changes in the behavior of family members owing to the social distancing policy during the pandemic, were selected as participants. The photovoice participants were housewives who interacted most actively with family members. The scope was limited to apartment residents in the metropolitan area (area less than 130 m<sup>2</sup>), where social solid distancing policies were implemented due to the high density of residents. The participants were recruited through a purposive sampling method to select those willing to actively share their personal residence experience with others and participate in the study. As the general number of photovoice participants comprises approximately 7–10 people [33], we carefully selected seven participants after conducting brief interviews with those who expressed their willingness to participate and judging their suitability. To provide guidance and education on the photovoice method, orientation materials were prepared that introduced the purpose of the study. These materials also introduced how to take pictures and the research schedule. All the materials for photovoice obtained ethical approval from the ethics committee of Chungbuk National University in June 2022. On 15 July 2022, we conducted a pre-education meeting for an hour on Zoom.

Second, residence experiences were collected in three stages in the data collection stage. In the first data collection stage, the participants were asked to freely take photos of spaces that revealed significant changes during the pandemic, spaces with negative living experiences, and their responses and improvements for approximately two weeks,

during 15–29 July 2022. Subsequently, the participants selected approximately 20 images that were judged to adequately represent their living experience among the photos they had taken. Two representative photographs that best showed the problem were selected and submitted to the researcher with a brief description of the reason.

In the second stage of data collection, after reviewing the submitted photos, the researchers selected additional photos deemed meaningful and requested explanations from each participant. By synthesizing the primary and secondary data, images with similarities in space and function were categorized, and keywords were organized.

Moreover, a focus group interview with seven participants was conducted for approximately two hours using the classified image data (8 August 2022). When the images classified by the researcher were shown to the participants, they provided additional explanations about the photos they had taken. In-depth personal experiences were collected and shared by discussing aspects that resonated with the other participants' photos, experiences, or related opinions. Five questions from the SHOWed technique were used to present participants' opinions: (1) What do you see in this picture? (2) What is happening in this picture? (3) How does this picture relate to our lives? (4) Why do these problems, worries, and advantages exist? (5) What can we do to address the identified problems? [31].

Third, in the data analysis step, the previously collected data were divided into meaningful sentence units, assigned code numbers, and further divided into meaning units with core meanings. The interview process was recorded with prior consent, and all collected data were transcribed and documented. Categorization analysis was conducted according to context by extracting keywords that were repeatedly mentioned or conveyed meaning from the recorded documents.

#### *2.4. Insights into Residents' Needs-Based Apartment Space Planning*

Insights into residential apartment space plans were derived by synthesizing all the results obtained in the literature review, survey, and photovoice interviews. According to the guidelines identified in the literature review, the problems and experiences felt by residents were connected to the corresponding items to identify specific and practical needs. Based on the final insights, the specificity of the spatial planning needs of Korean apartment residents in response to infectious diseases is discussed.

### **3. Results**

#### *3.1. Literature Review for Identifying Planning Guides to Prevent and Control Pandemics in Residential Apartments*

After identifying planning guides for effectively preventing and managing infectious diseases through reviews of 24 studies, 37 items were identified under five categories: general (G), entrance (EN), kitchen/dining room (KD), bedroom (BE), and balcony (BA). The general (G) category included 19 items: nine spaces (GS), two furniture (GF), three openings (GO), and five materials (GM). Two items were identified for the entrance (EN), and six items were collected for the kitchen/dining room (KD). Four items were found for the bedroom (BE), and six were identified for the balcony (BA) (Table 2).

In the general (G) category, the general space (GS) comprised variable walls, flexibility, access to outdoor space, biophilic, adjusting the opening and closing of spaces, access from the entrance to the bedroom to the living room, direct sunlight, and an improved mechanical ventilation rate. For general furniture (GF), fold/unfold flexibility/transformation and touchless motion sensor lights were emphasized. Regarding general openings (GO), ways to increase natural light and ventilation conditions were mentioned by planning multiple windows, large windows, ceiling windows, and folding doors. For general materials (GM), emphasis was placed on antibacterial materials, different finish glosses, and color control of the finish. In summary, the critical items for general apartment plans include spaces that change the structure of space and allow access to outdoor spaces; flexible and touchless furniture; different types of windows/doors for sunlight and ventilation; and variations in antibacterial and finishing materials.

**Table 2.** Summary of the literature review: space planning guides for pandemic-safe residential housing (\* indicates items mentioned more than five times).

| Category | Sub-Category | Code | Planning Guide  | Keywords  | Reference Code             |
|----------|--------------|------|---|---|----------------------------|
| General  | Space        | GS1  | Minimize the placement of load-bearing walls and plan them as flexible walls. *   | Flexible wall   | A-1, D-1, D-4, D-5         |
|          |              | GS2  | Plan an outdoor space of an appropriate size in addition to the indoor space for social distancing.                     | Access to outdoor                                     | D-4                        |
|          |              | GS3  | Utilize biophilic design that actively introduces natural elements into the interior space.                             | Biophilic design                                      | D-4, D-5                   |
|          |              | GS4  | Plan various spaces within the unit to allow easy access to the outdoors.   | Access to outdoor                                     | D-1, D-4                   |
|          |              | GS5  | Plan to open and close the space easily by utilizing movable partitions. *  | Flexible wall to adjust opening/closing               | A-3, A-12, D-1, D-7        |
|          |              | GS6  | Remove the wall between the living room and the bedroom to secure variability. *  | Flexible wall   | A-12, A-14, A-17, D-4, D-5 |
|          |              | GS7  | Plan to first enter each bedroom from the entrance and then connect to the living room.                                 | Direct access from the entrance to the bedroom        | D-4, D-5                   |
|          |              | GS8  | Plan to get as much direct sunlight as possible into the living space.  | Sufficient sunlight                                   | A-2                        |
|          |              | GS9  | Increase the mechanical ventilation rate to create a pleasant and hygienic living space.                                | Improved mechanical ventilation                       | D-7                        |
|          | Furniture    | GF1  | Plan the furniture to be foldable to be unfolded and used when needed.  | Folding to unfolding transformation                   | D-1, D-4                   |
|          |              | GF2  | Install motion lighting that reduces high-touch surfaces via motion switches.   | Touchless motion sensor                               | D-1                        |
|          |              | GO1  | Plan at least several small windows if large windows cannot be installed.   | Multiple windows                                      | D-1                        |
|          | Opening      | GO2  | Plan to receive as much natural light as possible through a multi-pane or large window plan.                            | Multiple/large windows for sufficient sunlight inflow | D-1, D-4                   |
|          |              | GO3  | Plan to install skylights or folding doors to let fresh air in.   | Ceiling windows/folding door for fresh air            | D-1, D-4                   |
|          | Material     | GM1  | Use antibacterial, mold-, odor-, and stain-resistant finishing materials (including outdoor fabric) for outdoor spaces. | Antibacterial material                                | D-1, D-4                   |
|          |              | GM2  | Use finishes with natural antibacterial properties that eliminate germs and bacteria.                                   | Antibacterial material                                | D-1, D-4                   |
|          |              | GM3  | Plan to vary the gloss level of the finish to add visual interest.  | Finish variation                                      | D-1, D-4                   |
|          |              | GM4  | Plan a comfortable living space using natural and calm colors.  | Color variation                                       | D-1, D-4                   |
|          |              | GM5  | Use bold and bright colors for wallpaper, and plan vivid colors for walls to be emphasized.                             | Color variation                                       | D-1, D-4                   |

Table 2. Cont.

| Category            | Sub-Category | Code | Planning Guide   | Keywords                                     | Reference Code                           |
|---------------------|--------------|------|--|--|--|
| Entrance            |              | EN1  | Plan a dry wash area and an air shower zone to wash hands right after entering the front door. *   | Facility for removing contaminants           | A-17, D-1, D-5, D-7                      |
|                     |              | EN2  | Install an inner gate between the entrance and the living space, and plan a dressing room at the entrance to remove contaminants from clothes before passing through the inner gate. * | Facility for removing contaminants           | A-1, A-2, A-5, A-12, A-14, D-1, D-5, D-4 |
| Kitchen/Dining room |              | KD1  | Install germ-resistant countertops and flooring, touchless faucets, and appliances.  | Antibacterial material, touchless appliances | D-1, D-4                                 |
|                     |              | KD2  | Plan a dining room that can be used as a community space between the kitchen and living room.  | Multifunctional dining room                  | D-4, D-5                                 |
|                     |              | KD3  | Install home appliances using non-contact systems such as voice recognition and remote control.  | Touchless appliances                         | A-5                                      |
|                     |              | KD4  | Plan to let natural light in or use natural lighting to spend more time in the kitchen.  | Sufficient sunlight inflow                   | A-5                                      |
|                     |              | KD5  | Divide the kitchen into a separate space or plan a second kitchen.   | Separate kitchen                             | D-5                                      |
|                     |              | KD6  | Plan an island kitchen or dining room using a semi-closed pocket door for a multifunctional space such as a home office.   | Multifunctional dining room                  | D-4                                      |
| Bedroom             |              | BE1  | Plan to have one basic bathroom for each bedroom.  | Individual bathroom for each room            | A-14                                     |
|                     |              | BE2  | The main bedroom should be planned as an isolated space among the living spaces.   | A separate main bedroom                      | A-5, A-14                                |
|                     |              | BE3  | The bedroom should be planned to be divided into multiple spaces by applying variable elements to support various activities such as work, hobbies, and relaxation.                    | Flexibility for multifunctional use          | A-1, D-7                                 |
|                     |              | BE4  | The bedroom should be equipped with lighting that changes to the appropriate color and brightness to allow for various activities and supports the variability of the space.           | Flexible light for multifunctional use       | D-4                                      |
| Balcony             |              | BA1  | Plan a balcony as a semi-public space to communicate with neighbors.   | Enhanced communication with neighbors        | D-1, D-4                                 |
|                     |              | BA2  | Plan the balcony for various purposes (e.g., home cafe, home camping, play area, vegetable garden).  | Multifunctional support                      | A-9, D-5, D-7                            |
|                     |              | BA3  | Plan a specialized floor plan with an external space for each unit.  | Access to outdoors                           | D-6, D-7                                 |
|                     |              | BA4  | Connect the balcony with the garden or nature, and plan it as an emotionally comfortable space.  | Garden planning                              | D-4                                      |
|                     |              | BA5  | Plan gardens to improve mental health and reduce dependence on grocery stores.   | Garden planning                              | D-4                                      |
|                     |              | BA6  | Plan balconies with flexible walls or doors to be easily opened and closed.  | Flexible wall to adjust opening and closing  | D-4                                      |

In the entrance (EN), the installation of wash basins, air showers, dressing rooms, and foyer doors was emphasized to remove external contaminants effectively. For kitchens/dining rooms (KD), antibacterial materials, touchless appliances, adequate sunlight, and separate kitchens with multifunctional dining rooms were emphasized. For the bedroom (BE), individual bathroom plans, a separate main bedroom, and variable elements (including lighting) for multifunctional support were identified as essential guide items. The balcony (BA) highlighted enhanced communication with neighbors, multifunctional support, garden planning, and flexibility to adjust opening and closing.

Among these, five items mentioned more than five times in the literature were identified. The essential keywords can be summarized as flexible walls to adjust the opening/closing for multifunctional use (GS1, GS5, and GS6) and facility plans to remove contaminants at the entrance (EN1 and EN2). Removing contaminants at the entrance and flexible wall structures throughout the indoor space are critical for effectively managing and preventing infectious diseases.

### *3.2. Analysis of the Overall Residential Experiences of Apartment Housing Residents during the COVID-19 Pandemic*

#### *3.2.1. Residential Experiences of Apartment Housing Residents According to Self-Quarantine Experiences*

We conducted an online survey to determine how apartment residents in Seoul felt about their living spaces while experiencing self-quarantine during the COVID-19 pandemic. The survey respondents had experienced self-quarantine within their residence for as few as 4 days and as many as 14 days. They spent most of their time in bedrooms (59.7%) and living rooms (29.9%) during quarantine. The main activities performed during self-isolation were rest (40.9%), sleep (22.0%), hobbies (12.3%), telecommuting (11.4%), and attending remote classes (7.7%). This result shows that social activities conducted outside homes before the COVID-19 outbreak were brought into residential spaces, and various activities occurred in a complex manner.

Regarding their dissatisfaction with space during the period of self-quarantine, hobbies (32.5%), rest (17.9%), telecommuting (13.2%), sleep (10.3%), and remote classes (9.8%) were identified in the order for which space and furniture did not adequately support daily activities. The result implied a functional limitation in supporting activities that were previously conducted outside when performed inside the dwelling, since it was impossible to leave (Figure 2).

#### *3.2.2. Residential Experience during the COVID-19 Pandemic*

As for the residents' dissatisfaction regarding the structure of the residential space and the function of each room, it was emphasized that there was no independent space for performing a specific function or that there was a space limit in accommodating the changed function due to the narrow area of the existing space. Further, two bathrooms were necessary for separate toilet use when family members were infected with COVID-19.

The spaces that residents felt the greatest need to change in residential housing during the pandemic were living rooms (21.7%), kitchens (12.4%), master bedrooms (9.6%), children's bedrooms (8.3%), bathrooms (8.0%), balconies (8.0%), entrances (7.6%), and study rooms or libraries (7.6%). Most of their time was spent in the bedroom and living room during self-quarantine. However, a change in the living room was found to be the most necessary because family members with different lifestyles gathered and spent time together in the living room.

When asked about their experience remodeling spaces or rearranging furniture as needed during the pandemic, living room changes (18.8%) showed the highest rate, followed by master bedrooms (10.2%), children's bedrooms (7.5%), kitchens (7.1%), and study rooms (6.0%). This result indicated that a change in the function of the living room and a consequent change in space planning were top priorities (Figure 3).

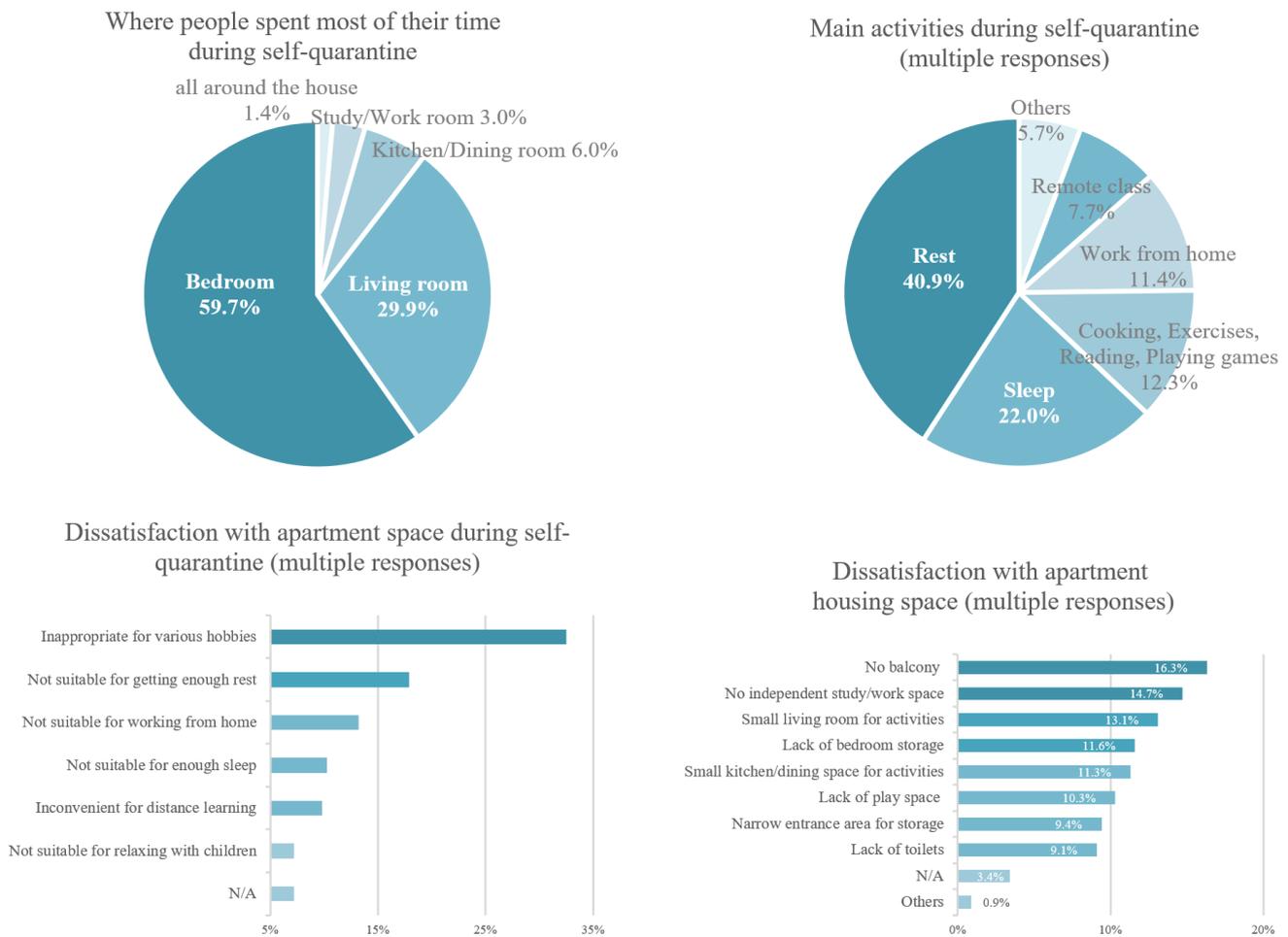


Figure 2. Summary of apartment residential experiences identified from the survey (1).

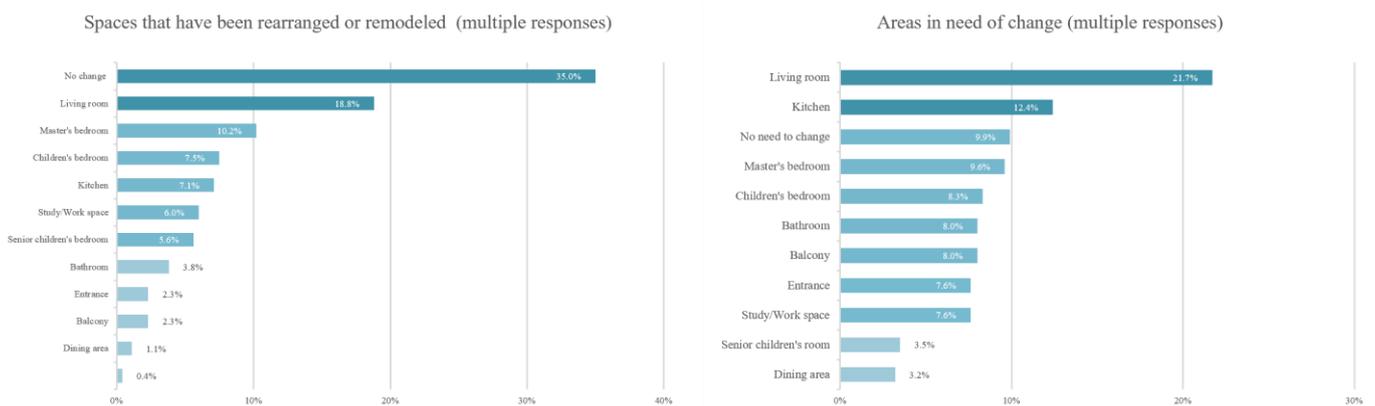
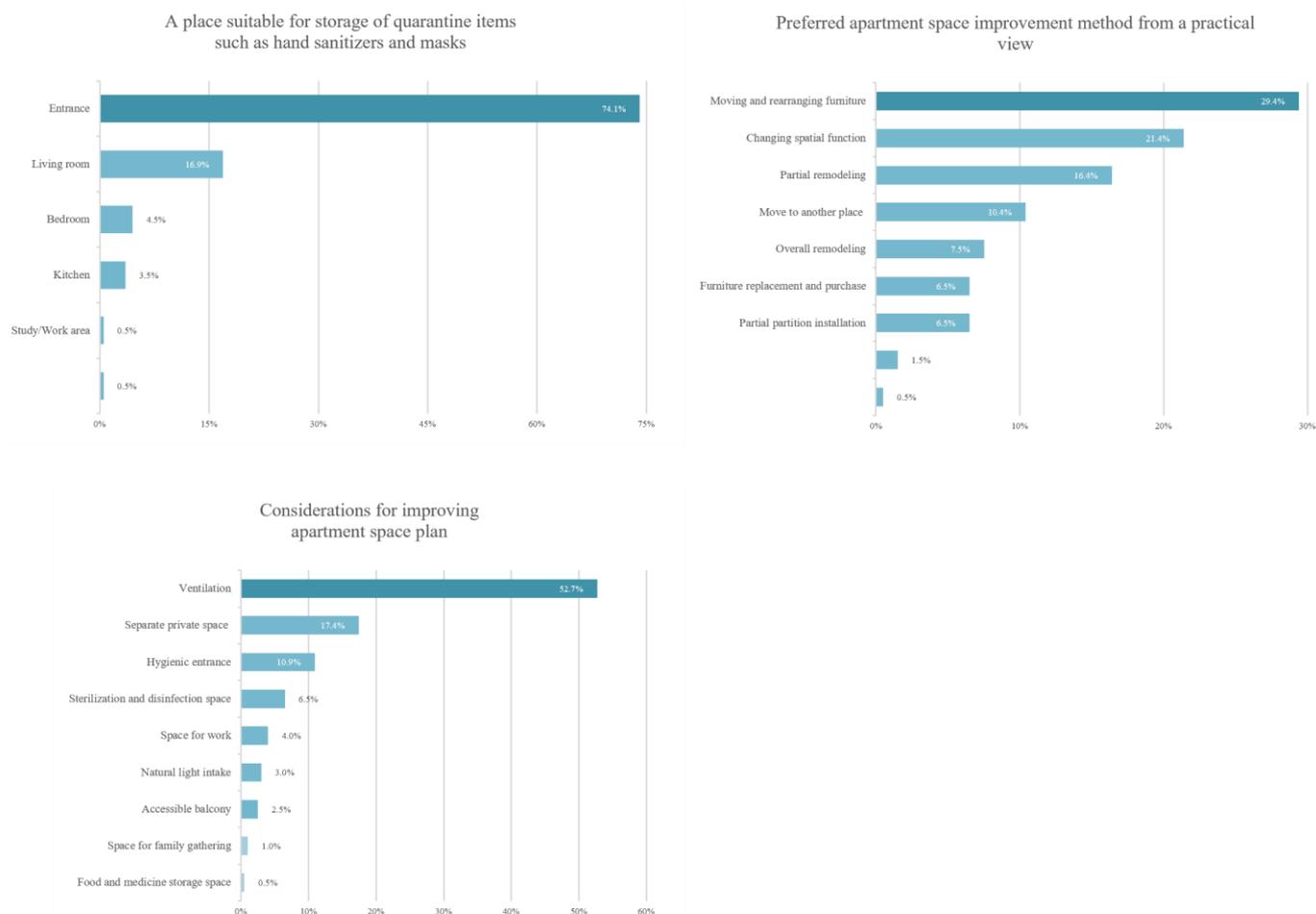


Figure 3. Summary of apartment residential experiences identified from the survey (2).

### 3.2.3. Resident Preference for Pandemic-Safe Housing

The preferred place to store quarantine items was the foyer room closest to the entrance (74.1%). As a space improvement method to prevent and manage infectious diseases, when considering cost, time, and realistic aspects, rather than changing the structure of the space, a simple and convenient method through furniture rearrangement (29.4%) was preferred. Subsequently, methods such as changing the function of the space (21.4%) and partial remodeling (16.4%) were preferred. It was found that the method of slightly altering the space according to the needs of residents was the most applicable.

The most relevant considerations for the effective prevention and management of infectious diseases were ventilation (52.7%), independent personal space (17.4%), and a hygienic entrance (10.9%). The emphasis on ventilation and sanitary entrances is interpreted to be due to the high rates of viral transmission and infection through the air. In addition, because family members are absorbed in several different activities indoors, securing the efficiency and privacy of their work or actions is essential (Figure 4).



**Figure 4.** Summary of apartment residential experiences identified from the survey (3).

### 3.2.4. Summary of Apartment-Housing Residential Experience during the COVID-19 Pandemic

In summary, the pandemic caused residents to primarily occupy their bedrooms and living rooms, where they spent the majority of their time engaging in restful activities such as sleeping (62.9%), as well as pursuing their hobbies, attending remote classes, and telecommuting (31.4%). Regarding dissatisfaction with the living experience, there was no independent space for a specific function and a narrow area to accommodate the changed function, and the need for two bathrooms appeared. This revealed the need to support functions newly absorbed into the indoor space due to the pandemic. The greatest need to change spaces appeared in the living room, bedroom, and kitchen—the place where the respondents spent the maximum amount of time showed a high need for improvement. Regarding actual space improvements, living rooms and bedrooms had the most scope, indicating that residents improved spaces out of necessity.

To prevent and manage infectious diseases effectively, priority was given to minimizing the spread of viruses through ventilation and sanitary entrances. Subsequently, securing an independent personal space was emphasized to increase the efficiency of the various activities of the family members without an invasion of privacy. This suggests that

it is worthwhile to increase the functionality of a private bedroom to support multiple uses rather than a living room shared by family members.

In terms of space improvement methods, furniture rearrangement, space function changes, and partial remodeling were preferred. This means that the space should be repurposed in a way that can easily change its function and ensure flexible use through furniture rearrangements.

The above discussion summarizes the insights for space planning based on their living experience during the COVID-19 pandemic that apartment residents described in their responses, as explained through the following steps: (1) reinforcing ventilation and front-door hygiene functions to prevent/manage infectious diseases; (2) supporting multifunctional use in living rooms and bedrooms; (3) securing an independent personal space that can secure hobbies, telecommuting efficiency, and privacy; (4) relaxing centered on the bedroom and enhancement of sleep function.

### *3.3. In-Depth Analysis of Apartment-Housing Residential Experiences during the Pandemic*

The following needs were identified for each space as a result of conducting photovoice interviews with seven participants (Table 3). At the entrance, insufficient storage space was emphasized as a negative living experience. In the living room, family members' different activities and needs cause problems such as noise, distraction, and privacy issues, and the low efficiency of individual activities was highlighted as a primary problem. The dining room and kitchen are often used as temporary workspaces when they are not furnished separately. Complaints were made regarding the low work efficiency and concentration level owing to the frequent access of other family members to the workspace. The integrated bedroom, workspace, play, sleep, and study space resulted in poor concentration and poor-quality sleep. Regarding the balcony, it was pointed out that it is difficult to control the temperature according to the season and that the lack of facilities to support various activities reduces space utilization.

### *3.4. Insights into Residents' Needs-Based Apartment Housing Space Planning*

The following summarizes spatial planning insights from apartment residents' living experiences obtained through a literature review, survey, and photovoice interviews (Table 4).

The literature review emphasized two aspects of planning a pandemic-safe residential space: (1) a flexible space plan using flexible walls, folding doors, or partitions, and (2) a facility for removing contaminants.

Regarding the flexible space plan, further considerations were derived for the living room, bedroom, hobby/telecommuting/learning space, and balcony. About the living room, support for multifunctional use was emphasized. Support for multifunctional use and reinforcement of sleeping and resting functions were highlighted in the bedroom. Securing separate, individual spaces was essential to ensure efficiency and privacy regarding hobbies, telecommuting, and learning spaces. Regarding the balcony, the need for indoor ventilation was highlighted. Regarding removing contaminants, the reinforcement of the hygiene function at the entrance was emphasized, indicating that the role of the entrance hall has become more crucial in blocking pollutants from the outside.

Additionally, residents' practical and specific needs in each space were identified. To support multifunctional living rooms, residents preferred separated areas that could be opened or closed. It was also emphasized that multifunctional support facilities, such as lighting, windows, ventilation, air conditioning, and heating, which can be individually controlled, should be built together. Regarding bedrooms, the need to prepare isolation spaces has been highlighted by suggestions of securing flexible furniture, facility planning, and exclusive toilets to support multifunctional use. Separating telecommuting spaces from study/sleep/play areas was also necessary to facilitate sleeping/resting functions.

**Table 3.** Barriers to the residential experience and insights for improvement identified from the photovoice.

| Space          | Quotes   | Residential Experience  | Insights  |
|----------------|--|---|---|
| Entrance       | “I bought sports equipment such as skateboards and badminton, but there was nowhere to store them, so I put them in the corner of the entrance. I had to clean it every time I opened and closed the shoe cabinet, which made my work cumbersome and the entrance even narrower.” (C)  | <ul style="list-style-type: none"> <li>- There is insufficient storage space for sanitary items such as disinfectants and masks at the entrance.</li> <li>- There is insufficient space to store exercise equipment; therefore, it is stored in the corner of the entrance.</li> </ul>  | <ul style="list-style-type: none"> <li>- It is necessary to secure sufficient storage space and an area to store various sanitary products and exercise equipment.</li> </ul>   |
| Living room    | “I have two children, one on the sofa in the living room and the other on the dining table for their remote class. The kids are still young; therefore, I have to take care of them, but when they take classes simultaneously, they can hear each other; thus, it gets in the way. I could not concentrate, so I separated the older kid so he could take classes in his room.” (C)             | <ul style="list-style-type: none"> <li>- Besides rest and family gatherings in the living room, various functions such as children’s learning, couples working from home, and hobbies are introduced, all complex activities.</li> <li>- Activities between family members conflict at different times of day, causing discomfort such as noise, privacy issues, and activity restrictions.</li> <li>- When two or more children share a learning space, efficiency decreases due to noise and distraction.</li> <li>- When the living room area is separated, there is a darkening problem because there is no ceiling light on one side.</li> </ul> | <ul style="list-style-type: none"> <li>- Areas should be separated, or independent spaces should be secured so family members can engage in various activities within the living room.</li> <li>- The learning space must be clearly separated if there are two or more children.</li> <li>- Facilities that can support multiple functions are required to utilize the living room for various purposes.</li> <li>- When separating areas, lighting, windows, ventilation, air conditioning, and heating must be adjusted and considered to secure individual facilities.</li> </ul> |
| Dining/Kitchen | “I work from home; however, I do not have a separate space for work, and I do it at the dining table. Even if the kids want to eat or have a snack, they cannot eat comfortably because of me.” (E)<br>“As I spend more time at home, I buy more things, such as necessities, hygiene products, and favorite foods. However, I do not have space to store them, so I just lay them outside.” (F) | <ul style="list-style-type: none"> <li>- It is close to households’ movements and has high accessibility to their children; therefore, they work from home, mainly at the table, but their work efficiency and concentration are low.</li> <li>- As the number of disinfectants, sterilizers, favorite foods, and delivery foods increased, there was a shortage of space to store items and more space was needed to separate and organize garbage.</li> </ul>   | <ul style="list-style-type: none"> <li>- A separate and independent space for telecommuting must be secured separately from the dining table.</li> <li>- Additional storage space must be secured to store hygiene products and hobbies.</li> <li>- Due to the increase in household waste, an efficient sanitary storage space must be secured for separate collection and organization of items.</li> </ul>   |

Table 3. Cont.

| Space                     | Quotes   | Residential Experience  | Insights   |
|---------------------------|--|---|--|
| Bedroom<br>(Main Bedroom) | "I do not have a place to work, so I am working from home with a desk and chair in the bedroom. It is inconvenient not to be able to work while my husband or children are sleeping." (G)                                  | <ul style="list-style-type: none"> <li>- If there is a home office space in the bedroom, it interferes with the sleep of other family members and restricts work hours, reducing concentration and efficiency.</li> <li>- The couple's bedroom has a larger area than other rooms, but it is challenging for other purposes due to fixed furniture/facilities such as a built-in wardrobe and dressing table.</li> <li>- The bathroom in the bedroom was used as an isolation space when COVID-19 was confirmed.</li> </ul> | <ul style="list-style-type: none"> <li>- I need an independent work-from-home space where I can concentrate on my work without disturbing the sleep of other family members.</li> <li>- Flexible furniture/facilities should be planned so that functions can be switched to various uses.</li> <li>- A dedicated toilet is secured in the room so that it can be separated into an isolated living space in the event of confirmation.</li> </ul> |
| Bedroom<br>(Children)     | "When my child is taking an online class, he tries to lie down on the bed and cannot concentrate. So, I moved the child's bed to our bedroom and created a learning atmosphere in the child's room." (A)                   | <ul style="list-style-type: none"> <li>- In the case of lower-graders, it is challenging to create a learning atmosphere because beds and toys are exposed during online learning.</li> </ul>   | <ul style="list-style-type: none"> <li>- In the case of children in the lower grades, it is necessary to separate learning and sleeping functions to create a learning atmosphere.</li> </ul>  |
| Space<br>for Study/Work   | "Originally, the study was shared by the family, but as my husband increased his work from home, he needed an independent space due to noise and privacy issues, so we separated it." (B)                                  | <ul style="list-style-type: none"> <li>- When both husband and wife work and children learn and play in the study, efficiency is lowered due to noise and a lack of concentration.</li> </ul>   | <ul style="list-style-type: none"> <li>- Spaces for work and study should be provided with independent spaces to minimize noise and increase concentration.</li> </ul>   |
| Balcony                   | "Unable to go out, I planted tomatoes and plants on the balcony and created a rest area to listen to the sound of rain or camp. However, it was too cold in winter and too hot in summer, so it was difficult to use." (B) | <ul style="list-style-type: none"> <li>- It was used as a space for various leisure/hobby activities such as plant cultivation, music appreciation, and camping.</li> <li>- It was hot in the summer and cold in the winter, so the time to move or use the exercise equipment was limited.</li> <li>- There is no place to store exercise equipment, camping equipment, and toys when not in use.</li> </ul>   | <ul style="list-style-type: none"> <li>- Balconies are reinforced for leisure and hobbies, requiring structures and facilities to support various activities.</li> <li>- A temperature control function should enable space utilization in the summer and winter.</li> <li>- There is a need for space to store items related to hobbies/leisure activities.</li> </ul>  |

**Table 4.** Synthesized results of identifying user needs for a pandemic-safe housing space plan.

| No. | Literature Review  |   | Survey  | Photovoice   |
|-----|--|---|---|--|
| 1   | Flexible space plan (flexible wall, folding door, and partition) | Living room                               | Support for multifunctional use                                   | <ul style="list-style-type: none"> <li>- Securing area separation or separate independent space to support various activities</li> <li>- Multifunctional support facility planning for multipurpose use</li> <li>- Individual control/security of facilities such as lighting, windows, ventilation, and air conditioning when separating areas</li> </ul> |
|     |  | Bedroom                                   | Support for multifunctional use                                   | <ul style="list-style-type: none"> <li>- Flexible furniture/facility planning to support multifunctional spaces</li> <li>- Securing a separate toilet in the room in preparation for quarantine</li> </ul>   |
|     |  | Space for hobbies/work from home/learning | Strengthen sleep and rest functions                               | <ul style="list-style-type: none"> <li>- Securing an independent homework space that does not disturb other family members' sleeping</li> <li>- Classification/separation of learning, sleeping, and play functions/areas</li> </ul>   |
|     |  | Space for hobbies/work from home/learning | Secure an independent individual space for efficiency and privacy | <ul style="list-style-type: none"> <li>- Separate learning space for two or more children</li> <li>- Securing an independent space for working from home, separate from the dining table (minimizing noise, considering privacy, maximizing work efficiency)</li> <li>- Securing storage space for related items</li> </ul>                                |
|     |  | Balcony                                   | Ventilation   | <ul style="list-style-type: none"> <li>- Building related facilities on balconies to support leisure/hobby activities</li> <li>- Plan to adjust the temperature by season</li> <li>- Securing storage space for related items</li> </ul>   |
| 2   | Facility for removing contaminants                               | Entrance                                  | Enhancement of hygiene function                                   | <ul style="list-style-type: none"> <li>- Securing sufficient storage space and space for sanitary products, delivery service, and exercise equipment</li> <li>- Efficient sanitary storage space planning for separate garbage collection</li> </ul>   |

To secure a separate individual space for hobbies/telecommuting/learning, the separation of learning spaces for each child, ensuring independence of the home workspace, and providing storage space for related items were required. For the balcony, while the importance of ventilation was emphasized in the survey, the construction of related facilities to support leisure/hobby activities, seasonal temperature control, and securing storage space was mentioned in the photovoice. These results show that practical space utilization was considered a priority for residents. The need for storage space for sanitary products, delivery services, exercise equipment, and garbage disposal spaces was emphasized at the entrance.

#### 4. Discussion

Considering the above results, space planning for preventing and managing infectious diseases among apartment residents in South Korea differs slightly from the results of previous studies. Previous studies [34–43] have emphasized the importance of removing contaminants by installing dry wash basins, air showers, inner gates, and entrance dressing rooms to strengthen sanitation. The opinions of apartment residents in this study indicate that securing efficient storage space for various items is more important than adding new facilities. The observed discrepancy suggests that the incorporation of supplementary amenities is practically challenging due to the financial strain and limited foyer space when implementing the optimal amenities in contemporary residential areas. Therefore, to narrow the gap between the ideal and reality, a plan to increase space utilization and share functions can be proposed by planning the circulation from the entrance to the living room through each room and linking each room, such as the entrance, laundry room, multipurpose room, and bathroom.

For living rooms, eliminating walls and flexibly adjusting space divisions using flexible walls, doors, and partitions have been emphasized in previous studies [34,37–44]. Korean apartment residents emphasized that although separating areas is necessary, establishing flexible facilities that can be individually adjusted for each space should also be considered. The reason for this is that the residents are taking into account not just the physical structure, but also the practicality and usage of the space, showing that there is a limit to the utilization of space with simple spatial division and no consideration of facilities. Previous studies [34,43] have emphasized that bedrooms should be able to support various activities such as work, rest, and hobbies. Korean residents prefer separate workspaces and study spaces for work efficiency, noise blocking, and privacy. Notably, they did not want the sleep and rest functions of the bedroom to be replaced with other functions. However, securing an individual bathroom for each bedroom and using it as an isolation space when an infectious disease is confirmed is consistent with the results of previous studies [36,38]. Taking these results together, at least one bedroom needs to be placed as far from the living room as possible and it should have an individual bathroom with the function of an isolation space. Additionally, it is desirable to strengthen the functions of sleeping and resting by separating them from learning and working.

In previous studies, antibacterial materials, touchless systems [40,41], securing natural light [32], and planning a dining room as a community space between the kitchen and living room [41,42] were emphasized to secure the independent functions of the kitchen. This aspect has the same context, as residents do not prefer the dining table as a homework and study space. Activities such as meal preparation, eating, studying, and working are unique functions that cannot be shared in one place; therefore, the study or workspace should be prepared as a separate space rather than using a dining table when considering noise, privacy, and work efficiency. In particular, because the kitchen is a place that all family members frequently access, functions that require concentration, such as studying or working, must be separated from it.

Regarding balconies, contents such as communication with neighbors, connection/expansion to external spaces, planting gardens, and vegetable garden utilization have been highlighted in previous studies [40,41]. However, for domestic residents, functions

such as exercise, camping, and rest were emphasized, whereas functions such as plant cultivation, gardening, and kitchen gardens were relatively passive. Additionally, the need to build practical facilities to maximize space utilization, such as outlets, storage spaces, and temperature control functions to support multipurpose use was emphasized. Notably, while communication and networks with neighbors were considered necessary during the epidemic of infectious diseases abroad, in Korea, communication and contact with the outside were blocked entirely, and outside activities continued in a closed manner via the balcony.

In short, the guidelines of the reviewed literature (Table 2) on preventing and managing infectious diseases emphasized flexibility, communication with the outside world, and establishing facilities to block pollutants. Korean residents have expressed the importance of securing semi-enclosed flexibility within residential spaces, constructing facilities to maximize space utilization, and separating study and workspaces to increase efficiency. This difference demonstrates the practical perspective of domestic residents on maximizing multifunctionality and efficiency within a limited area. To effectively respond to future infectious diseases, the unit space of an apartment building should consider the following five critical directions: (1) enhancing sanitary function/space utilization by linking rooms around the entrance; (2) variable separation of living areas and securing flexibility of related facilities; (3) functional separation and independence of study, workspace, and kitchen; (4) considering the use of isolation space in the bedroom and strengthening the sleeping function; (5) provision of related practical facilities on the balcony to support leisure/hobby activities.

This study verified and presented the direction of spatial planning for preventing and managing infectious diseases as objectively as possible through a triangulation of literature reviews, quantitative surveys, and qualitative user interviews (photovoice). However, as the COVID-19 pandemic is a recent occurrence, it has a limitation in that the number of papers and reports considered is limited compared to other topics, and this study has focused on a specific period. Additionally, the photovoice interviews conducted to reflect the actual voice of the user in detail had seven participants. Although it is included in the range of adequate numbers required to identify needs, the additional needs of many users still need to be discovered. When domestic residents' experience-based space planning needs are continuously met, a residential space design with high resident satisfaction is proposed. In addition, since the main purpose of this study was to understand practical experiences such as behavior, emotion, and interactions of residents, indoor environment requirements such as ventilation, windward flow, and fresh air were not directly addressed within the scope of this study. Experts were not included as participants because the focus of this study was to collect and analyze the vivid voices of urban residents. For this reason, rather than presenting a detailed and professional-level planning guideline, the results were limited to presenting critical insights that can be referred to in setting the criteria and direction of future residential space plans.

## 5. Conclusions

The COVID-19 pandemic has become endemic; however, many researchers are still considering the potential occurrence and spread of different types of infectious diseases. Continuous study of space planning is essential for residential spaces to function as comfortable and safe shelters for humans, especially regarding the effective prevention and management of infectious diseases, in terms of public health. This is due to the fact that residents consider not only the physical structure but also the practicality and usage of the space. In terms of flexibility, Korean urban residents showed greater interest in efficient space utilization such as storage and access to outlets, switches, and windows when dividing the space. In addition, it was remarkable that spatial support for outdoor physical activities such as exercise and camping was more important than plants and gardening for Korean residents.

Understanding residents' potential and practical needs is usually limited to presenting a theoretical guide or collecting quantitative opinions. Thus, we used a mixed-use method, as it is essential to understand user needs from multiple perspectives. This study is significant because it deeply grasps the living experiences of Korean residents during the COVID-19 period and derives practical design directions based on these experiences. The reason why we still need such research at the end of the pandemic is that public health issues including infectious diseases are critically related to human safety and must be jointly addressed worldwide. Recalling that the level of quarantine among countries was not the same during the COVID-19 pandemic, in order for the world to properly respond to infectious diseases in the future, it is critical to systematically understand the experiences we have gone through. The results of this study can be used as a framework for designing user research methods for user-centered residential space designs in the future. Finally, we believe that the insights for space planning presented in this study can systematically respond to future public health issues including infectious diseases, and serve as a guide to reflect the practical needs of urban residents.

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**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics committee of Chungbuk National University (CBNU-202206-HR-0138, 24 June 2022).

**Data Availability Statement:** The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Reviewed literature.

| Code. | Authors (Year)                       | Title  |
|-------|--------------------------------------|--|
| A-1   | AIA (2020) [34]                      | Strategies for Safer Multifamily Housing   |
| A-2   | AIA (2020) [35]                      | Re-occupancy Assessment Tool V3.0  |
| A-3   | Morgan, B. (2020) [44]               | 4 Ways COVID Has Changed Home Design   |
| A-4   | Peters, T., & Halleran, A (2020) [7] | How Our Homes Impact Our Health: Using a COVID-19 Informed Approach to Examine Urban Apartment Housing |
| A-5   | Lee, H. K. (2021) [36]               | Hyundai Engineering Develops Specialized Flats Tailored to the Era of COVID-19                         |
| A-6   | Lee, S. W. (2021) [45]               | Synergy between ePyeonhansesang C2 House and 4Bay innovative flat.                                     |
| A-7   | Massenburg, D. R. (2021) [46]        | The house that quarantine built: Post-pandemic home design trends                                      |
| A-8   | Scileppi, T. (2021) [47]             | The Latest Home Design Trends of 2021 as told by Debra Design Group                                    |
| A-9   | An, S. Y. (2022) [48]                | Catch end-users who have become strict... Constructor plane specialization war.                        |
| A-10  | Spennemann, D.H. (2022) [49]         | Designing for COVID-2x: Reflecting on Future-Proofing  |

Table A1. Cont.

| Code. | Authors (Year)              | Title  |
|-------|-----------------------------|--|
| A-11  | Elrayies, G. M. (2022) [50] | Prophylactic Architecture: Formulating the Concept of Pandemic-Resilient Home  |
| A-12  | Lee, K. W. (2022) [37]      | LH, Proposes an Integrated Public Rental Housing Plan Tailored to the Life Cycle   |
| A-13  | Glavan et al. (2022) [51]   | COVID-19 and City Space: Impact and Perspectives   |
| A-14  | Tanamas et al. (2022) [38]  | Space Adaptations During Pandemic in Apartments  |
| A-15  | Benbow, W. (2022) [52]      | COVID-19 in Long-Term Care: The Built Environment Impact on Infection Control  |
| A-16  | Ching & Rani (2023) [53]    | The Impact of COVID-19 Pandemic on Home Spatial Design   |
| A-17  | Chen et al. (2023) [39]     | Effects of COVID-19 on Residential Planning and Design: A Scientometric Analysis   |
| D-1   | Kim, M. S. (2021) [40]      | A study on Architectural Approaches Corresponding to the Post-COVID Era  |
| D-2   | Kim et al. (2022) [54]      | Analysis of Prior Research Studies to Develop Guidelines for Apartment Housing Planning in Response to Infectious Disease Disasters    |
| D-3   | Shin et al. (2022) [55]     | The Architectural Planning Strategies for Multifamily Housing in a Post-Pandemic World   |
| D-4   | Lee et al. (2022) [41]      | Changes in Housing Function and Space Preference in the Post COVID Era   |
| D-5   | Jeon et al. (2022) [42]     | Reconstruction of Residential Space in the Post-COVID Era  |
| D-6   | Kim et al. (2023) [56]      | Analysis of User Experience Using Photo Voice Technique for Apartment Residential Space Planning in Responding to Infectious Diseases  |
| D-7   | Park et al. (2023) [43]     | Analysis of Residents' Interest Areas and Preference of Based on Eye Tracking for Apartment Planning in Response to Infectious Disease |

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