How our homes impact our health: using a COVID-19 informed approach to examine urban apartment housing

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Abstract

Purpose – The COVID-19 global health crisis is undeniably a global housing crisis. Our study focuses on quality of life in urban mid- and high-rise apartment housing, the fastest growing housing types in many cities around the world. This housing typology presents unique challenges relating to connection to nature, daylight and fresh air.

Design/methodology/approach – This multi-disciplinary literature review analyzes more than 100 published papers from peer-reviewed sources from environmental psychology, building science and architecture relevant to quality of life in high-rise housing, as well as more than 40 recent newspaper and magazine articles about the possible impacts of COVID-19 on housing. We identify synergies between passive design strategies and health-promoting architecture or “restorative environmental design” principles.

Findings – Post-pandemic, health-promoting apartment housing design must prioritize (1) window placement and views that support stress recovery and restoration; (2) lighting levels based on spaces that can satisfy multiple uses and users; (3) bedrooms designed for restful sleep that contribute to circadian regulation; (4) living rooms with better indoor air quality, with a focus on natural ventilation; (5) access to nature, through the purposeful design of balconies and (6) unit sizes and layouts that enable physical distancing and prevent crowding.

Originality/value – We identify new social and environmental design priorities in the form of evidence-based design principles to inform and promote healthy and restorative living environments for residents in apartment housing.

Keywords Apartment housing, COVID-19, Daylight, Wellbeing, Health, Restorative environmental design, Social sustainability, Views, Physical distancing, Circadian lighting, Thermal comfort, Balcony design

1. Introduction

As cities around the world continue to densify, high-rise apartment housing will remain a dominant residential housing typology in urban environments. Due to COVID-19 city shutdowns and quarantines which began in many countries in early 2020, people have been spending far more time than usual in their homes; thus it is paramount that occupant wellbeing and health become a priority in residential design. Restorative environmental design (RED) is a theory from environmental psychology that the built environment around us can help us recover from stressors and replenish our resources depleted by concentration and distractions using nature (Kaplan, 1995). As currently designed, high-density urban housing does not offer restorative experiences for residents, but by critically rethinking some

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parameters, there could be great improvements in quality of life in this housing typology. Our homes could become environments that improve our well-being, comfort, quality of life and mental and physical health. Studies show that people spend more time at home than we perhaps realize. For example, even pre-COVID-19, before working from home was the norm, and when schools and workplace were open, urban dwellers in Toronto Canada spent a surprising amount of time at home. The Canadian Human Activity Pattern Survey (administered from 1996 to 1997), conducted 2,381 resident interviews in four major Canadian cities; it found that Toronto residents spend on average 16.1 h/day indoors at home (Leech et al., 2002). Examining apartment housing through a post-COVID-19 lens, it is alarming to consider how the number of hours residents spend indoors at home must have grown due to pandemic related city shutdowns. The pandemic has acted as a catalyst for discussions concerning the health-promoting qualities of our homes, shining light on a topic of great importance that must be addressed.

This paper addresses both the primary and secondary impact of the “stay at home” protocols, i.e. social distancing and social isolation as it impacts on the psychological and physical health of residents and the changing and multiple use and time of homes under such provisions. The lens restorative design provides strategies for improving quality of life in apartment housing, by reconsidering the design of windows, views and access to nature within the home. This multi-disciplinary literature review resulted in findings relating to the importance of window views, the need for variability and variety in lighting levels based on new uses, daylight for circadian regulation and environmental design that promotes well-being and comfort. Inspired by the potentials for improving apartment housing during and after the COVID-19 crisis, we have determined architecturally relevant strategies for integrating restorative environmental design into mid- and high-rise apartment housing to improve resident quality of life in the city during and following a pandemic.

2. Background: apartment housing and the city
As a housing typology, mid-rise and high-rise urban apartment housing have certain inherent challenges, and many of these are worsened by the impacts of COVID-19 on apartment living. Unlike in single-family detached homes or low-rise townhouses, apartment housing design must consider additional programmatic elements that seem at odds with the heightened awareness of hygiene and physical distancing such as elevators and elevator waiting areas, shared staircases, garbage and recycling rooms, underground parking areas, shared lobbies, shared laundry rooms, balcony access and proximity to other balconies and often exercise rooms and common roof decks. Within dwellings, compared to other urban housing forms, small unit sizes, daylight from a single facade, poor quality and resident control over indoor air quality (IAQ) and thermal comfort are the norm and potentially pose serious concerns for occupant health and well-being (Andargie et al., 2019). As residents are increasingly spending the majority of their time at home, the ability of their apartments to support resident mental health and well-being also becomes critical. To create a sense of restoration in apartment housing, the focus should be on the quality of dwellings, with more attention to placement of windows, qualities of views and access to nature. Numerous studies demonstrate that daylight and access to nature have positive impacts on health and well-being at home (Veitch and Galasiu, 2012). While these are challenging to retrofit into an existing design, they should certainly be prioritized in new housing. Post-pandemic, daylight quantity and quality in apartment housing could prove to be a great starting point for design innovation and act as a preventative therapy in restorative design for future pandemics (see Plate 1).

Urban densification is occurring globally, creating a concentration of apartment housing in urban centers. For example in Toronto, Canada, 29.4% of the city’s population live in apartment buildings with five or more storeys (Government of Canada, 2017). Restorative
environmental design could serve a dual function, both replenishing people’s stress and promoting well-being and also helping to address climate change and the need to meet ambitious new energy efficiency goals. Many of the strategies for human health and well-being utilize passive design strategies like operable windows for natural ventilation that result in low-environmental impact thereby also promoting environmental sustainability (Peters, 2017). The application of biophilic design principles that connect people with nature also play a role in restorative environments (Kellert et al., 2008).

2.1 Healthy housing
The current pandemic is not the first time that architecture has had to respond to disease through design innovations, and it will not be the last. In 1800’s New York, the Tenement House Acts were created as a solution to squalid conditions in tenement housing. The Acts upgraded standards of safety, ventilation and health in dwellings and resulted in the implementation of the “dumbbell” housing design, which featured a central light well to increase ventilation and daylighting throughout the home (Arbuckle, 2016; Giacobbe, 2020). The 1918 “Spanish Flu” pandemic following the first World War led to the formation of public health regulations and in countries like Canada the establishment of a federal Department of Health. Furthermore, until antibiotics were widely available, visiting a sanatorium was a common treatment to combat tuberculosis. For instance, the Paimio Sanatorium (1933) by Alvar Aalto was integrated into a forested landscape in Finland, providing ample natural views, open daylight balconies and nearby walking paths to patients. At this time, daylight and exercise were prescribed as state-of-the-art treatment to patients. In future, perhaps some of the design principles of sanatoriums will become the new basis of design for all buildings, where light and air are at the center of health-promoting architecture. It may be that postCOVID-19 housing will share similar goals and place health and wellness at the forefront, building on the rising acceptance of the WELL building rating system and other advances in this direction (International WELL Building Institute, 2018).

3. Methods, literature review
This paper analyzes results of a literature review that identified and evaluated relevant peer-reviewed studies relating to COVID-19 and apartment housing from multiple disciplines including architectural design, environmental psychology, building science, engineering,
urban planning and health. The study included relevant government publications, news articles and magazine articles to gain an up-to-date understanding of COVID-19 and its implications on architectural design. The findings are architecturally relevant design recommendations for restorative apartment housing in the context of COVID-19. Several challenges were encountered throughout this literature review. In selecting papers for analysis, we found it challenging to use key word searches as terminology varied between disciplines. We noticed that often in building science or engineering journals multi-unit residential buildings (MURB) were used to describe this housing type, while often in social sciences and humanities journals, apartment housing, multi-storey apartment buildings or high-rise residential towers were terms used. Occasionally relevant papers were also categorized as multiple-unit housing, rental housing, social housing or condominium housing. Another challenge was that the articles that we included varied in their study location, and therefore their culture and political climate. For example, results from residential daylighting studies in Hong Kong that examine occupant preferences may not be applicable to its Canadian residential counterparts due to specific societal norms and cultural preferences. Furthermore, as there is limited published research on COVID-19 and housing, there was a general uncertainty in applying recommendations, as we, like the rest of the world, do not know how COVID-19 will continue to evolve. It should also be noted that because COVID-19 has progressed differently from country to country, our interpretation of how the results from studies completed in other countries relation to Canada and may not always be relevant in all contexts. Additionally, this study did not focus on housing for accessibility, for affordability or for people recovering from illness. Future studies could examine these issues and how they relate to apartment housing through a postCOVID-19 lens as they are highly relevant.

4. Findings and discussion
The current pandemic poses opportunities for change in the design world as existing social and political issues in contemporary architecture and housing have been brought to attention. It is crucial that resident quality of life be a focus in housing design. We identified seven areas of intersection between state-of-the-art housing research, restorative environmental design and studies relevant to COVID-19 for mid- and high-rise apartment housing (see Figure 1).
4.1 Window views, spatial variety and privacy

Windows in dwellings are necessary for inhabitant comfort and health, perhaps even more so during a pandemic. The quality of the view to the exterior is of great importance when activities outside are limited and is fundamental to a dwelling’s ability to provide a sense of restoration to inhabitants. Attention restoration theory (ART) explores how fatigue caused by “directed attention” or concentration on tasks using emotional energy can be mitigated or replenished through an environment’s ability to support recovery by creating spaces that do not require great amounts of directed attention (Kaplan, 1995, 2001). Environments which support “soft fascination”, enabling the mind to reflect on unresolved thoughts that have the ability to deprive more critical attentional resources, offer a source of relief and restoration (Basu et al., 2019; Kaplan, 1995). For example, studies have found that looking outside throughout a day provides micro-restorative experiences, which have the capability to provide restorative qualities of nature to occupants within their home (Kaplan, 2001). In a time where individuals are not able to leave their dwellings as freely as they have become accustomed, the value of a view to the outdoors is essential to residents’ wellness. Natural window views and nature experiences are shown to enhance well-being through physiological calming and improved focus, mood and resident satisfaction (Kaplan, 2001; Talbot and Kaplan, 1991; Ulrich et al., 1991; Veitch and Galasiu, 2012). Nature is being capable of holding one’s interest and attention, proving to reduce fatigue and stress while restoring the mind and body (Kaplan, 1995). In a time where anxiety and loneliness are on the rise, the benefits of the natural environment become central to the well-being of residents in apartment housing.

In urban apartment buildings, direct views to green landscapes may not be possible, but research has shown that a clear view of the sky can also be restorative. In a study exploring people’s perceptions of apartment window views, views with maximum amounts of sky are perceived as most restorative (Masoudinejad and Hartig, 2020). Furthermore, in an investigation of the relationship between neighborhood satisfaction and perceptions of naturalness and openness, findings indicate that openness, which is understood as unobstructed, open spaces is the most important factor in overall neighborhood satisfaction (Hur et al., 2010). In apartment housing, city views into other buildings are often the norm, whereas we must consider that having all available views blocked by adjacent buildings make views less capable of restoration, satisfaction, well-being, comfort and soft fascination to residents. With this knowledge, urban densification must be managed, and apartment housing views and surroundings must be considered in the design process.

As a result of COVID-19, privacy, individual space and the relationship between the individual and the family and the family and the neighborhood have changed (Nielsen, 2020). The theory of prospect–refuge (Appleton, 1975) purports that people naturally prefer varied environments that include places where they can see activities but cannot be easily overlooked by others. Windows that provide residents with a “lookout” view of the city street or greenspace, act as a source of prospect (Hwang and Lee, 2018). The feeling of refuge can be achieved in spaces where the resident feels a sense of retreat and security within their home. It can be expected that privacy within the home will become more crucial as people spend more time at home. Windows that supply both prospect and refuge conditions through balcony spaces, shading devices, operable louvers, automatic blinds and vertical screens will become valuable as a determinant of residents’ perceptions of liveability within the city. For many reasons, designers must prioritize window views and spatial variety throughout the design process as it is proven to support occupant health, wellness, stress reduction and restoration.

4.2 Designing variety in visual and thermal comfort and adaptable floor plans

As the home becomes a more multi-functional space that is required to facilitate working and schooling environments, as successfully as it enables entertainment, cooking and rest,
a variety of lighting and thermal comfort levels throughout the home which support these new functions must be considered. A review of studies investigating occupant comfort in apartment housing found that poor thermal conditions and IAQ greatly affect occupant health and productivity (Andargie et al., 2019). Our homes are likely to remain spaces for learning and working in the near future, so we must start acknowledging that these spaces will need to support productivity and health.

There are few design guidelines and no standardized metrics for daylighting levels developed specifically for apartment housing (Kesik et al., 2019). However, there are some recent studies that examine occupant preferences. A recent study in Singapore found that the threshold of resident daylight satisfaction varies depending on room use (Jakubie et al., 2019). Lighting levels deemed satisfactory were measured at 175 lux in kitchens, 150 lux in living rooms and 200 lux in bedrooms. Far more research needs to be carried out in this area, to find out what light levels are desirable in each room and how location, climate and culture impact preferences. As people are spending more time within their homes than ever before, it follows that daylighting in the home will become a fundamental parameter in resident satisfaction. In a recent study in Hong Kong, 55% of participants reported feeling satisfied with the daylighting conditions in their kitchens and considered unit size as a more important design parameter (Siu-Yu Lau et al., 2010). Yet, it should be noted that 47% of those participants spent less than 15 min in their kitchens daily. This has likely changed drastically since that study. As our kitchens and dinner tables have replaced restaurants, bars and coffee shops, people will inevitably be spending more time cooking and dining at home. While daylight quality may not have been a priority preCOVID-19, it can be expected that in postCOVID-19 times, people will desire optimal light conditions not just in their kitchen but throughout their entire home.

Apartment layouts that can be adapted to be used in many ways will become essential to the perceived liveability of apartment housing in postCOVID-19 design. More research in flexible design systems with enough flexibility and convince is necessary. Australian design office Woods Bagot have developed a modular system, AD-APT, that includes a series of adjustable walls and screens to divide an open-plan apartment unit to accommodate many activities (Bahadursingh, 2020). Due to mandatory quarantine, American architectural office SO-IL have worked to update current apartment designs to reflect pandemic anxiety. The office proposed changes to the designs of the the kitchen, dining room and living room as separated rooms; bedrooms that are spaced out throughout the apartment supporting acoustic buffering and the creation of larger home office spaces and larger exterior greenspaces (Chayka, 2020). Residential design has already begun adapting to COVID-19, and it is predicted that these changes will continue to increasingly impact our homes and the way we live.

4.3 Circadian regulation: bedrooms designed for sleep

As people may be confined to small apartment units for much of the day, due to shelter-in-place orders, it is important that window design supports the regulation of occupants’ circadian rhythms. Routines have shifted and ongoing stresses and anxieties heightened by the COVID-19 crisis, and so many peoples’ ability to sleep well at night has been affected (Weikle, 2020). Studies of the nonvisual impacts of lighting in residential settings prove that a higher daily light dose contributes to better sleep quality and circadian regulation (Torrington and Tregenza, 2007; Veitch and Galasiu, 2012). Designing apartment units to have ample daylight exposure on at least two facades will help allow for the regulation of circadian rhythm as well as potentially offering opportunity for cross ventilation (Kesik et al., 2019). There is no need for bedrooms to have floor to ceiling glazing. Instead, bedrooms should provide lower window to wall ratios and feature operable windows for regulation of thermal comfort and natural ventilation that support restful sleep (Kesik et al., 2019).
Additionally, it is important that nonbedroom spaces promote alertness and resident physical activity which support restoration and result in better resident mental health and sleeping patterns. In a recent study on youth mental health, findings suggest that higher restorative qualities and improved mental health are associated with more physical activity and social cohesion (Dzhambov et al., 2018). It could be that reports of poor mental health, reduction in social interactions and the lack of physical activity created by city shutdowns due to COVID-19 are contributing to peoples’ poor sleeping patterns during the pandemic. Recent studies of sleep and cognition have shown that disrupted sleep in times of crisis is an evolutionary effect; where fear keeps us on high alert of possible threats (Weikle, 2020). Sleep is important as a way of regulating our emotions and strengthening our immune systems, so it is critical in these times of crisis that healthy sleeping habits are maintained. Improved residential lighting can enhance the physical well-being and quality of life of residents by supporting the sleep-wake diurnal cycle (Torrington and Tregenza, 2007). Exposure to gradual dawning through window daylighting can improve quality of sleep and morning alertness (Vecht and Galasiu, 2012). Bedrooms must be designed so that windows can be closed off for darkness throughout the nighttime hours and allow adequate daylight throughout the day.

Another consideration for bedroom design is that in small apartment units there is often not enough space for rooms that allow for a variety of activities to occur. This is especially true in shared units, where residents likely are spending more time in their bedrooms during the pandemic. Increased time spent in the bedroom not sleeping, but perhaps watching movies on laptops or scrolling through social media on cell phones, can be problematic for resident well-being. Residential sleep studies prove that disruptive exposure to prebedtime fluorescent light within the bedroom can disrupt sleep, increase nighttime alertness, decrease melatonin and shift circadian rhythms (Rahman et al., 2017). While residents spend more time in their apartments throughout the day due to city pandemic-related shutdowns, it is important that the bedroom remain a place for rest. Spatial variety is important. Just as the bedroom should be designed for sleep, shared spaces like living rooms should support alertness and other experiences to allow environments for entertainment, socializing and other leisure pursuits.

There are several environmental design parameters that can be optimized for sleep. Noise can be an annoyance that prevents restful sleep. Some studies suggest that implementing redundant air-sealed triple glazed windows in apartment housing could be an approach to mitigate exterior city noise pollution, improve thermal comfort and increase security, which may result in restful sleep (Race, 2019). In a residential daylighting study, small adaptations including painting walls white, moving occupant activities into spaces closer to windows and deterring spaces without windows from being used as dwellings are suggested to support the regulation of the human circadian clock (Gochenour and Andersen, 2009). Post-pandemic architecture that integrates sustainable, lasting solutions that promote resident health and well-being through restorative bedroom design and spaces for restful sleep must be prioritized.

4.4 Restorative spaces to support positive social interactions

A recent review concluded that social interaction and mental health are among the primary topics of concern in high-rise residential buildings (Kalantari and Shepard, 2020). Now more than ever as many people are spending the majority of their time indoors at home, it is critical to keep these concerns in mind when thinking of ways to improve the liveability of apartment housing. Some effects of COVID-19 on the noninfected population include loneliness, reduced productivity, unhealthy sleeping and eating habits, obesity and loss of human to human interactions (Salama, 2020). Figure 2 illustrates how design can respond to the effects of COVID-19 on the noninfected population or those self-isolating. By improving the quality of
the spaces in which we live, we have the opportunity to tackle many of these issues. For example, by providing outdoor and indoor communal living spaces that support physical distancing, we can provide safe spaces for passive and active social interactions. Increasing thermal comfort and IAQ will result in improvements in occupant health and productivity (Andargie et al., 2019). Providing indoor and outdoor space for comfortable, physically distant exercise, in combination with desirable apartment lighting designs that support sleep, can help regulate resident circadian rhythms.

In a study investigating benefits of natural and urban environments, physiological measurements and reports from participants found that recovery from stress is faster and more complete when subjects are exposed to natural environments (Ulrich et al., 1991). Results indicated that natural environments established a positive emotional state, positive changes in physiological activity levels and sustained attention. It is imperative that architects and designers prioritize natural views, so that optimal recovery environments can be established at a time where stress and anxiety are prevalent. Daylighting can provide a multitude of benefits to individuals well-being, comfort and mental and physical health, whether you are fighting an illness or during everyday living.

4.5 Natural ventilation and thermal comfort at home
There is evidence that the spread of COVID-19 accelerated in areas where high temperature and humidity levels were ideal for airborne transfer (Bate, 2020). Knowing this, poor thermal comfort in housing that places individuals at high risk must be addressed for health and also for comfort and well-being. In a study of social housing buildings in Toronto, results indicated that residents who live in buildings with the highest amount of exterior glazing report higher thermal discomfort (Vakalis et al., 2019). It was also found that residents who reported thermal discomfort experienced a higher frequency of health issues. In a recent thermal dynamic simulation study, it was proven that apartments exposed to higher amounts...
of solar radiation due to floor level, orientation and high glazing ratios exceed daylighting requirements and are at higher risk for overheating during the summer months (Nebia and Tabet Aoul, 2017). Further, a review of studies which investigated occupant comfort in apartment housing, thermal conditions and IAQ are reported to be the most important factors to maintain occupant comfort within MURBs (Andargie et al., 2019). To ensure year-round thermal comfort, apartment design must consider the implications of facade design and high window-to-wall ratios.

Another dimension to consider is that in the context of COVID-19, access to daylight, nature and thermal comfort have become privileges linked to status. Socioeconomic status is a powerful predictor of disease, disorder, injury and mortality (Goodman and Conway, 2016), and COVID-19 has forced people to acknowledge issues of systemic inequality, due to the highly contagious form of the virus. There is a new realization that strangers’ health is affecting people’s own health, and it is time to re-evaluate all living environments to ensure that all individuals have homes that support healthy living. An Australian study examining energy use, indoor thermal comfort and health in social housing found that many dwellings exceeded healthy CO₂ levels; 42% of dwellings reported mold, 32% of participants suffered from allergies and 54% reported health problems (Haddad et al., 2019). The COVID-19 crisis could be an opportunity to make significant changes to apartment housing standards so that healthy living conditions are available to all individuals, decreasing the likelihood that people of low socioeconomic status will develop chronic diseases.

The availability of natural ventilation and operable windows could be simple passive strategies to make indoor spaces more comfortable and healthier. COVID-19 has created a sense of mistrust in building ventilation and mechanical systems. For example, it was reported in the news that 45 residents of a high-rise apartment building in Calgary, Canada contracted COVID-19; however, the cause of the outbreak remains unknown (Pike, 2020). In early April, 2020, an outbreak of COVID-19 occurred in a small restaurant in Guangzhou, China. Scientists concluded that the virus-containing particles were spread throughout the restaurant through the air-conditioning system (Blackwell, 2020). Overreliance on active heating and cooling systems, in buildings with minimal operable windows, has caused a great dependence on active building systems. In a residential window study, findings suggest that the concentration of CO₂ is the best predictor of window opening behavior (Jian et al., 2011). Operable windows are critical to gaining residents’ trust in their homes by maintaining ideal IAQ, thermal comfort and ventilation.

4.6 Connection to nature
As residents spend more time at home, balconies have become an unexpected new venue for socialization, protest and celebration (Maiztegui, 2020). Balconies that may have gone unused in the past have become important spaces of community, offering a semi-public place to look out, communicate with neighbors and engage with nature. In a post-occupancy evaluation of balconies, findings indicated that residents prefer balconies with parapets and glass wall enclosures as they afford better views, improve resident mood and provide a perception of greater spaciousness (Xue et al., 2016). Further, a recent comprehensive literature review found links between balcony types and indoor environmental quality and energy consumption. The study found that open balconies led to improved thermal comfort, IAQ, visual comfort and acoustic comfort (Ribeiro et al., 2020). Conversely, glazed balconies often resulted in overheating problems contributing to decreased air infiltration rates and reduced daylighting conditions of adjoining living spaces. Thus, it is necessary to consider the implications of climate when determining the ideal balcony design. In an occupant survey and interview study of thermal comfort in multi-storey apartment buildings in the sub-tropics, it was found that natural ventilation and outdoor private living spaces such as balconies determine residents’ perceptions of liveability (Kennedy et al., 2015). It can be assumed that
these factors will become more critical to resident satisfaction in postCOVID-19 housing. Access to private balconies in housing for the elderly, especially within high-rise residential buildings, has been shown to significantly improve resident morale (Lawton and Nahemow, 1979). For balconies to be successful outdoor spaces, they should be large enough that people can comfortably fit a table and chairs, to sit and enjoy the view. Another issue to consider is that typically balconies protrude from building façades and shade units below (Peters et al., 2020). However, depending on climate, the level of enclosure and shading should vary. A new consideration with COVID-19 physical distancing regulations in place is that balcony designs must support physical distancing between apartment units.

As a response to the pandemic, biophilic design is likely to increase in popularity as visual engagement with nature reduces anxiety and improves mental health (Crosbie, 2020). As exposure to nature is recognized as being capable of providing restorative experiences (Kaplan, 2001), small scale urban farming may become more popular since gardening has proven to improve mental health (Makhno, 2020). While most urban apartment buildings have a lack of outdoor green spaces; sunrooms and balcony spaces for urban farming may be used to facilitate nature experiences (Nielsen, 2020). Thus, urban residents’ connection to nature must be stronger to support resident wellness and health (see Figure 3).

4.7 Appropriate unit sizes and layouts that support physical distancing
Around the world, national health guidelines have advocated minimum distances for physical distancing based on the estimated spread of COVID-19, but surprisingly countries have imposed different regulations. These guidelines are a result of both cultural differences and scientific research, Figure 4 illustrates these discrepancies. The United Kingdom’s Sage research committee suggests that when people are one meter apart from carriers of COVID-19, they are between two and ten times more likely to contract the virus, compared to a two meter distance (Shukman, 2020). Research shows that the greater the distance between individuals the lesser the likelihood of disease transmission.

It must be a priority to consider how to support physical distancing of at least two meters between residents to establish comfort and safety within shared dwellings. YouGov, a British online survey, found that 31% of adults have experienced mental or physical health issues due to the quality of living conditions within their homes during lockdown (Sansom, 2020). Furthermore, the survey indicated that 30,000 Britons have spent city lockdowns in one-room dwellings. There is considerably more research required as to how apartment housing can be designed to create more generous spaces that allow physical distancing in units.

![Figure 3. Physical distancing guidelines based on country (Authors, 2020)](image_url)
Figure 4. Physical distancing between partners and roommates living in one- and two-bedroom apartments at The Yards proves to be challenging (Redrawn and analyzed by Authors, 2020).
The new normal created by COVID-19 involves physical distancing, working from home and engagement with the virtual world (Salama, 2020). Residents who live in apartment housing have many concerns as they adapt the way they live in their apartment buildings during the pandemic. An issue with living in apartment housing during COVID-19 is “trying to adopt all of those kinds of protective measures that you can, in a situation that you may not have full autonomy and control over” (Bergen, 2020). In future, apartment residents will likely remain cautious when touching surfaces including handrails, elevator buttons, door handles and laundry machines and when interacting with neighbors. Landlords across Canada have announced similar strategies for how they will be dealing with containing the spread of COVID-19 in their buildings. Common tactics include increasing the cleaning of frequently used spaces, closing communal spaces, decreased occupancy of elevators and laundry rooms and fewer building visitors (Bruce, 2020). However, there has been much less conversation surrounding how roommates in shared apartments will self-isolate in such small units as spacious hallways, multiple washrooms in units and multiple communal living spaces are luxuries only provided in expensive apartment buildings. Designing flexible housing that can support self-isolation within shared units will become critical in containing the spread of COVID-19 or future pandemics.

Similar to restaurants, which have adapted to allow for larger circulation spaces and seating arrangements that support physical distancing, consideration for shared and congregate housing must become more flexible, so that distancing between roommates can safely occur. The Canadian Federal Health guidelines require people that test positive for COVID-19 to self-isolate, maintain a two-meter distance from others, stay in separate bedrooms from partners or children and use a separate bathroom, if possible (Stueck, 2020). While these guidelines may be attainable in single family homes, in shared apartment housing, these health and safety protocols may prove to be challenging. The Yards is a typical 28-storey apartment building, completed in 2013 by Wallman Architects, in downtown Toronto. Through the analysis of a one-bedroom and two-bedroom unit floor plans, it is clear that physical distancing between partners, families or roommates is impractical. As one-bedroom apartments are commonly occupied by two people, both one- and two-bedroom unit types will be impacted. Typically a one-bedroom unit has one bathroom, the hallway is too narrow for two people to use at once, and the kitchen and living room can only be comfortably occupied by one person at a time. These issues make both units inadequate for physical distancing between roommates, partners or families. It should be noted that these are quite expensive units and would not be considered affordable housing.

COVID-19 notwithstanding, providing daylit living spaces is crucial to resident quality of life in apartment housing. Even if single units are much smaller, it can be expected that having one’s own space will be in high demand during post-COVID-19 times. This may result in minimum size requirements for apartment units and required physical distancing capabilities within apartment building communal spaces. Furthermore, COVID-19 may cause an increase in mid-rise apartment development as people may prefer living in buildings that do not require elevator use.

As currently designed, most urban apartment housing is not very resilient. Passive survivability is defined by a building’s ability to maintain critical life-supporting conditions for occupants in times where power, heating fuel or water are unavailable for an extended period (Wilson, 2005). Specifically, this concept can be applied to apartment housing when considering how high-rise residential buildings may maintain thermal comfort throughout a power outage or for example, how residents get to their unit on the 26th floor when the elevators are not working. Apartment design must support passive survivability as climate change continues to cause more frequent and severe weather events. Considering the COVID-19 pandemic, providing at least two bathrooms in shared apartments and designing
apartments that support physical distancing from others should become an additional principle in passive survivability. COVID-19 will not be the last pandemic to disrupt the way we live, so apartment housing must be designed to be more resilient.

5. Architectural design recommendations
Upgrading standards of apartment living conditions to support occupant health and wellness will require social, economic and political changes. By utilizing restorative environmental design principles to inform apartment housing design, apartment housing can provide better living conditions that support inhabitant health and well-being.

The following design recommendations for restorative apartment housing in the context of COVID-19 are based on the research findings. We have identified recommendations based on new build and renovation projects. Architects and designers must prioritize the following to enable living environments which support resident health and wellness:

5.1 Window views, spatial variety and privacy
(1) Window design in dwellings should provide unobstructed views of the sky and nature. These views are proven to enhance well-being by promoting physiological calming, improving focus, enhancing mood, increasing resident satisfaction and aiding in recovery from illness.

(2) A variety of prospect–refuge conditions within apartment units are necessary. Windows should allow residents an interesting “lookout” view; for example, a view over a city street or greenspace. The concept of refuge can be achieved when people have a space of sanctuary and retreat within their home.

5.2 Designing variety in visual and thermal comfort and adaptable floor plans
(1) The home has become a multi-functional space that must facilitate working, schooling, exercising, cooking, socializing and screen-based entertainment. Daylighting, indoor air quality and thermal comfort recommendations normally reserved for learning and office environments that support productivity now become relevant in apartment units.

(2) Apartment layouts that can be adapted to be used in a variety of ways is essential to support the changing role of the home. New buildings should focus more attention on acoustic separation between rooms and for home-office spaces.

5.3 Circadian regulation: bedrooms designed for sleep
(1) Small adaptations including moving occupant activities into spaces closer to windows and designing all occupied areas to have glazing to outdoors can support the regulation of the human circadian clock.

(2) Bedrooms should not have floor-to-ceiling glazing and should provide operable windows for thermal comfort and natural ventilation which support restful sleep.
(3) Provide nonbedroom spaces that promote alertness and resident physical activity support restoration resulting in improved resident mental health and sleeping patterns.

5.4 **Restorative spaces to support positive social interactions**

(1) Shared common spaces within apartment buildings that support physical distancing enhance social interactions among residents and support restoration. For example, amenities could include shared roof terraces, exterior courtyards and communal lounge rooms designed to support physical distancing.

(2) Daylight must be better considered in residential building design as resident mood and social behavior is greatly influenced by daylight exposure within and outside of the home.

5.5 **Natural ventilation and thermal comfort at home**

(1) Operable windows in living and cooking spaces are critical in maintaining comfortable indoor air quality and thermal comfort. This promotes occupant comfort, productivity and health within apartment housing.

(2) Retrofitting underperforming housing must be addressed. Poor thermal comfort conditions can place vulnerable populations at high risk in apartment housing. Undercooling in the summer, overheating in the winter and high window-to-wall ratios are primary causes of thermal discomfort, resulting in reports of olfactory discomfort and increased health issues (Vakalis et al., 2019).

5.6 **Connection to nature**

(1) Balconies have become even more popular amenities for socialization, protest and celebration that offer a window into public life. Their role in postCOVID-19 apartment housing is crucial, and thus people’s preferences for balconies and outdoor spaces that can be used year-round should be considered as priorities. Balconies must be designed to support daylighting within units and must enable physical distancing between balcony neighbors.

(2) Exterior public spaces must be generously sized to accommodate buffer zones that allow people to feel comfortable in social settings that enable physical distancing.

(3) The application of biophilic design should increase as nature restoration can produce a multitude of benefits for residents through improvements in mental and physical health.

5.7 **Appropriate unit sizes and layouts that support physical distancing**

(1) Provide spaces, especially within dwellings, that support physical distancing of at least two meters between individuals. This will likely mean re-examining apartment layouts by providing more than one bathroom in larger units and more generous living room spaces. This applies to shared apartment units but also responds to the need for physical distancing in family occupied units if one person in a family becomes ill.
(2) Apartment design must promote passive survivability by utilizing passive design strategies to maintain life-supporting conditions. For example, providing operable windows for residents to maintain environmental indoor quality, limiting building height to decrease reliance on elevators and providing multiple bathrooms in shared apartments.

References


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