Chapter 87
Nursing Homes During COVID-19 Pandemic—A Systematic Literature Review for COVID-19 Proof Architecture Design Strategies

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Abstract The immense impact of the coronavirus disease 2019 (COVID-19) pandemic on older adults living in nursing homes (NH) and other long-term care facilities, who at baseline are at increased risk of infection due to fragility, cognitive impairments, and complex comorbidities, has renewed the attention of researchers to the unmet needs of this population. It is well known that the built environment can significantly influence human health, a reality which is often overlooked in the setting of NHs. Recognizing how qualities of the NH built environment can influence resident outcomes, particularly in the context of the COVID-19 pandemic, can provide architects and medical professionals implementable strategies. As such, we conducted a systematic literature review from May to November 2021 to identify components of the NH built environment and their potential impacts on the health and well-being of NH residents during the COVID-19 pandemic. Relevant articles were identified with a search of Scopus, Web of Science, and PubMed scientific databases, as well as a search of gray literature. The initial search resulted 481 articles, though after the application of eligibility criteria and full-text screening, 17 articles remained for inclusion. From these, a total of 24 built environment features were identified, divided across four domain levels of NHs: Overall Facility, Building, Service Space, and Residential Room. These features were differentially linked to improved facility infection control, decreased COVID-19 incidence and mortality from COVID-19, better air quality, and enhanced resident health, quality of life, and socialization. This research defines a set of design/architecture strategies that NHs

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may implement to improve COVID-19-related outcomes as well as the overall health and quality of life of their residents. Additional research utilizing primary data and testing these identified interventions is needed to provide stronger evidence-based suggestions.

Keywords Elderly · Built environment · Nursing homes · COVID-19 · Evidence-based design

87.1   Introduction

The global population is aging. By 2050, the number of people aged 65 years or older is predicted to double while also occupying a greater percentage of the overall population, increasing to 16% from 9% in 2020 (United Nations Department of Economic and Social Affairs 2020). The Italian context is expected to see an even more dramatic change over this same time frame, with the proportion of those age 65 years or older projected to increase from 23% in 2020 to 35% (Instituto Nazionale di Statistica 2021). As such, it is vital to recognize the increasing demand that global populations will have for appropriate facilities to care for the elderly, as well as the critical role that these facilities play in health care and social infrastructures.

Throughout the course of the coronavirus disease 2019 (COVID-19) pandemic, its disproportionate toll on older adults, in terms of both infection and mortality rates, has been well documented. The effects of COVID-19 were compounded in long-term care facilities, places comprised primarily of older adults and previously known to be vulnerable to respiratory disease outbreaks (McMichael et al. 2020). By May 2020, 37–66% of COVID-19-related deaths in European countries were attributed solely to residents of long-term care facilities (ECDC 2021).

Emerging research investigating the characteristics of long-term care facilities that may have contributed to these COVID-19 death rates has primarily focused on characteristics of residents, characteristics of the surrounding community, management strategies, or performance metrics (Zhu et al. 2022). Less attention has been paid to the built environment of these facilities and how their design features may have impacted resident outcomes during the COVID-19 pandemic. These outcomes extend beyond COVID-19 incidence and mortality, instead including resident physical and mental health, socialization, and quality of life, all of which may be impacted by the built environment (Evans 2003).

The role of the built environment on improving health and well-being outcomes in health care (Ulrich et al. 2008) and broader urban environments (Rao et al. 2007) is well known, with growing evidence of this relationship emerging in the wake of the COVID-19 pandemic (Capolongo et al. 2020a; Capolongo et al. 2020b). These discussions have been comparatively quiet in the context of long-term care facilities (Parker et al. 2004) with the COVID-19 pandemic revealing how their built environments represent yet another inadequacy in this sector (Fulmer et al. 2020).

Search Topic	Search Terms
Nursing homes	"Nursing home" OR "Healthcare facilities" OR "Long-term care"
Built environment	"Built environment" OR "Physical environment" OR "Indoor quality"
Older adults	"Older adults" OR "Senior" OR "Elderly"
COVID-19	"COVID" OR "COVID-19" OR "Sars-Cov-2"

Fig. 87.1 Search topics and terms

This systematic review, focusing on 24-h residential long-term care facilities typically referred to as nursing homes (NH), aims to identify components of the NH built environment and their corresponding impacts on the health and well-being of NH residents during the COVID-19 pandemic. In doing so, we aim to synthesize evidence-based design interventions that have emerged throughout the pandemic, providing both NH design recommendations to prepare for the future of elderly adult care and avenues for future research in the field of NH evidence-based design.

87.2 Methods

To accomplish the aims of the research, a systematic literature review of existing articles related to NH design was completed (Pati and Lorusso 2018). This was conducted from May to Nov 2021 using the scientific databases Scopus, Web of Science, and PubMed, as well as gray literature. Key search terms were identified within the following thematic categories: nursing homes, built environment, older adults, and COVID-19 (Fig. 87.1).

87.3 Results

The initial literature search conducted on scientific databases identified 456 articles with an additional 25 articles identified from gray literature databases, for a total of 481 articles. Following the removal of duplicates and initial screening of these articles, 41 articles remained for full-text evaluation. Of these, 22 were excluded based on their content being outside the scope of this review, leaving 17 eligible articles for data extraction and analysis in this study. The literature search and selection process is summarized in Fig. 87.2.
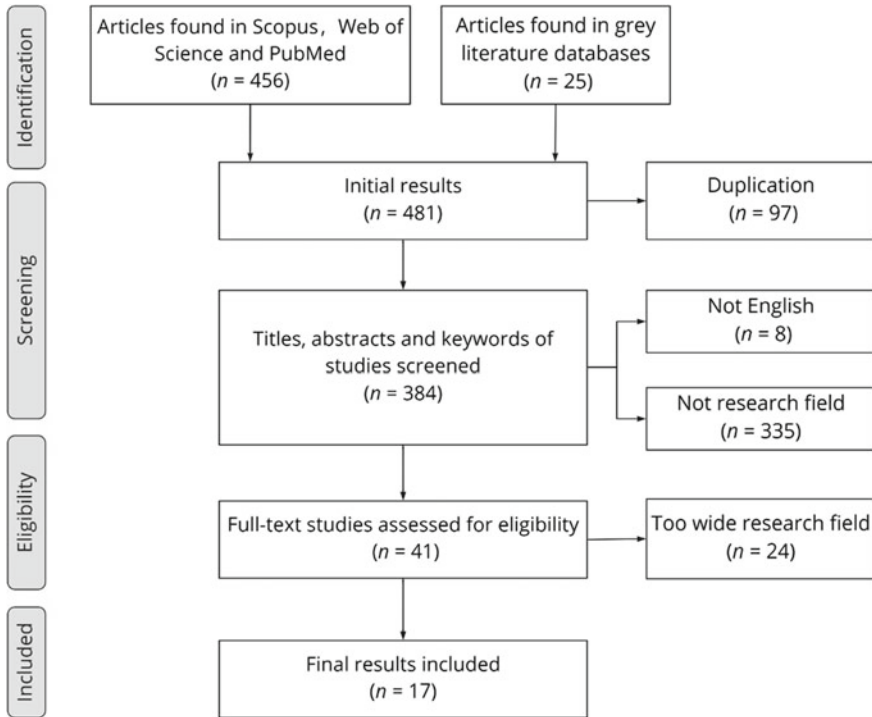
Fig. 87.2 Flow diagram of the literature search and selection process

87.4 Characteristics of Included Studies

The general characteristics of the 17 included articles are detailed in Fig. 87.3. The article types were classified as either research, review, or theoretical studies. Four articles collected primary data in the form of a case study, questionnaires, or interviews, though secondary data sources (databases, guidelines, previously published articles, etc.) were the predominately utilized data source.

A total of 24 elements of the built environment of NHs were extracted from the 17 included articles. These were classified into four domain levels of NHs: Overall Facility, Building, Service Space, and Residential Room. The corresponding impacts of each built environment feature on outcomes related to the health and well-being of older adults in NHs are identified and organized in Fig. 87.4. Seven outcomes were identified and are listed here from most to least discussed: infection control, quality of life, COVID-19 incidence, COVID-19 mortality, overall health, socialization, and air quality improvement.

N°	Author	Title	Year	Source Name	Country	Article Type	Data Source
1	Abrams H.R. et al.	Characteristics of US Nursing Homes with COVID-19 Cases	2020	Journal of the American Geriatrics Society	USA	Research	Secondary
2	Anderson D.C. et al.	Nursing Home Design and COVID-19: Balancing Infection Control, Quality of Life, and Resilience	2020	Journal of the American Medical Directors Association	USA	Review	Secondary
3	Brown K.A. et al.	Association between Nursing Home Crowding and COVID-19 Infection and Mortality in Ontario, Canada	2020	JAMA Internal Medicine	Canada	Research	Secondary
4	Cazzoletti L. et al.	Risk Factors Associated with Nursing Home COVID-19 Outbreaks: A Retrospective Cohort Study	2021	International Journal of Environmental Research & Public Health	Italy	Research	Primary
5	Chow L.	Care homes and COVID-19 in Hong Kong: how the lessons from SARS were used to good effect	2021	Age and Ageing	Hong Kong	Research	Secondary
6	Dosa D. et al.	Long-Term Care Facilities and the Coronavirus Epidemic: Practical Guidelines for a Population at Highest Risk	2020	Journal of the American Medical Directors Association	USA	Editorial	Secondary
7	Estabrooks C.A. et al.	Restoring trust: COVID-19 and the future of long-term care in Canada	2020	Facets	Canada	Review	Secondary
8	Harrington C. et al.	Nurse Staffing and Coronavirus Infections in California Nursing Homes	2020	Policy, Politics, & Nursing Practice	USA	Research	Secondary
9	He M. et al.	Is There a Link between Nursing Home Reported Quality and COVID-19 Cases? Evidence from California Skilled Nursing Facilities	2020	Journal of the American Medical Directors Association	USA	Research	Secondary
10	Khairat S. et al.	US Nursing Home Quality Ratings Associated with COVID-19 Cases and Deaths	2021	Journal of the American Medical Directors Association	USA	Research	Secondary
11	Konetzka R.T. et al.	A systematic review of long-term care facility characteristics associated with COVID-19 outcomes	2021	Journal of the American Geriatrics Society	USA	Review	Secondary
12	Liu M., et al.	COVID-19 in long-term care homes in Ontario and British Columbia	2020	Canadian Medical Association Journal	Canada	Research	Secondary
13	Olson N.L. and Albensi B.C.	Dementia-Friendly 'Design': Impact on COVID-19 Death Rates in Long-Term Care Facilities around the World	2021	Journal of Alzheimer's Disease	Canada	Review	Secondary
14	Spaetgens B. et al.	The Post-Acute and Long-Term Care Crisis in the Aftermath of COVID-19: A Dutch Perspective	2020	Journal of the American Medical Directors Association	Netherlands	Editorial	Secondary
15	Verdoorn B.P. et al.	Design and Implementation of a Skilled Nursing Facility COVID-19 Unit	2021	Journal of the American Medical Directors Association	USA	Research	Primary
16	Wang Z.	Use the Environment to Prevent and Control COVID-19 in Senior-Living Facilities: An Analysis of the Guidelines Used in China	2021	Health Environments Research and Design Journal	China	Research	Primary
17	Zimmerman S. et al.	Nontraditional Small House Nursing Homes Have Fewer COVID-19 Cases and Deaths	2021	Journal of the American Medical Directors Association	USA	Research	Primary

Fig. 87.3 Characteristics of included studies

87.5 Overall Facility Level

The Overall Facility Level represents the broadest domain analyzed and refers to aspects of the built environment related to the entirety of the nursing home site. There are four specific features organized at this level and include: (i) small NH size, (ii) crowding index, (iii) integration with health/social services, and (iv) proximity to home community. NH size (i) was discussed in eight articles and was suggested or found to be related to decreased incidence of COVID-19 infections, decreased mortality due to COVID-19, and increased quality of life for NH residents (Cazzoletti et al. 2021) also evaluated the role of NH size on rates of COVID-19 incidence

Domain	Feature of the Built Environment	Outcome on Older Adults
Overall Facility	Small nursing home[1,2,7-11,17]•	COVID-19 mortality[9,11,17]; COVID-19 incidence[2,8-11,17]; Quality of life[2,17]
	Crowding index[3]	COVID-19 mortality; COVID-19 incidence[3]
	Proximity to and integration with health and social services[2]	Overall health[2]
	Proximity to resident home community[2]	Quality of life; Socialization[2]
Building	Dedicated resident, visitor, and staff access areas[2,16]	Infection control[2,16]
	Large internal circulation space[2,7,16]	Infection control[2,16]
	Alcohol hand sanitizer widely available in residential and public spaces[6,14]	Infection control[6]
	Dedicated and separated infectious unit[2,7,15,16]	Infection control[2,16]
	Outdoor areas and spaces for social interaction/exercise[2,13,16]	Infection control[2,16]; Socialization[2,16]; Overall health[13]; Quality of life[13]
	Natural and mechanical ventilation[2,13,16]	Air quality improvement[13]; Infection control[2,13,16]
	Homelike environment[2]	Quality of life[2]
	Telemedicine/telecommunication capabilities[7]	Quality of life[7,15,16]
	Adequate natural light[2,13]	Overall health[13]; Quality of life[2,13]
	Wayfinding and orientation[13]	Overall health; Quality of life[13]
Service Room	Reception room for visitor screening[16]	Infection control[16]
	Compartmentalized staff hygienic areas[2,15]	Infection control[2]
	Decentralized care stations[2,15]	Infection control[2]
	Designated space for contaminated waste[16]	Infection control[16]
	Compartmentalizable common spaces[2,16]	Infection control[2,16]
	Onsite medical clinic[16]	Infection control; Overall health; Quality of life[16]
Residential Room	Private rooms and bathrooms[2,5,12,17]	Infection control[5]; Quality of life[2]
	Adequate transitional spaces[2]	Quality of life[2]
	Wide and accessible walking area[2]	Quality of life; Infection control; Socialization[2]
	Outdoor views[2,5]	Quality of life[2]; Socialization[2,5]

Fig. 87.4 Relationships between elements of the built environment and outcomes for older adults across organizational levels

but found no significant association. The second feature is (ii) crowding index, a quantitative metric relating the number of NH residents to the number of bedrooms and bathrooms within a NH site.

Higher crowding index was associated with both increased incidence of COVID-19 infection and mortality due to COVID-19. The final two features, (iii) integration with health/social services as well as (iv) proximity to a resident's home community, are related to the geographic location of NHs. These features are suggested, respectively, to be related to enhanced overall health and enriched quality of life/socialization for residents.

87.6   Building Level

The next domain of the NH built environment is the Building Level and includes ten specific features. Elements within this level are related to the organization and structure of the individual buildings that comprise NHs. The first of these features is (i) dedicated resident, visitor, and staff access areas with its potential impact focused on improved infection control in NHs by reducing non-essential interactions. The second, third, and fourth features at this level all similarly are suggested to support infection control in NHs. These features are: (ii) a large internal circulation space, referring to large enough corridors to provide for social distancing and one-way flows; (iii) alcohol hand sanitizer widely available in residential and public spaces; and (iv) dedicated and separated infectious units within NHs. While also being linked to improved infection control, the fifth feature, (v) outdoor areas and spaces for social interaction/exercise, is suggested to promote resident socialization, overall health, and quality of life, and the sixth feature, (vi) adequate natural and mechanical ventilation, can improve overall NH building air quality. The final four features within the Building Level are: (vii) telemedicine/telecommunication capabilities, (viii) a homelike environment, (ix) wayfinding and orientation, and (x) adequate natural light. Through different mechanisms, these all are suggested to improve the quality of life for NH residents, with features (ix) and (x) having an additional benefit for resident overall health.

87.7   Service Room Level

There are six features of the built environment organized within the Service Room Level. These are (i) reception room for visitor screening, (ii) compartmentalized staff hygienic areas, (iii) decentralized care stations, (iv) designated spaces for contaminated waste, (v) compartmentalizable common spaces, and (vi) an onsite medical clinic. All factors within this domain are suggested to positively impact infection control in NHs. An onsite medical clinic, which may double as a geriatric care site for the surrounding community, additionally expands overall access to medical care for residents, thus improving health and quality of life.

87.8   Residential Room Level

The fourth and final domain is the Residential Room Level, with four associated built environment features. All four features at this level are suggested to improve resident quality of life. The first of these is (i) adequate transitional spaces, referring to spaces such as porches and corridor alcoves where residents can sit and receive visual and cognitive stimuli. The second feature, (ii) private rooms and bathrooms,

supports infection control as well as quality of life. The third feature, (iii) wide and accessible walking areas, and fourth feature, (iv) outdoor views, both support resident socialization, while (iv) also provides elements of infection control.

87.9 Discussion

Our population is aging and will be increasing shuttled to a systemically and extensively flawed system of NHs, spaces that function both as institutional care centers as well as homes. This sector requires sweeping reform across several domains, one of which is the built environment. As places of healing and as residential spaces for the elderly, it is critical that these facilities can be designed with the specific needs and vulnerabilities of their residents in mind. This systematic review identified 17 articles that discussed 24 features of the NH built environment, providing variable targets in four different domains (Overall Facility, Building, Service Space, and Residential Room) to improve outcomes during the contemporary COVID-19 situation as well as in the future. These features were most frequently implicated in improving general infection control in NHs, which helps combat infectious disease outbreaks, improve resident morbidity and mortality, and reduce healthcare costs. Quality of life was the second most frequently discussed outcome which, through its impact on well-being, stress, and resilience, can improve longevity (MacLeod et al. 2016). Improved socialization, only discussed in three of the articles, is relatively underrepresented as an outcome and target for the built environment. Social isolation, a significant existing challenge facing older adults, was amplified during the COVID-19 pandemic with the potential to increase the risk of premature death, mental health disorders, cardiovascular disease, and dementia in this population (Centers for Disease Control 2021). Designers should follow the guiding principle of creating a more homelike environment for the residents of these NHs, following or expanding upon established nontraditional designs for NHs. From this principle of creating an ideal home environment for older adults, many of the desired design features highlighted in this review would follow, including private rooms and bathrooms, outdoor areas, outdoor views, natural light, ventilation, large circulation spaces, adequate way finding, and telecommunication, all within a non-crowded building with < 20 residents that is close to and integrated within their home community.

Designers can then incorporate features specific to the healing environment of the NH, making sure that they are compartmentalizable and decentralized, including staff hygienic areas, common spaces, contaminated waste areas, visitor screening areas, and infectious units.

87.10   Conclusions

This research represents a starting point in defining a set of design/architecture strategies that NHs may implement to improve COVID-19-related outcomes as well as the overall health and quality of life of their residents. Creating smaller nursing homes integrated with the surrounding community that are designed to be home-like with single rooms/bathrooms, adequate outdoor space/views, and telecommunication capabilities emerged as features with significant positive impact on residents. Additional research utilizing primary data and testing these identified interventions is needed to provide stronger evidence-based suggestions in this sector. This research must be applied within the larger sociologic and political situations that shape outcomes in NHs, yet nonetheless provides insight into the benefit of interdisciplinary research and collaboration between healthcare designers and healthcare providers, while also arming these actors with new strategies to support and not to forget the elderly. Though this review fills a knowledge gap by synthesizing published information about the NH built environment during COVID-19, results of this review are limited by its brief and early time frame that may have missed relevant research articles still underway.

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