

The Role of Nursing Homes Architectural Design in Mitigating the Risk of COVID-19 Pandemics: The Case of Slovenia

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Currently, many older people live in institutions for various social and health reasons. In Slovenia, this proportion is almost 5% of the population aged 65 and over. In the COVID-19 pandemic, the elderly proved to be the most vulnerable social group, as they are exposed to a number of comorbidities that increase the risk of mortality. At that time, nursing homes represented one of the most critical types of housing, as seen from a disproportionate number of infections and deaths among nursing home residents worldwide, including Slovenia. During the emergency, a number of safety protocols had to be followed to prevent the spread of infection. Unfortunately, it turned out that while the safety measures protected the nursing home residents, they also had a negative effect on their mental health, mainly due to isolation and social distancing. It follows that especially in times of epidemics of infectious respiratory diseases, the quality of life in nursing homes requires special attention. In this context, it is also necessary to consider whether and how an appropriate architectural design can help mitigating the spread of infections, while at the same time enable older people to live in dignity and with a minimum of social exclusion. To this end, the present study examined 97 nursing homes in Slovenia, analysing the number of infections in nursing homes and their correlation with the degree of infection in the corresponding region in Slovenia. Additionally, 2 nursing homes were studied in more detail with the use of newly developed “Safe and Connected” evaluation tool, analysing the architectural features of each building. The advantages identified so far include living in smaller units, single rooms with balconies, the possibility of using green open spaces and the use of an adequate ventilation. Conclusions of this study are useful for further consideration of design of new nursing homes and the refurbishment of existing ones.

Introduction

In recent decades, the world has increasingly faced the phenomenon of an ageing population due to a prolonged period of declining birth rates and increased life expectancy. In the European Union, the proportion of elderly people over 65 years of age exceeded 20% of the total population in 2020, while projections for the coming decades indicate that this proportion will continue to increase, reaching 29.5% by 2050.¹ In the COVID-19 pandemics it became clear that older people in

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1. Eurostat, *Population Structure and Ageing* (Eurostat, 2021).

our society are the most vulnerable. Data from 20 European countries showed that the proportion of people over 70 years of age among confirmed SARS-CoV-2 infections accounted for 79-89% of COVID-19 associated deaths in 16 of 20 countries with available data.² Likewise for Slovenia, mortality data showed that the population aged 65 years and older accounted for the largest proportion of deaths in the actively infected population.³ The reason for such drastic numbers is likely that older age is often associated with the presence of comorbidities that increase the risk of death⁴.

Alleviating the risk of COVID-19 spread among a demographic group of seniors has much to do with their living environment. Throughout the world, many older people live in long-term care facilities (LTCFs). In Europe, for example, there is a wide range of facilities, from home-based settings to those that provide specialized medical care, such as nursing homes, retirement homes, skilled nursing facilities, assisted living facilities, residential care homes, and palliative or rehabilitation centres. All of these facilities care for older people who are no longer able to live independently in the community due to a combination of various physical, mental, intellectual, or sensory impairments.⁵ The 2020 COVID-19 pandemics showed a disproportionate share of infections and loss of life among residents of LTCFs worldwide.⁶ In the EU/EEA countries and the UK, there has been a remarkable morbidity and mortality among LTCF residents since August 2020,⁷ which poses a major challenge for disease prevention and control in such facilities.⁸ In Slovenia, nursing homes (NHs) are the most common type of LTCFs, with about 4.59% of the elderly population living in such facilities⁹ (as of 1.1.2020) and this proportion could be even higher if there were no lack of available capacity. At this point, nursing homes represented one of the most critical housing types, as all similar facilities where people congregate for living, working or educational purposes, such as educational, work and student residences, could be temporarily abandoned, while nursing home residents did not have this option. Despite the fact that the first wave of the COVID-19 pandemic had a relatively small number of infected residents in Slovenian NHs, the number of infections by the beginning of December 2020 was immense. In comparison, the

2. Christian Hoffmann and Eva Wolf, "Older Age Groups and Country-Specific Case Fatality Rates of COVID-19 in Europe, USA and Canada." *Infection* 49, no. 1 (2020): 111-116.

3. COVID-19 Sledilnik. 2021. [COVID-19 Tracker 2021.] <https://covid-19.sledilnik.org/si/stat>.

4. A. Fallon, T. Dukelow, S. P. Kennelly and D. O'Neill, "COVID-19 in Nursing Homes," *QJM: An International Journal of Medicine* 113, no. 6 (2020): 391-392.

5. Hubert Blain, Yves Rolland, Jos M. G. A. Schols, Antonio Cherubini, Stéphanie Miot, Desmond O'Neill, et al., "August 2020 Interim Eugsms Guidance to Prepare European Long-Term Care Facilities for COVID-19." *European Geriatric Medicine* 11, no. 6 (2020): 899-913.

6. Jennifer K. Burton, Gwen Bayne, Christine Evans, Frederike Garbe, Dermot Gorman, Naomi Honhold, et al., "Evolution and Effects of COVID-19 Outbreaks in Care Homes: a Population Analysis in 189 Care Homes in One Geographical Region of the UK," *The Lancet Healthy Longevity* 1, no. 1 (2020): e21-e31.

7. European Centre for Disease Prevention and Control - ECDC, *Increase in Fatal Cases of COVID-19 Among Long-Term Care Facility Residents in the EU/EEA and the UK* (ECDC, 2020).

8. European Centre for Disease Prevention and Control – ECDC, *Surveillance of COVID-19 at Long-Term Care Facilities in the EU/EEA* (ECDC, 2021).

9. SiStat, *Podatkovna baza SiStat* (Republic of Slovenia, SiStat, 2021).

first wave peaked between 30.3.2020 and 5.4.2020 with 96 confirmed infections in NHs, while the last peak of the second wave was between 30.11.2020 and 6.12.2020 with 1,410 confirmed infections among NH residents.¹⁰ In 2020, according to National Institute for Public Health, 2891 people died in connection with COVID-19 in Slovenia, out of these 1682 or 58% of the deaths were NH residents.¹¹

In general, the risk of infection among nursing home residents can be attributed to a variety of reasons, among them most likely to failures in organizational protective measures, but also shared spaces. As is well known, most accommodation for older people is planned as a conglomerate of shared and private spaces, with private spaces often being double, triple or multiple in the case of Slovenian facilities. Sharing of spaces, which are associated with a greater risk of infection COVID-19, on the other hand, are of great importance for the socialization of residents. In¹² the authors emphasize that the desire for connection leads many older adults to live in different models of connected facilities. The authors also argue that collective spaces and the transition between public and private spaces are critical to managing the spread of infections. The COVID-19 pandemic increases the urgency to rethink the design of NHs to create safer environments.¹³ The built environment has a significant impact on the health and well-being of its users. Inadequately designed spaces can have a negative impact on users' health, both physical and mental.¹⁴ Interdisciplinary integration of health and design professions can encourage design solutions that improve quality of life in addition to pandemic preparedness and resilience. It follows that there is a need to review the architectural design of the existing built environment in order to develop alternative and holistic models that balance infection control and quality of life.¹⁵ The latter is particularly important given that the number of people potentially in need of care in the EU-27 will increase from 19.5 million in 2016 to 23.6 million in 2030 and 30.5 million in 2050,¹⁶ and that societies of the future face the prospect of living in "new realities". In the existing literature, there are few studies that address the design of NHs in the context of the COVID-19 outbreak, most of which are guidelines for their architectural design within epidemic safety protocols.¹⁷ Unlike the above studies, this research focuses on the comprehensive

10. Ibid, 3.

11. GOV.SI., *Država v Domove Starejših Občanov ni Vlagala, Zato je Veliko Smrti Stanovalcev* (GOV.SI., 2021).

12. MASS Design Group, *The Role of Architecture in Fighting COVID-19, The Role of Architecture in Fighting COVID-19: Designing Senior Housing for Safe Interaction* (MASS Design Group, 2020).

13. Ibid, 5.

14. Jakub S. Bil and Leszek Pawłowski. 2016, "Influence of Architecture on Mental Health - Selected Issues," *Space&FORM*, no. 28 (2016): 41-52.

15. Diana C. Anderson, Thomas Grey, Sean Kennelly and Desmond O'Neill, "Nursing Home Design and COVID-19: Balancing Infection Control, Quality of Life, and Resilience," *Journal of the American Medical Directors Association* 21, no. 11 (2020): 1519-1524.

16. European Commission, *Green Paper on Ageing: Fostering Solidarity and Responsibility between Generations* (Brussels: European Commission, 2021).

17. Mengying He, Yumeng Li and Fang Fang, "Is There A Link Between Nursing Home Reported Quality And COVID-19 Cases? Evidence From California Skilled Nursing Facilities," *Journal of the American Medical Directors Association* 21, no. 7 (2020): 905-908.

design of NHs. However, in order to establish guidelines for the quality architectural design of NHs, it is first necessary to identify which qualities are essential to combat the adverse effects of COVID-19, which requires a more detailed analysis and evaluation of the quality of existing NHs in relation to the demonstrated epidemiological picture.

The review of existing quality assessment systems for nursing homes showed that numerous definitions of quality exist, while the range of quality indicators for nursing homes is considerable.¹⁸ One of the most commonly used systems is the Five-Star Nursing Home Quality Rating System, also known in the field as Nursing Home Quality Measures. The areas of assessment are extensive. They include the nursing home environment, resident rights, staff/resident interaction, skin care, medication management, quality of life, nursing home administration, and proper food preparation and storage.¹⁹ However, the outbreak of the COVID-19 pandemic presented new challenges for NS quality assessment. The urgent need for measures to prevent the spread of infection became apparent, followed by the introduction of safety protocols that have been repeatedly modified and adapted to new evidence since the outbreak. Over time, the protocols based solely on preventing the spread of infection and thus on the measure of isolation - preventing contact between residents- have shown their inadequacies, particularly in terms of worsening the psychosocial well-being of residents. The latter is also evidenced by the fact that high quality nursing homes have successfully prevented the spread of COVID-19 and deaths from COVID-19 following safety protocols, but have had significantly more non COVID-19 deaths related to the consequences of loneliness.²⁰ It follows, that two very important starting points need to be considered when developing new qualitative guidelines for NH: First, measures as well as architecture must ensure that the risk of spreading infections is minimised, and second, the quality of social integration of residents must be promoted. This equates the two conditions of mental health vs. physical health, which are considered equivalent at the time of the epidemic outbreak - and which have been shown not to be mutually exclusive.

This study focuses on Slovenian NHs, as Slovenia was at the top of the EU in terms of incidence of the virus,²¹ and also had the highest mortality rate in Europe. The aim of this study is to analyze the influence of the architectural design of NHs on the risk of infection of COVID-19 and at the same time on the social integration of its inhabitants. For this purpose, the study uses a newly developed "Safe and Connected" quality evaluation tool for NHs with a focus on architectural design, which comprehensively considers both the safety aspect against the spread of the virus and ensuring maximum opportunities for social inclusion and connection of residents.

18. N. G. Castle and J. C. Ferguson, "What Is Nursing Home Quality and How Is It Measured?" *The Gerontologist* 50, no. 4 (2010): 426-442.

19. American Council on Aging, *Using CMS' Nursing Home Compare and 5-Star Quality Rating System* (American Council on Aging, 2020).

20. Christopher Cronin and William Evans, *Nursing Home Quality, COVID-19 Deaths, and Excess Mortality* (Cambridge, 2020).

21. Nuška Čakš Jager, *Po Mnenju Epidemiologov Policijska ura ni Potrebna, Slovenija je Sicer po Pojavnosti Virusov v Vrh EU* (Maribor: Večer, 2021).

Based on theoretical assumptions, the authors propose three basic hypotheses:

H1: The degree of infections in the region affects the degree of infections in NH.

H2: The size of NHs building correlates with the degree of infections in NH.

H3: The architectural design of NH environment affects the degree of infections in NH.

In this study the term “infection” is related to COVID-19 infection disease caused by SARS-Cov-2. Based on the framework developed, it will be possible in the future to develop guidelines for the design of new nursing homes and the renovation of existing ones. Such recommendations could avoid a risk that the construction of new homes only creates the necessary capacity, which, without sufficient architectural quality, impairs the mental, social and physical health of the residents in the long term!

Nursing Homes in Slovenia

Taking into account formal institutional care, there are currently 97 public and private nursing homes in Slovenia with a total capacity of 19,729 beds,²² which corresponds to approximately 4.50% of the elderly population. Slovenia is also characterised by a rather uneven distribution of homes, including small homes with a capacity of up to 150 places, medium-sized homes with a capacity of between 151 and 300 places, and large homes with a capacity of more than 300 places.²³ The existing capacity of Slovenian NHs is far too small for the demand. According to official figures, 9,621 people are waiting for a place in a home. Data from recent years show that the number of applications continues to rise year on year.²⁴ The shortage of space in NHs is an acute problem, especially since the government has not built a new home in 15 years.²⁵ Although private and foreign investors are appearing, the construction of such homes is subject to economic interests and is not systematically addressed as part of the national policy on care for the elderly.

In light of the above, and in addition to the fact that population aging projections indicate a continued increase in the proportion of the elderly population,²⁶ there is a need to increase NHs capacity. However, in addition to the need to increase capacity, it is increasingly important to ensure a high quality of life, which in the context of the spread of infectious disease means both ensuring safety from the spread of infection and enabling appropriate social interaction

22. Skupnost Socialnih Zavodov Slovenije, *Pregled Kapacitet Institucionalnega Varstva Starejših in Posebnih Skupin Odraslih* (Skupnost Socialnih Zavodov Slovenije, 2021).

23. Jana Breznik, Ženja Brezovar, Barbara Lampič, Nina Ocvirk, Maja Šipelj, Alma Zavodnik Lamovšek, et al., “Dostopnost Zelenih Površin Za Oskrbivance Domov Starejših Občanov V Majhnih Mestih Slovenije,” *Dela*, no. 52 (2020): 61-91.

24. Ibid, 23.

25. Alenka Marovt, *Država je Zadnji dom Zgradila pred 15 Leti, na Posteljo Čaka 12.300 Starostnikov* (24ur. Com, 2020).

26. Ibid, 1.

between those cared for in the home and with the outside world. The occurrence of the COVID-19 pandemic has contributed to a shift in the way society and its needs are approached - from sustainability to resilience. Both, existing NHs architecture and new construction need to be considered comprehensively. In particular, it is important to identify which architectural parameters have a pronounced impact on reducing the risk of spreading respiratory infections and enabling a healthy, comfortable and inclusive living environment, even in times of emergency related to the spread of Sars-Cov 2 and similar infectious diseases, such as the influenza virus, which occur annually in Slovenia.

Methodology

The research focuses on environment of NHs in the period COVID-19, considering NHs from different scales; location in the region, building size and architectural design. Based on the various literature, considering architectural design strategies to balance infection control and social interaction, and surveys conducted by NH directors, we developed an evaluation tool titled "Safe and Connected". The tool focuses more on the architectural design of the NH, considering organizational - architectural protocols. Prior to defining the evaluation tool, we also investigated whether the degree of infection in NHs was influenced by the degree of infection of the region in which the individual NH was located, and the size of the home in terms of the capacity of available spaces. An analysis of all 97 NHs in Slovenia, divided into 12 statistical regions, was performed.

The research methodology is based on eight phases, which basically consist of:

1. *NH inventory in Slovenia*

From the document,²⁷ we obtained data on the number of NHs, their capacity (number of vacancies) and the structure of rooms in terms of number of beds and their categorisation by region.

2. *Statistics on infections*

- *in individual NHs between 20.07.2020 and 7.12.2020*
- *in the population by region between²⁸ 20.07.2020 and 7.12.2020*

The cut-off dates of 20.7.2020 and 7.12.2020 were chosen due to the following facts; on 20.7.2020, after the cancellation of the first wave of the epidemic (11.5.2020), a slight increase of infections in NH is again observed, which reaches a peak on 7.12.2020. After this date, there is a resumption of the decline of infections in NH.²⁹

27. Ibid, 22.

28. Ibid, 3.

29. National Institute of Public Health, 2021. <https://www.nijz.si>.

3. *Analysis of the correlation between the infection degree of a region and the infection degree of NHs in that region*
4. *Statistics on infection degree in relation to the size of NH environment: small, medium, large NH³⁰*
5. *Review and analysis of existing literature - existing guidelines for the architectural design of NHs in the Covid-Pandemics situation*

Based on the literature analysis it is evident that many guides for NH (safety and health protocols) in fighting COVID-19 focus on how to keep people distanced from each other. But there are also some design guidelines which aim to achieve infection control principles, while offering solutions that allow elderly to safely interact.³¹ Moreover, the role of open spaces and green areas are very important for the well-being of elderly people,³² as for the NH residents mental and physical health in the COVID-19 period.

6. *Establishment of an internal rating scale linked to the quality of the NH's architectural design and development of survey questionnaires*

To facilitate data processing, the survey was prepared on the Ika.si portal (open source application). Since not all responses were used in the web applications, we emailed the surveys in pdf format. The response rate to the surveys was very low. 97 questionnaires were sent out and after the first mailing we received only 3 completed questionnaires. We formally requested the assistance of the Ministry of Labour, Family, Social Affairs and Equal Opportunities to reissue a call for surveys. Following a second call from the Ministry to NHs, we subsequently received a further 10 completed questionnaires by the end of April 2021.

7. *Evaluation of the completed questionnaires, obtaining additional information through interviews with the NH leaders and home visits (on site)*
8. *Correlation of the influence of architecture on infection rates in NH*

In this paper we have included only 2 cases of NH from different regions, of different size and with different infection rates: NH_A (Primorsko-Notranjska region) and NH_B (Savinjska region). Due to the time delay, we included in the final analysis updated data on infections during the cut-off dates 19.10.2020 and 11.4.2021 to make the correlation more reliable. The new cut-off dates were chosen due to the following facts; 19.10.2020 was officially declared the second wave of the COVID-19 epidemic in Slovenia, and 11.04.2021 is the last day of the spring lockdown in Slovenia.

At this stage, we excluded mortality due to COVID -19 for the following reason; in Slovenia, all deaths of population having addition to other comorbidities

30. Ibid, 29.

31. Ibid, 12.

32. Artmann, Chen, Iojă, Hof, Onose, Ponizy, et al., "The Role of Urban Green Spaces in Care Facilities for Elderly People Across European Cities," 2017: 203-213.

having also COVID-19 were categorised as deaths due to COVID-19. In fact, many residents of NHs died from the psychological consequences of isolation or from comorbidities. Because it was not possible to identify or isolate cases of deaths attributable solely to COVID-19 from national statistics, we excluded mortality data from the final analysis for reasons of study relevance.

In contrast to the previously mentioned guides (safety and health protocols) which are mainly involved in the prevention of infections COVID-19 in NH, this research focuses on the comprehensive design of NHs taking into account protocols to prevent the spread of infections as a starting point and additionally including the quality of social life to prevent the mental health problems of residents. Designing of NHs does not only focus on interior and floor plan design of the NH-s buildings, but also on open space and green areas or any connection with outdoors spaces.

Results

As mentioned in Chapter 2, there are 97 public and private nursing homes in Slovenia with a total capacity of 19,729 beds and 11,801 rooms. There are 45% single rooms, 47% double rooms, 5% 615 triple rooms, less than 3% four-bed rooms, 0.3% five-bed rooms and 0.1% apartments.³³

Slovenia is divided into 12 statistical regions, which at the time of the epidemic were also closed regional areas between which citizens were allowed to move only with specific exceptions. During a certain period of the epidemic, freedom of movement was even restricted to smaller municipal units within each region.

In the first phase of the study, we aimed to determine whether the degree of infection in the region affected the degree of infection in NHs located in that region. For this purpose, the analysis of statistical data on infected cases in individual Slovenian regions and associated NHs was performed, as shown in Table 1.

33. Ibid, 22.

Table 1. Statistical Data on Infected Cases in Regions and NHs in Slovenia

Regions	N° of NHs	N° of residents REGION	Share of infections REGION (%)	N° of residents NH	Share of infections NH (%)	Share of NH/REGION residents (%)	Share of infections NH/REGION residents (%)
Pomurska	8	114,396	5.51	1263	54.32	1.10	10.89
Podravska	9	324,875	4.10	2822	46.39	0.87	9.83
Koroška	3	70,683	5.34	697	58.11	0.99	10.73
Savinjska	15	257,425	4.47	2527	33.24	0.98	7.30
Zasavska	4	57,059	3.73	663	21.42	1.16	6.68
Posavska	2	75,807	3.71	760	32.11	1.00	8.66
Jugovzhodna Slovenija	8	144,688	4.08	1295	47.72	0.90	10.46
Gorenjska	9	205,717	5.34	1626	36.41	0.79	5.39
Primorsko-notranjska	3	52,818	3.31	433	50.58	0.82	12.54
Goriška	7	118,008	2.62	1393	48.38	1.18	21.76
Obalno-kraška	4	115,613	2.11	698	30.23	0.60	8.66
Osrednje-slovenska	25	552,221	3.90	4944	33.47	0.90	7.69
Total	97	/	/	/	/	/	/
Average			4.02		41.03	0.94	10.05

The different statistical regions vary in size and number of residents, ranging from a minimum of 52,818 to a maximum of 552,221. For the first phase of the survey, we examined available data from 97 NHs in 12 different regions. In each region, there are between 3 and a maximum of 15 units of nursing homes. In the first phase, we analysed the proportion of infected residents in the region, as well as the proportion of infected residents in the nursing homes. We considered the available data on infections on 7.12.2020 for the period starting from 20.7.2020, i.e. the cumulative number of confirmed cases. Different regions had different infection rates during the epidemic period. For example, the cumulative proportion of infected inhabitants in a region as of 7.12.2020 ranged from 2.11% for the Obalno-Kraška region to a maximum of 5.51% for the Pomurska region, while the average proportion of infected inhabitants in all regions was around 4%. Another important figure is that the number of residents of the NHs in question is on average barely 1% of the total population of each region. In most Slovenian nursing homes, the number of infected residents in the second wave of the epidemic was extremely high. On average, 41% of residents in NHs were infected, highest in NHs in Koroška and Pomurska regions with 58.11% and 54.32%, respectively, and lowest in homes in Zasavska region with 21.42%. The high figures are also reflected in the analysis when we look at the percentage of infections among nursing home residents in the region. The data in Table 1 show that infections in nursing homes account for an average of 10.05% of all infections in the region, which is a highly alarming figure considering that the average proportion of

residents in nursing homes is barely 1% of the population in each region. The latter suggests that a high concentration of infections was found in nursing homes.

While we confirmed that NHs were a hotspot for infections during the epidemic, we were interested in whether the infection rate in each of the 12 regions (proportion of infected residents in a region) had an impact on the infection rate of NHs (proportion of infected NHs in the region) located in a given region. We analysed the infected cases data for regions and nursing homes and found an R correlation coefficient, with a calculated value of $R=0.3545$, as shown in Figure 1. Although technically a positive correlation, the relationship between the regional infection degree and nursing home infection degree variables is weak (the closer the value is to zero, the weaker the relationship), so the correlation could not be demonstrated, nor could the influence of regional infection rate on nursing home infection rate.

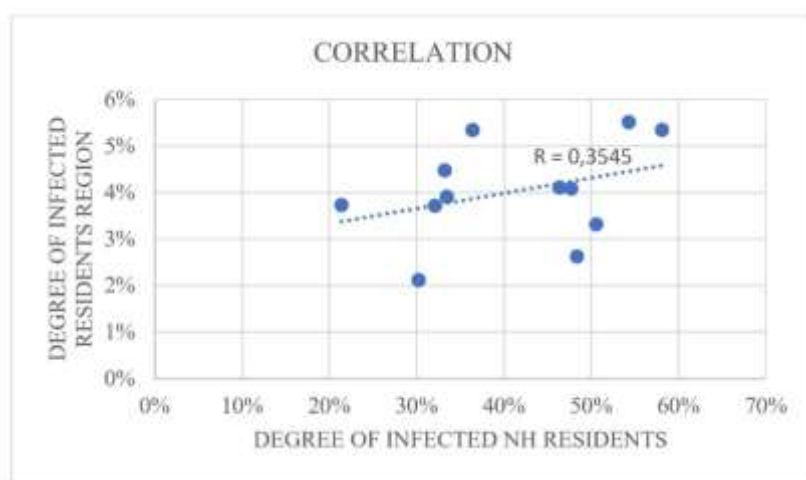


Figure 1. *The Correlation Between Infection Degree of Each of 12 Regions and Infection Degree of NHs Located in Each of Those 12 Regions*

The almost non-existent correlation, as shown in Figure 1, indicates that the infection rate in NHs is not primarily influenced by the condition in the region and places a high responsibility on NH design, organizational measures and quality, which will be analysed in further steps of the study.

The next step we analysed a correlation between the size of NHs and infections. Generally, as mentioned earlier, we divide NHs into small, medium and large homes, depending on the number of residents. Some homes also have several units in different locations. The analysis shows that in Slovenia the type of medium-sized NH predominates, accounting for about 50% of all NHs. About 46% are small and about 4% are large. After reviewing the number of infections by individual NH (National institute of Public Health), we can conclude that the size of NH does not affect the number of infected residents, as a high number of infections occurs in both small and medium and large NH, and vice versa; a low number of infections occurs in both large and medium and small NH.

To conduct additional analyses on factors influencing infections in NHs, we proceeded with the development of an evaluation tool. First, we selected 2 NHs to be analysed more in detail with its basic data presented in Tables 2 and 3.

Table 2. *Data on Residents and Infections*

NH Case Study	NH_A	NH_B
N° of Infected Residents (19.10.2020-11.4.2021)	22	31
Degree of Infected Residents (%)	53	20
N° of Residents	42	157

Table 3. *Data on Architectural Design and Parameters*

NH Case Study		NH_A	NH_B
Building Typology		Block	Semi-Open Perimeter Block
Floor Area (m ²)		2673	8000
N° of Storeys		P+2	P+5
Room Configuration	N° of Rooms (total)	33	106
	Single bed room – share (%)	73	52
	Double bed room - share (%)	27	48
	Triple bed room – share (%)	/	/
	Four bed room – share (%)	/	/
Residential Density (m ² /resident)		63	51
Residential Density of Share Space in Bubble* (average of m ² /resident)		1.75	4.07

*Common space in bubble: community rooms have been set up on each floor for people to meet and participate in community programmes. When used outside of the peak of an outbreak, these spaces can help reduce social isolation while reducing the level of vulnerability.

Based on the literature review, the following facts represent a major motive in the development of evaluation tool. The tool includes an assessment of 5 different fields of Quality Measures: bubble concept, open space and green areas, distancing spaces, ventilation and organizational-architectural measures. Each of these fields consists of different sets of criteria (each field consists of 3 criteria), where each criterion is scored with 1 point, which means a total of 3 points per field, as shown in Table 4. Achieving 1 point means a 100% match with the criterion. In total, a maximum of 15 points can be achieved in the tool, which is the highest score in terms of NH quality associated with the period COVID-19. In the area of organizational-architectural measures, 2 sets of sub-criteria also appear exceptionally, which define the criteria “Prevention of entry of infections into NH”^(a) and “Prevention of transmission of infections into NH”^(b) in more detail.

Table 4. Results of Evaluation Tool “Safe and Connected”

Fields	Criteria	Scores (max)	NH_A	NH_B
Bubble Concept*	Smaller units (100%=12 residents)	1	0.67	0.71
	Share of single bed rooms with private bathroom	1	0	1
	Share of residents living in single rooms	1	0.59	0.31
Open Space and Green Areas	Open space and green areas with the programme	1	0	1
	Rooms with balconies	1	0.18	1
	Common rooms with balconies/teraces and visual contact with outdoor environment	1	0.25	0.4
Distancing Space	Flexible room**	1	0	1
	Safe room for visitors***(external access and separation of physical contact)	1	0	0.5
	Red zone**** (flexible room/outdoor unit/common rooms/rooms of residents)	1	0	0.5
Ventilation	Bedrooms (mechanical with fresh air or direct natural with adequate frequency)	1	0.5	0.5
	Common rooms	1	0.5	0.5
	Corridors and staircases	1	0.5	0.5
Organizational-Architectural Measures	Quarantine of delivered goods*****	1 ^a	0.33	0.33
	Staff working in bubble		0.33	0.33
	Limited movement of visitors		0.33	0.33
	Contactless door (main entrance, bathrooms, rooms)	1 ^b	0	0,11
	Use of outdoor areas by healthy residents		0.33	0.33
	Individual entrance (employees/residents/delivery)		0	0.33
	Common rooms (reduction of capacity if being in use/protocol of use/partition of space)	1	0	1
Scores Total		15	4.51	10.68
Estimated Degree (%)		100	30	71

*Bubble concept: It is scientifically proven that the social bubble helps slow the spread of COVID-19 because it limits the number of people with whom someone interacts meaningfully. **Flexible room: multipurpose space of the NH that could be the red zone during COVID-19. ***Safe room for visitors: the visiting room in the NH allows residents to spend time with their visitors in a safe manner during the colder months. Residents and visitors are separated by a large glass (window). The safe room is equipped with what is called a plastic “hug bubble” that allows people to touch and hug each other. ****Red zone: All residents, including any new or readmitted, known to have tested positive for COVID-19 (asymptomatic or symptomatic). *****Quarantine of delivered goods: Ready room for cleaning of packages. This should be done in the lobby to avoid unnecessary exposure within tight circulation paths such as hallways and elevators.

From Table 2, it can be seen that NH_A represents a small NH (42 inhabitants) where 53% of the inhabitants were infected, and NH_B represents a medium NH (157 inhabitants) where only 20% of the inhabitants were infected.

From the results of the comparative analysis (Table 4), we can conclude that in NH_B more than 70% of the criteria apply, which provides a quality living

environment for the elderly. We also found that NH_A does not meet the “Safe and Connected” criteria as only 30% of the criteria match. The final assessment score by percentage is shown in Figure 2 on a five-colour scale.

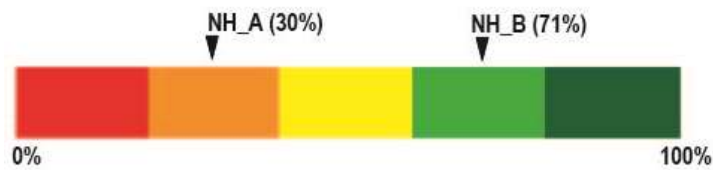


Figure 2. Final Evaluation Mark of the “Safe and Connected” Tool by Percentages for NH_A and NH_B

The additional compliance with “Safe and Connected” tool criteria is represented by fields in Figure 3. It can be seen that the NH_B, unlike the NH_A, includes many of the criteria of the “Safe and Connected” tool. The deficiencies have been identified in the criteria relating to the “distancing spaces” and “open space and green areas”.

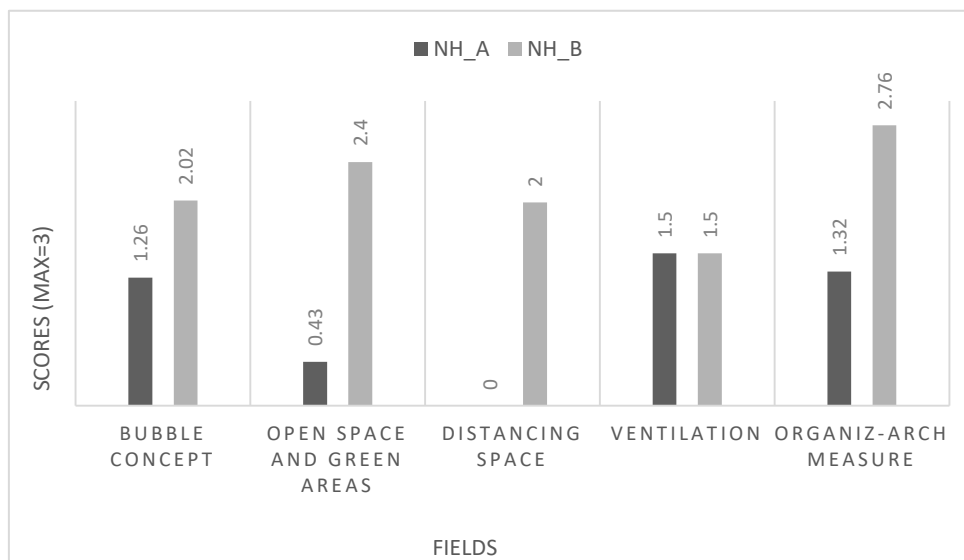


Figure 3. Evaluation Scores for Different Fields of the Evaluation Tool “Safe and Connected” for NH_A and NH_B

The NH_A has no open or green spaces nearby. Barely a fifth of all rooms have a balcony, also only a quarter of the common areas have direct contact with the outdoors, whereas in NH_B all rooms have a balcony, almost half (40%) of the common rooms have contact with the outdoors and, most importantly, NH_B also includes a spacious, open, green atrium that allows for a variety of programming for the elderly. To prevent infections, the NH_A does not have a safe room for visitors, the building also does not have a flexible room, but the red zone is organized directly in the department of dementia. However, not to be neglected, NH_A has no single room with private bathroom, although it has a higher

percentage (73%) of single rooms compared to NH_B (52%), while NH_B still has all single rooms with private bathroom, as shown in Table 2.

Conclusions

The COVID-19 pandemic has indicated the need to rethink the design of NHs to create quality living environments that enable residents to live healthy, safe, and socially inclusive lives. While there are many existing assessment methods for determining the quality of NHs, the COVID-19 pandemic has highlighted the need for more comprehensive assessment tools that, in addition to established criteria, include criteria for assessing safety in terms of reducing the possibility of the spread of infection and, at the same time, criteria that focus on reducing resident isolation.

One of the objectives of this study was to find out whether there are certain correlations from which important factors influencing the spread of infections among NH residents can be extracted, and these factors include the architectural design aspect. In this context, three basic hypotheses were formulated. After careful analysis, the first 2 hypotheses were rejected:

H1: The degree of infections in the region does not affect the degree of infections in NH.

H2: The size of NHs building does not correlate with the degree of infections in NH.

On the other hand, the hypothesis H3: The architectural design of the NH environment affects the degree of infections in NH, was confirmed. To validate the hypothesis, a “Safe and Connected” evaluation tool was developed. According to the evaluation results, the NH_B shows significantly better quality than the NH_A in terms of all the estimated quality fields, which correspond to the lower degree of infection in the NH_B.

The paper shows that architectural design can serve as a foundation for creating a comprehensive healthy, safe and inclusive social environment. Based on the findings of the “Safe and Connected” evaluation tool, it is possible to make some recommendations for the design of nursing homes that are somewhat easier to consider when designing new homes than when renovating existing ones. In general, it is recommended that NHs should be designed with smaller units of up to 12 residents per unit, consisting primarily of single rooms with private bathrooms and balconies. It is very beneficial if some surplus space is planned, since it can be used as flexible room that can be adapted for any purpose in different situations. In the event of an epidemic of infectious disease, the flexible room could be used to isolate COVID-19 patients. In addition, safe rooms for visitors are very useful to prevent the spread of infections and allow social contact with family and friends. Furthermore, it is important to design the associated open spaces and green areas to allow safe social interaction and a variety of active and passive activities for residents. Finally, adequate ventilation of all indoor spaces should be given high priority, especially as adequate air exchange can significantly reduce the risk of infection. It can be concluded that architectural design plays an

important role in creating a healthy and safe environment in nursing homes, as more organisational measures can be taken to prevent infections in appropriately designed homes. The conclusions of this study are useful for further consideration of the design of new nursing homes and the renovation of existing homes.

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