

**Age, Place, and Health: Exploring the Impact of Environmental and Technological Innovations on
Enhancing Quality of Life in Older Adults**

by

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DEDICATION

This dissertation is dedicated to you both, my cherished niece and nephew, Rojan and Ryan. May you be inspired to explore uncharted territories, fueled by your innate curiosity and passion. Trust in your abilities, for they will guide you towards remarkable accomplishments.

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ABSTRACT

‘Aging-in-place’ as a globally embraced health policy has prompted numerous environmental and technological innovations to improve the well-being of older adults. While these innovations enable seniors to stay in their homes longer, they often overlook the rising social isolation and loneliness that can diminish their quality of life (QoL). My research focuses on exploring how older adults engage with these spatial and technical innovations, and especially their potential to enhance social connections. I investigate seniors’ interactions with social information and communication technologies (Social ICTs) and the physical aspects of their homes that promote social engagement.

My overarching explorative research question is: *to what extent does access to Social ICTs and residential spatial features of older adults’ homes impact their experience of social connectedness? And more specifically, what is the role of the residential built environment-- including and access to Social ICTs-- in preventing or encouraging social connectedness for older adults in their homes?*

I employ a mixed-methods research design utilizing two phases: correlational research design that incorporates a survey questionnaire as the initial tactic for data collection, followed by a second phase of qualitative research design that utilizes in-depth interviews. This research informs built environment designers about the importance of prioritizing social connectivity for older adults’ enhanced QoL and wellbeing. I will outline design and housing policy strategies

that can protect the health and wellbeing of older adults against the detrimental consequences of social isolation, including strategies such as:

1) Inclusive and accessible design of the built environment is critical for older adults' social health. Although attention to inclusivity and accessibility has been repeatedly advocated in the architecture and design literature, only 3.5% of the US housing stock is designed with accessibility in mind (Gonyea, 2021). Home designs that facilitated safe social interaction and contributed to older adults' well-being during the Covid-19 pandemic included features such as: access to a backyard (or a form of communal green space in the community), enough spaces to physically distance, and visual access to outdoors through a window.

2) Utilizing Social ICTs for 'experiential sharing' was highlighted throughout this research, underscoring the importance of designing at the intersection of physical space and digital interface. To create an interactive and co-creative experience (e.g., transferring culinary knowledge and participation in virtual communal events) while engaging Social ICTs, the supportive role of spatial features, such as adequate lighting, are essential.

3) The results of this research indicate the multiple benefits of access to Social ICTs for older adults as a resource for battling isolation and loneliness. Housing policies, especially those outlined by HUD, are critical tools in providing access to digital infrastructure for the older adults. The FY 2022 NOFO (Notice of Funding Opportunity) Toolkit by HUD's Section 202 Supportive Housing for the Elderly Program emphasizes the importance of constructing supportive housing that promotes wellness, aging in place, and social health for low-income older adults. However, the toolkit's 'Physical Design' section lacks a prioritization of technology for social well-being, with internet access listed merely as an optional feature alongside other amenities. In contrast, this research recommends prioritizing internet infrastructure, along with

Social ICT devices, supportive spaces, as well as training and educational infrastructure in the toolkit as elements of broader housing and health policies.

Chapter 1 Introduction

1.1 Problem Statement

“Aging-in-place” is a widely adopted global policy that encourages older adults to remain in their own homes and communities for as long as possible as they age. This concept has emerged as a pivotal global policy response to the challenges posed by the rapidly growing population of older adults. This paradigm shift recognizes the desire of many older individuals to maintain their independence, autonomy, and familiarity with their surroundings. Aging in place aims to provide older adults with the necessary support and technical services to live comfortably and safely, even as their needs may change with age. By allowing seniors to stay in familiar environments, aging in place seeks to promote a sense of continuity, improved quality of life, and well-being.

This “Aging-in-Place” philosophy has sparked many environmental and technological innovations aimed at enhancing the quality of life (QoL) of older adults. In the context of an aging global population, the engagement of older adults with these technological and spatial accommodations and the capacity of these innovations in enhancing seniors’ QoL need to be examined. Per aging-in-place policies, older adults are encouraged to remain in their own homes and communities as they age. However, this recommended living arrangement can potentially put many senior residents in danger of increased social isolation and loneliness that can substantially reduce their wellbeing and quality of life. Consequently, studying seniors’ experience of QoL as a multi-dimensional concept that includes social and environmental aspects in its analysis is essential.

The burgeoning of technological innovations for aging can potentially influence older adults' wellness as well as many dimensions of their QoL experience. Social Information and Communication Technologies (Social ICTs) encompass a wide range of digital platforms and tools that facilitate communication, interaction, and social engagement among individuals. In the context of aging in place, these technologies may hold significant importance in several ways such as: 1) overcoming geographical barriers in maintaining social connections due to geographical distances or mobility limitations; 2) fostering intergenerational connections as well as contributions to a sense of purpose and belonging; and 3) reducing social isolation and loneliness. So, it is well worth the effort to explore the effectiveness of these technologies for older adults' improved QoL.

The spread of the Covid-19 pandemic across the world has exposed numerous shortcomings in the current design of the residential environments for older adults. While many architectural and spatial scenes of our cities today – such as Central Park in New York City – are reminders of robust responses from designers and planners of 19th and 20th century to the infectious diseases of the time (Olmsted, 1870), another pandemic has once again changed the environments that we live and work in today. The pandemic has also brought to light older adults' struggles in their right to access healthy environments in face of the systemic obstacles along the way, especially the existing disparities in health and resources among older adults. Those from marginalized communities faced additional challenges in accessing technology, healthcare, and social support during this time.

Notably, the Covid-19 pandemic has significantly impacted older adults, especially in terms of social isolation and loneliness, while exacerbating many existing challenges associated with aging. As a highly contagious virus, COVID-19 posed severe health risks to older

individuals, leading to widespread precautionary measures such as lockdowns, social distancing, and isolation to protect this population. Unfortunately, these necessary measures yielded many unintended consequences regarding the mental and physical well-being of older adults, especially due to the increased risk of social isolation and loneliness, as a result of limitations on engaging in communal social activities and visiting friends and family members.

As the COVID-19 pandemic intensified the challenges associated with aging, particularly regarding increased risk of social isolation and loneliness among older adults, investigating the role of technological innovations as environmental tools in combatting the negative impacts of isolation on older adults' health and quality of life is essential.

This dissertation investigates the role of Social Information and Communication Technologies (Social ICTs) utilized in the home environment in supporting social connections among older adults who are aging in place in the context of widespread precautionary social distancing measures implemented during the Covid-19 pandemic. I will explore the engagement of older adults with the environmental and technological attributes of their homes and the impact of these techno-spatial arrangements on their social connectedness, which is an essential component of QoL.

In this context, I highlight that 'place' is a socially constructed concept, encompassing physical, technological, and social aspects. Additionally I emphasize the timely role of interdisciplinary collaborations in the design and construction of humane, age-integrated, and dignified housing environments for older adults.

In addition, in this research, policies regarding the design and construction of housing for the older adults will be explored as effective levers for protecting the health and wellbeing of older adults against the detrimental consequences of social isolation. Although designing

equitable policies and programs for the aging population is encouraged by the decision-makers at the government level, the potential of technology for supporting the health of seniors in their housing environments, in tandem with health policies that mandate social technology within residential settings will be analyzed in this research. This research will inform built environment designers about the importance of prioritizing both the social connectivity for older adults as well as the significance of equitable spatial design policies that can protect the health and wellbeing of older adults and mitigate the negative consequences of social isolation.

1.2 Gaps in Knowledge

The ‘home’ environment has been the central focus of innovations in spatial and technological advances for aging in place for a long time. But more recently, ‘functional monitoring’ and ‘safety and physiological monitoring’ are the two domains that have received the most attention in the design of Smart Homes for aging in place, and homes of older adults in general (Lee & Kim, 2019). However, there is a notable lack of emphasis on social connectivity: many existing aging in place technologies prioritize safety monitoring, fall detection, and health management. While these features are undoubtedly important, they often overlook the fundamental role of social connections in promoting the overall well-being of older adults. The emotional, cognitive, and psychological benefits of staying socially connected are equally vital for maintaining a high quality of life in old age. In addition, social isolation and loneliness are significant challenges faced by older adults. However, most current technologies fail to effectively address these issues. Innovations should be designed not only to ensure physical safety but also to foster virtual interactions, provide avenues for meaningful engagement, and combat the negative effects of social isolation.

Informed by public health literature about the health benefits of social engagement, this research aims at prioritizing ‘social connectedness’ as central to older adults’ QoL, while also shedding light on the design features that can increase older adults’ in-person and virtual social interaction.

1.3 Overview of the research and dissertation outline

In order to explore the significance of the environmental design of residential settings for older adults’ social life, my overarching explorative research question is: *to what extent do access to Social ICTs and residential spatial features of older adults’ homes impact their social connectedness? And more specifically, what is the role of the residential built environment and access to Social ICTs in preventing or encouraging social connectedness for older adults in their homes? And in what ways do spatial features and Social ICTs influence older adults’ social connectedness?*

In this study, the overall research question will be explored using a two-phased research design involving: correlational research strategy in stage one and a qualitative research strategy in stage two. The research questions explored in each stage are outlined below:

Stage 1:

To explore the role of residential built environment, and specifically residents’ access to Social ICTs in preventing or encouraging social connectedness for the older adults in their homes, the following research questions are investigated in the first stage of the research via a correlational research design.

1) Which spaces in the older adults’ residences were more likely to be utilized for in-person social activities prior to the pandemic? And what are the potential environmental design barriers and facilitators of social engagement within older adults’ residences?

2) To what extent did older adults engage with video-calling – as a form of virtual communication – to socially connect with their friendship network during the Covid-19 pandemic? What are the potential built environment features that may prevent or encourage such virtual socializing?

3) How does this sample of my older adult respondents rank regarding their social connection measures? Are there any general patterns of relationships between participants' virtual engagement behavior and their social connection measures?

Stage 2:

In the second stage of this research, the lived experiences of older adults who are aging in place – particularly understanding the interaction between the built environment of their housing and their access and use of Social ICTs for social connectedness during the Covid-19 pandemic – and, ultimately, their quality of life is investigated. The research questions that informed the qualitative research design are identified in the following:

1) Engagement with Social ICT technologies – What are the systemic, as well as life course experiences and factors that impact the engagement of older adults with Social ICT technologies?

2) Perception and access to Social ICT technologies – How do older adults describe their access, interaction with, and sentiments towards ICT devices and technologies?

3) An in-depth look at Zoom as an example of a screen-based and voice-activated Social ICT: How do older adults describe their engagement and criticism of this type of Social ICT, as well as speculations about positive potentials of it?

4) Body, health, and ability to engage with currently-designed ICT technologies – How do older adults describe health issues that impact their ability to engage with the currently designed ICT technologies?

5) What are the spectra of older adults' jobs, volunteer activities, and the impact of the Covid-19 pandemic on older adults' social life?

6) City life and home spatial design: What are the spectra of older adults' home environments and the interaction of space and technology, and their impact on older adults' social life in light of the Covid-19 pandemic?

This dissertation is organized in the following eight chapters:

- Chapter 1 – Introduction: In this introductory chapter, I establish the general overview of the topic and introduce the research questions and objectives.
- Chapter 2 – Conceptual Framework: I review the theoretical framework relevant to the broad concept of 'quality of life' and the socio-ecological model of health, as well as the 'Place' model emphasizing the dynamic interactions that occur among the individual, social, psychological, and built environment in this chapter. And I highlight the standpoint that older adults' perceptions and experiences about their health are a function of the person, the environment, and interaction of the person with the environment (Ottoni, Sims-Gould, & Winters, 2021; Yen et al., 2014; Bronfenbrenner, 1977).
- Chapter 3 – Systematic Review of the Related Literature: The review of literature investigating the evidence regarding the role of technological innovations as related to older adults' social engagement is presented in this chapter.

- Chapter 4 – Research Design and Methodology: The research methods and an overview of the research design and research questions is discussed in this chapter. In addition, this chapter also provides the rationale for the design of the specific research tactics, such as design and development of survey questionnaire, and outlines the K-means Cluster Analysis and Multidimensional Scaling (MDS) procedures involved in the selection of participants for conducting in-depth qualitative interviews. Finally, in Chapter 4 discussion of data analysis approaches utilized in the ensuing chapters is presented.
- Chapter 5 – Quantitative Research Findings: This chapter is dedicated to discussing the findings of the quantitative research phase based on descriptive statistics as well as regression analysis.
- Chapter 6 – Qualitative Research Findings: the findings of the qualitative research phase based on content analysis of transcribed interviews with older adult participants are presented in this chapter.
- Chapter 7 – Synthesis of Findings: a synthesis of findings from both quantitative and qualitative research strategies is outlined in this chapter.
- And finally, Chapter 8 – Conclusions: Design and Research For the Future of Healthy Aging-in-Place – is dedicated to providing future design and research recommendations, study limitations, and final concluding thoughts.

Chapter 2 Conceptual Framework

2.1 Brief Background: Macro-economic and health policy shifts after the 1970s and their continuing impacts on the residential spaces and institutions for the care of aging adults

In the conceptualization of places for graceful aging, foregrounding the notion of ‘place’ as socially constructed and inseparable from the macro-sociological context of American society calls for an in-depth empirical investigation. This inquiry will facilitate a structural analysis of the contexts for ‘aging in place’ in contemporary residential spaces. To investigate the phenomenon within urban, architectural, and gerontological discourse as it relates to its cultural, social, and economic environments, a brief analysis of the dynamics that has continuously transformed spaces for aging in the US becomes necessary. The modern dynamics and conditions from the late 1940s to the early 1970s, and “construction of the welfare state”, resulted in the social production of ‘institutions’ for retirement and aging (Bengtson, 2009, p. 618). After 1970’s the concept of ‘old age’ and spaces dedicated to it has undergone major transformations. One critical outcome of the shifting state of political economy after 1970’s is the trend towards the privatization of pension systems in the US and globally (i.e., welfare state retrenchment). The movement follows two rationales: 1) the elimination and/or reduction of government budget deficits related to population aging; and 2) the reduction of government spending on population aging and pension systems without increasing taxes (Williamson & Béland, 2015). It should be highlighted that this movement towards privatization of pension systems is thought to contribute to income inequality, gender inequality, and increased risk of

poverty during retirement years (Béland & Waddan, 2012; Williamson, 2011). As a result, agendas on partial privatization of Social Security¹ in the US are among the health policies that the government is currently evaluating in order to reduce the projected depletion of the assets in the Social Security trust funds in 2033.

In the early 90's, organizations such as the World Bank and the International Monetary Fund (IMF) started to reshape the welfare-state-related social policies and agendas towards partial privatization of pension and financial security (Williamson & Béland, 2015). Aligned with this movement, are the World Health Organization's (WHO) health policies on 'Aging in Place' that follows the continuous shift from the provision of care in the government-run institutionalized settings such as hospitals and nursing homes towards the less institutionalized settings of the residential environment. As a consequence of such global health policies on 'Aging in Place', we can identify a range of proposals for the design of the built environment; cohousing, for example, is one of the alternatives that was created as a bottom up grass root response to combat solitude at the old age via creating new forms of community (Tummers, 2016). On the other hand, we can classify market-based models of housing for older adults, namely: Continuing Care Retirement Communities (CCRC), New Towns in the sunbelt region (such as the Villages in Florida). These New Towns are described as "historically new forms of idealized leisure society: retirement utopias", as sites for examination of the competing and conflicting dimensions of individualized and privatized vision of 'emancipatory leisure' in

¹ . According to Williamson and Beland (2015), 'Partial privatization of Social Security' is a hotly debated policy effort toward pension reform in the U.S. and worldwide. In the U.S., the proposal is about diverting a fraction of the current Social Security payroll tax into individual accounts (i.e., 401(k)- like personal accounts). Moreover, the proposal advocated for reducing the size of defined benefit (DB) component of social security (defined benefit (DB) refers to the benefits that are calculated based on number of years in employment and a wage-indexed portion of past wages).

contrast to a more communal perception – shared, public, and inclusive social and spatial responses for a diverse range of aging adults (Simpson, 2015, p. 134).

This brief background allowed me to contextualize the direction of major macro-economic and health policy shifts that impact the design of the built environment for aging at various scales. Architects aligned with public health professionals and gerontologists share the ideal that ‘context’ is indistinguishably linked to human functioning and any comprehensive public health strategy to population aging needs to take into account the physical and social environments (Beard & Bloom, 2015). WHO’s Global Network of Age-friendly Cities and Communities constitutes one of the interventions that have been developed to blend macro and micro aspects of environment while emphasizing healthy and active aging (Beard & Bloom, 2015).

“Optimizing opportunities for health, participation, and security in order to enhance quality of life as people age” has been a robust goal of WHO’s Age-friendly Cities initiative (Rowles & Bernard, 2013, p. 40). As a result, in defining the ‘place’ for aging, and for synthesis of the research from fields of public health, with architecture and built environment, it would be appropriate to consider ‘place’ with its physical, social, and psychological aspects² (Mollenkopf et al., 2007). This conceptualization can have profound impacts on the nature of design in that it necessitates both an interdisciplinary perspective and the assembly of an interdisciplinary team for a successful and inclusive outcome (Mollenkopf et al., 2007).

Age-friendly communities depend on the successful relationship between policies that support aging in place, and specifically the physical, social, and psychological aspects of the

² . **Physical environment:** Built environment of home, community, city.

Social environment: Spaces (including the public space) that older adults connect with everyone.

Psychological environment: exploring the experience and meaning of physical and social environment.

place that can provide an enhanced quality of life while aging. In this regard, enhanced ‘quality of life’ of our aging population is among the important outcomes of aging in place policies and environmental practices. Moreover, it would be appropriate to examine the promises of these policies in light of the numerous environmental and technological innovations aiming at enhancing the quality of life (QoL) of older adults and ask: *to what extent does access to both Social ICTs (Information and Communications Technologies) and the specific residential spatial features of older adults’ homes impact social connectedness, consequently improving the quality of life of seniors?*

2.2 Theoretical Framework

2.2.1 Model of Place, and the Purposive Model of the Experience of Places (David Canter)

Relying on empirically based research, environmental psychologist David Canter introduced the ‘model of place’ that is useful and particularly compatible with Mollenkopf et al., (2007) conceptualization of ‘place’ encompassing its social, psychological, and physical aspects (Canter, 1977). Canter (1977) explained that personal, social, and cultural interactions blend with human environment-specific experiences, thus, highlighting the socio-physical construction of place (Canter, 1997). He drew our attention to the importance of an ‘explanatory theory’ that combined cultural, social and individual processes that could be tested empirically to enrich our comprehension of the experience of places (Canter, 1997).

Canter (1977) highlighted three facets of place to be explored: the activities that occur in an environment (social aspects); personal perceptions and image of a place; and physical characteristics of a place defined through design (Figure 1.1). As a result, in studying the evolving nature of places in relation to aging processes, this analytical and explanatory framework can have valuable implications for research questions concerned with the distinct

aspects of place. Canter (1983) later proposed ‘The Purposive evaluation of Places – A facet Approach’ model as a theoretical lens for place evaluation utilizing the facet approach for hypothesis testing.

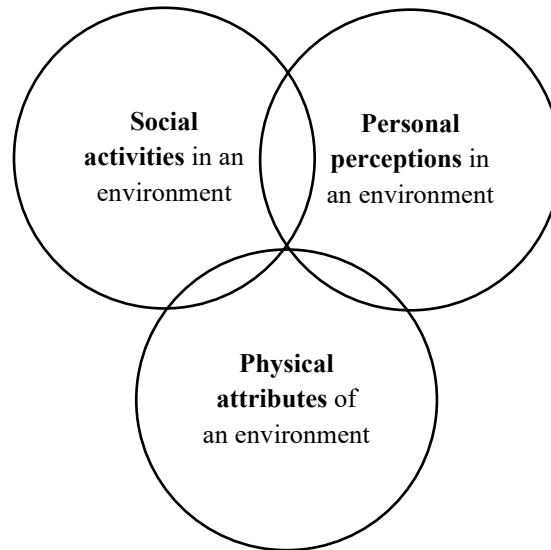


Figure 2.1: Model of Place adopted from Canter, D. (1977). *The psychology of place*. London: Architectural Press.

2.2.2 Quality of life Framework – Towards integration of public health perspectives on aging into the design of built environment

I am situating my work at the intersection of environmental design research and public health. In this theoretical framework section, I will clarify a definition for the concept of quality of life as a multi-faceted concept that allows for integration of public health perspectives on aging into the design of built environment. To give a broad overview of the concept of QoL, I will examine the following four aspects of QoL that are directly connected to the design of the domestic techno-spatial environments: 1) social connectedness; 2) autonomy; 3) mobility; and 4) civic engagement.

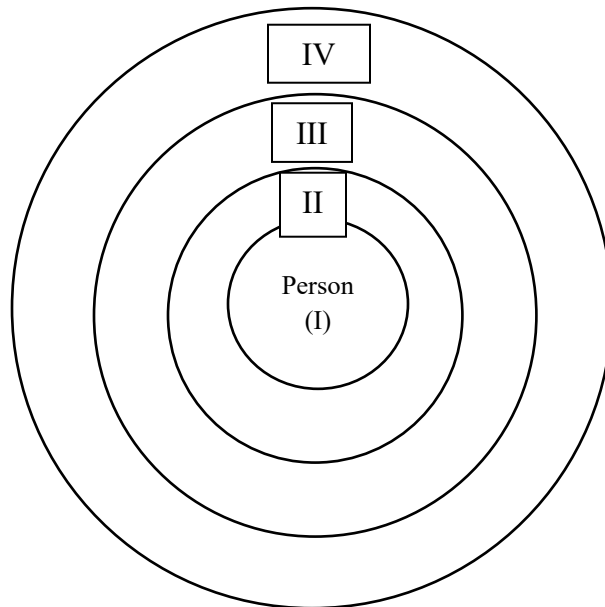
2.2.2.1 Quality of Life – Definition

The concept of ‘Quality of Life’ (QoL) has been cited in literature as dynamic and multidimensional; a holistic and complex notion that necessitates an interdisciplinary effort towards including social, environmental, structural and medical aspects in its analysis (Mollenkopf & Walker, 2007,) (Pinto et al., 2017). Because aging is a multi-faceted process in itself, reviews of the literature on Quality of Life in old age also demonstrate an extensive range: from subjective indices of life satisfaction and well-being, objective social indices, functional indicators of health, to the interpretation of values and ideologies held by older adults that depicts the powerful role of subjective assessment (Mollenkopf et al., 2007) (Mandzuk & McMillan, 2005).

The complexity of grasping QoL as the meta-level, and as an all-encompassing construct that is constantly connected to various dimensions of a person’s life, guides us to examine the concept via a socio-ecological perspective: we can look at QoL in old age from a person-centered model and trace the impacts of meso-level and macro-level constructs on the individual’s QoL.

Socio-ecological models of health emphasize the dynamic interactions that occur among the individual, social, psychological, and built environment, and highlight the standpoint that older adults’ perceptions and experiences about their health are a function of the person, the environment, and interaction of the person with the environment (Ottoni, Sims-Gould, & Winters, 2021; Yen et al., 2014; Bronfenbrenner, 1977). Consequently, the environment that actively supports older adults’ overall QoL through improving their social connection is my central focus of the conversation about spatial design and healthy aging. By adopting

Bronfenbrenner's Ecological Theory³ to understand QoL at the old age, the following diagram is generated (Bronfenbrenner & Morris, 2007):



- I) personal control, subjective evaluations
- II) social relations, social networks, and their spatial materializations (public space; neighborhood; community)
- III) Economic systems and governmental social policies that shape environmental conditions that support or inhibit older adults' well-being
- IV) Time and critical influences of Life Course

Based on (Mollenkopf et al., 2007, p. 6) examination of the field on different models of QoL applied in gerontological literature, eight models are identified; 3 of which will be

³ . In Bronfenbrenner's Ecological Theory, human behavior occurs in the embedded subsystems (micro-, meso-, exo-, and macro- subsystems) that encompass the settings and life space of human development. Each subsystem has an impact on the individual and other subsystems. In addition, influence of time and life course experiences are accounted for in Bronfenbrenner's Ecological Model. The social ecological models (including Bronfenbrenner's Ecological Theory) are widely used frameworks for understanding intricate factors that are influential in human health, as well identifying points of intervention across different subsystems (Wendel, Garney, & McLeroy, 2015).

highlighted for further consideration due to their significance for an environmental design research:

- 1) **Social Capital, social networks** and support, and community integration.
- 2) **Environmental and neighborhood resources** that cover both objective indicators (housing and services resources, adequate access to transportation, etc.) as well as subjective indices (satisfaction with residential quality, local transportation, perception of safety and neighborliness, and technological competence).
- 3) **Psychological factors and associated models of autonomy**, control, cognitive competence, self-efficacy, coping and adaptation.

These three overarching models for defining the construct of QoL, comprehensively cover the physical, social, and psychological aspects of the environment and create a framework that can be useful in linking gerontological research with the material characteristics of the environment. A fourth construct that can be adapted from the ‘Successful Aging Framework 2.0’ and emphasizes avenues for civic engagement of older adults can be outlined as:

- 4) **Civic engagement and active citizenship:** Towards a more socially sustainable society and the role of built environment and design in enhancing the culture of social participation among individuals (Rowe & Kahn, 2015).

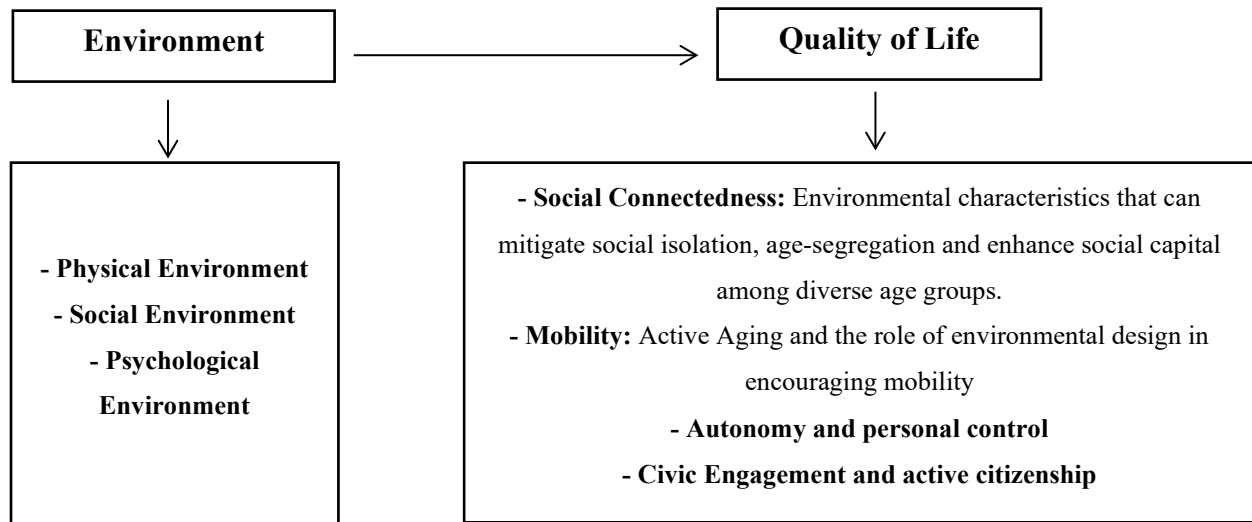


Figure 2.2: Environment and Quality of Life Framework

Each of these four constructs of QoL are discussed in the following:

2.2.2.2 Social Connectedness

‘Spatiality of aging’ impacts the levels of generational behavior and intergenerational social interactions that happens among people (Rowles & Bernard, 2013, p. 29). (Rowles & Bernard, 2013, p. 32) emphasizes that issues of “ownership, security, regulation, and rights” shape social interaction that occurs within public places. Observing degrees of ‘intergenerational interactions’ in public spaces of a community can offer important lessons for designing for visibility and age-inclusion of older adults. Observing the use of public space according to the economic and educational rhythm of specific locale can also be illuminating (Rowles and Bernard, 2013): The public space should be ‘enabling’ as a result, and the empirical observation of mobility and behavioral flows of older adults can be another step in designing for equity. Rowles and Bernard, (2013, pp. 202–203) identified ‘**physical insiderness**’ for older people in the deprived neighborhoods of UK and Canada was closely connected to factors that demonstrate the

relationship between aging and place, and presence of strong social support network and social capital, factors such as “place knowledge and physical attachment; social attachment; spirituality; historical attachment; and personal life course.”

2.2.2.3 Age-integration – revisiting Lewis Mumford’s advocacy for “not segregation but integration”

The ambition for creating age-integrated environments is not a novel endeavor. Lewis Mumford (1956) in a seminal article published in the journal of Architectural Record – “For older people – not segregation but integration” – noted the positive implications of age integration both in residential design and in the context of neighborhood development. He highlighted not only the physical integration of older adults’ dwellings in neighborhoods, but also their involvement in activities and intergenerational relationships that are vital in strengthening balance in the urban community.

In revisiting and continuing the work of scholars such as Mumford, we are faced with the legacy of environmental planning and design that has focused on spatial and programmatic separation of activities with profound social impacts. The legacy of these zoning separation schemes has also created mono-generational environments in communities catering to the distinct needs, interests, and abilities of each age spectrum separately (Talen, 2002). As a result, our task demands the recognition of the overlaps and synergies in patterns of behavior, interactions and interests that exist among age groups that should necessarily shape the policies, programs, and places for a livable city and community for the entire age spectrum. Intentional environmental design cannot exist independent of contextual factors that shape it: “programmatic, organizational, socio-cultural, political, and economic goals and realities” represent equally important forces at play (Kaplan, Haider, Cohen, and Turner (2007, p.89).

This expanded and contextualized framework for the creation of age-inclusive environments highlights the importance of spatial ‘programming’ that happens prior to any physical design. By highlighting the essential involvement of users in programming processes, investigating the co-construction of intergenerational spaces and technologies with older adults is a fundamental goal of this research endeavor.

2.2.2.4 Personal control, independence, and autonomy

Scholars such as Daatland and Hansen (2007) discuss two contrasting perspectives on the conceptual definition and approaches to studying QoL: 1) the tradition that focuses on the living standards consisting of material and economic standards that can more directly impact a good life; and 2) the pathway that is based on conceptualization of good life around subjective well-being and happiness. The second approach has been advocated by psychologists, while first one originated in economics and was enhanced by sociologists by including indicators such as education, housing, health, and social support (Ringen, 1995). In advocating for a third line that bridges the two lines of thought, Daatland and Hansen (2007) identified ‘personal control.’ It has been mentioned as an “internalized sense of capabilities; which is a characteristic of the person-environment relationship (Sen 1993; Daatland & Hansen, 2007).” Moreover, personal control can impact the perception of relationship between subjective wellbeing and living conditions through interpretation of the living conditions – low control can lead to easier surrender to external barriers (Daatland & Hansen, 2007). As a result, we can conceptualize environment as a material condition that can impact older adults’ personal control – measured through constructs such as self-efficacy and internal control – and affecting their well-being.

I have highlighted the role of environmental stimuli and the consequent demands on older adults’ wellbeing and QoL. For the purposes of this research the potential consequences of

technology in enhancing people's independence and autonomy is central. Independent living is encouraged by aging-in-place policies that have cost reduction in healthcare expenditure as one of their primary goals. Along with technological advances, the micro-environment of home has incorporated technology toward independence and enhanced quality of life for the older adults. Two influential contemporary applications of technology in the smart home environment can be identified as: 1) Home automation and automatic control of devices and systems; 2) Monitoring wellness and occupant's health status (Liu et al., 2016). However, the threat of social isolation and lack of active engagement with social life can effectively endanger the vision of successful aging at both the individual and societal levels if the smart home technology does not promote social interaction, social capital, and enhancements in physical and cognitive functioning as its core mission. As a result, the vision for enhanced autonomy and control over the environment, and enhanced quality of life of individuals can be negatively impacted and thereby obstructing the goal of aging-in-place policies. Vercelli, Rainero, Ciferri, Boido, & Pirri (2018, p. 39) discussed several human values that are crucial in technological design. Values such as "human welfare; ownership and property; privacy; freedom from bias; universal usability; trust; autonomy; informed consent; accountability; identity; calmness; and environmental sustainability." The potential impacts of integrating technology in the design of residential spaces represents a timely avenue for investigation.

2.2.2.5 Mobility

The gradient of age-integration to age-segregation contributes to the varied degrees of age inclusion or exclusion, are encompassed by the dimensions of spatiality. Thus, space becomes the important medium and context that actively structures and materializes the

inequalities among the older adults. In that regard aspects of equitable access to transportation and overall mobility become critical to an empirical investigation.

In their advocacy of active aging and maximum user participation in community life, Rowles and Bernard, (2013) categorize the barriers in mobility for older adults into two groups: 1) physical barriers such as poor and incompatible environmental design; and 2) social obstacles such as stigmatization of old age and ineffective social acceptance. Essential to the goal of maintaining an active life at old age, mobility constitutes a fundamental predictor for social participation. The literature on the processes of aging – mainly based on empirical evaluation of the aspects of mobility at the old age – cites functional decline as a consequence of aging that can be improved by social interactions and physical activity (Unger, Johnson, & Marks (1997); Zisberg et al., 2011). As a result, human-centered, age-appropriate, and the safe design of transportation systems – from pedestrian sidewalks to varied modes of transit – are encouraged.

Lawton and Nahemow's (1973) ecological theory of aging stands out as one of the main theories focused on human-environment relations in old age. This theory is widely used in delineating accessibility in the physical environment. By emphasizing human-environment fit, Lawton and Nahemow (1973) describe an accessible environment as one that allows for bridging between a person's functional capacity and demands of the physical environment (Rowles & Bernard, 2013, p. 177). This model asserts that the optimal person-environment 'fit' happens when his/her capacities are congruent with the environment's demands; and at the same time the environment provides ample opportunities for that person's competencies to grow. The foundational equation of B (*Behavior*)= $f(P$ (*Person*) $.E$ (*Environment*)) continues to inspire many researchers in designing quasi-experimental and correlational research studies that seek to uncovering the static and objective environmental characteristics (proximity and access to care

facilities, public transportation and mobility, amenities, etc.) that affect both aging in place and place attachment.

2.2.2.6 Re-imagining the activities and spaces of life span: Social sustainability – materializing intergenerational civic engagement

Much of the research on aging in place has identified ‘successful aging’ as closely connected with the success at the ‘societal level⁴’. This success at the societal level includes several criteria, such as: 1) social engagement and productivity through volunteering and participation in the labor force; 2) social cohesion and synergy between socioeconomic strata and generations; 3) resilience and effective response to stress; 4) and social sustainability (Rowe & Kahn, 2015). This framework later allowed the scholars to identify three main goals for conducting further empirical research and building of theoretical inquiries that prioritizes “successful aging” at the level of society: 1) re-thinking core societal institutions; 2) adopting a life course perspective; 3) and recognizing human capital throughout the life span (Rowe & Kahn, 2015).

To achieve the goal of a more socially sustainable society, the role of socio-physical space becomes an important agent for enhancing the culture of civic engagement and active citizenship – by enabling synergies and cohesion between socioeconomic strata and generations. In outlining a cross-disciplinary research agenda for sustainability in aging societies, Pillemer, Wells, Wagenet, and Meador (2011), highlighted intergenerational linkages as a critical consideration while designing policies and programs across the themes of housing, health, and behavior. Scharlach (2017) called for engagement in civil society and promotion of social ties

⁴ . The MacArthur Foundation assembled an interdisciplinary team of scholars in 2007 to recommend special policies towards a successfully aging society (Rowe & Kahn, 2015). Criteria that the committee recommended towards success at the societal level were initially recommended by this network.

across generations to be prioritized while designing and planning for a society's physical infrastructure, social opportunities, and supportive services. As a result, spatial considerations for cross-generational civic engagements are essential to fostering healthy aging at a societal level.

2.2.3 Summarizing the Framework

In adopting this framework for operationalizing the construct of 'quality of Life', the close connection and invaluable contribution of the built environment to a successfully aging society becomes apparent. It becomes crucial to re-think the current spatial programming of our society's core institutions such as families and housing, healthcare and hospitals, workplaces, educational settings, etc. on the successful aging of our population. Although a formidable task that extends beyond the realm of architecture towards arenas of policy and planning, yet it is necessary for planners, programmers, and designers of our built world to understand, empirically analyze and continuously re-examine the spatial programming and design of our core institutions. As Rowe and Kahn, (2015, p. 595) have noted: "A nation of gated residential areas, electrical fences, and armed body-guards does not make for successful aging on either side of the fence."

Adopting a life-course perspective in an aging society can also yield crucial lessons for the designers of our built environment. Currently our *roles* across the lifespan are distributed according to major *activities* (e.g., education, work, leisure, and retirement – the lack of these being a roleless role that lacks in purposeful engagement). These roles need a critical revision if we adopt a life-course perspective that prioritizes "adaptation to changes in longevity" and the recognition that changes introduced at any stage in life will impact opportunities and needs at other stages (Rowe & Kahn, 2015, p. 595). A redistribution of our activities will allow for increased opportunities for volunteering, and age-appropriate employment at an older age.

The spatial consequences of this adaptation will have significant lessons for designers. Adopting the life-course perspective enables us to critically re-imagine accepted roles and responsibilities of youth, midlife, and retirement and create an inclusive built environment accordingly. In the empirical investigation of the overarching research question, all three aspects of place – the activities that occur in an environment (social aspects); personal perceptions and image of a place; and physical characteristics of a place defined through design (Canter, 1977) – need to be investigated and integrated into the design of residential spaces for successful aging in place.

A model that values human capital (i.e., health, education) and social networks among aging populations – while simultaneously discouraging social norms that are based on chronological age – can be another step for achieving successfully-aging societies. As an example, designers and planners of the built environment can re-imagine spaces for higher-educational settings that recognize the value of education throughout the life-course instead of being limited to youth. Together with public health professionals, built environment designers can be at the forefront of promoting intergenerational civic engagement and establishing social norms based on accrued capabilities and knowledge rather than chronological age.

Chapter 3 Systematic Review of the Related Literature

3.1 Introduction – Systematic review of the literature about the impact of techno-spatial environments on social engagement behavior of older adults

In the previous chapter, I discussed a theoretical framework for the construct of Quality of Life (QoL) and outlined the central role of ‘social connection construct’ to older adults’ enhanced QoL. The rapid growth of technological innovations for aging can potentially influence older adults’ wellness and quality of life by enhancing their independence, autonomy and safety. The purpose of this chapter is to investigate the published evidence regarding the role of technological innovation as related to older adults’ social engagement while exploring the capacity of the physical built environment to influence this relationship.

This systematic literature review will be conducted using the PICO framework within Web of Science, PubMed, and Google Scholar, as well as supplementary hand-searched studies. The articles that were included were published between 2010 and 2020 and reported empirical studies about technological interventions that cover a broad range of devices and services: Social ICTs (Information and Communications Technologies), AT (Assistive Technologies), Sensors; touch screens and interactive displays; audiovisual Virtual Reality (VR technologies), etc. Explorative studies that reflect the perspectives of older adults and other stakeholders such as family members and caregivers about technological innovations were also included.

Ten articles met the inclusion criteria for this in-depth review. Relying on the intersection of theories of STS (Science and Technology Studies) and Gerontechnology (Peine, 2019)

allowed me to emphasize that evaluating technologies for aging in their interaction with both the physical and social environments and their complexities is critical to shining light on the ethical, social, and cultural consequences of technologies for aging. In the reviewed studies the promotion of social communication in technological innovations for aging was identified as a key influencer in supporting the quality of life and health and wellbeing of older adults. The role of physical environment was also highlighted as influential in shaping one's social relations and interaction with technology.

The goal of this chapter is to offer a systematic review of the efficacy of technological innovations in fostering social engagement among older adults, identify gaps in knowledge, and offer recommendations for improving future environmental intervention that connects technology, space, and public health, toward designing healthy places for successful aging at home, in the community, and broader societal contexts.

3.2 Aging-in-Place policies and the health impacts of social engagement throughout the life course – Views from the intersection of STS (Science and Technology Studies) and Gerontechnology theories

The phenomenon of Population Aging across the world has marked a long-term and unparalleled shift in the field of global age demographics. “Aging in place” as a global policy response to this demographic shift has received increasing attention from health policymakers, public health professionals, and designers of the built environment around the world. This can be attributed to the compatibility of these policies with the global decentralization trends in the provision of healthcare and prioritizing primary care and care delivery at the community level (Normie, 2017). Per aging in place policies, older adults are encouraged to remain in their own homes and communities as they age, however, many senior residents are at the danger of

increased social isolation and loneliness that can substantially reduce their wellbeing and quality of life. Considering the rapid technological developments such as Information and Communication Technologies (Social ICTs), Assistive Technologies (AT), and Human-Computer Interaction technologies (HCI), one's home becomes the most promising site for applications of technologies (Pilotto, 2018). The domestic micro-environment of home has incorporated technology toward independence, enhanced autonomy, safety, and higher quality of life for older adults.

We are witnessing an increased application of technology in the home environment – whether as home automation and ambient control systems and devices, telehealth or telemedicine tools, or occupant's health monitoring sensors and tools. However, many ethical and psychosocial issues such as attention to human values and dignity, respect for privacy, and freedom from bias and stigma require attention in the increasingly interdisciplinary field of Gerontechnology and environmental design for aging (Liu et al., 2016; Pilotto, 2018; Vercelli et al., 2018).

Public health studies have increasingly examined social connections facilitated by social relationships and documented their positive impacts on the promotion of healthy communities (Seino et al., 2018; Greaves & Farbus, 2006). As influenced by social networks and social capital, social engagement is based on social interaction at a community level (Bixter et al., 2018). The following definition applies to our discussion: “**social engagement refers to the degree of participation in interpersonal activities and the maintenance of meaningful connections with other people** (Bixter et al., 2018, p. 180).” Individuals experience varying degrees of social engagement during life course that has significant consequences for their quality of life, and health outcomes such as hypertension, cognitive health, and resulting in

profound implications for delaying the onset of disability and dementia (Barnes et al., 2004; Bixter et al., 2018; Mendes de Leon et al., 2001).

With the rapid developments in technology, social interaction among all age groups has changed dramatically; the role of technology in supporting social engagement and exploring the associations to health outcomes for older adults needs timely evaluation and represents one of the least studied areas in environmental design for aging.

In offering theoretical underpinnings at the intersection of Gerontechnology and Science and Technology Studies (STS), Peine, (2019 p. 54) posits that science, technology, and aging are inextricably entangled in the “socio-material constitution of later life”. In this theoretical lens, technology is conceptualized beyond simply providing an ‘efficient solution’ to the ‘problem’ of aging, rather its introduction into the home environment shifts the networks and relationships between technology and people (Peine, 2019). Innovation doesn’t stop while a piece of technology enters an environment, rather it extends well into the domain of technology use and the user’s agency. This perspective as advocated by STS scholarship challenges the widespread notion that emphasizes the older persons as a passive, inept, and vulnerable technology user, rather it renders the older persons as co-creators of innovation and “active participants in processes of technoscientific change (Peine, 2019, page 56)”. Consequently, home and community, social, physical, and digital environments become an entangled and comprehensive site for the inter-operation of products and services. Relying on STS theories of science, technology, and aging, allows us to emphasize that evaluating technologies for aging in their interaction with both the physical and social environments and their complexities is critical to shining light on the ethical, social, and cultural consequences of technologies for aging.

3.3 Methodology for conducting the systematic review of the related literature

A systematic review search of databases was performed using the PICO search model (Figure 2.1). Studies that I identified through the following databases included: PubMed, Web of Science, and Google Scholar.

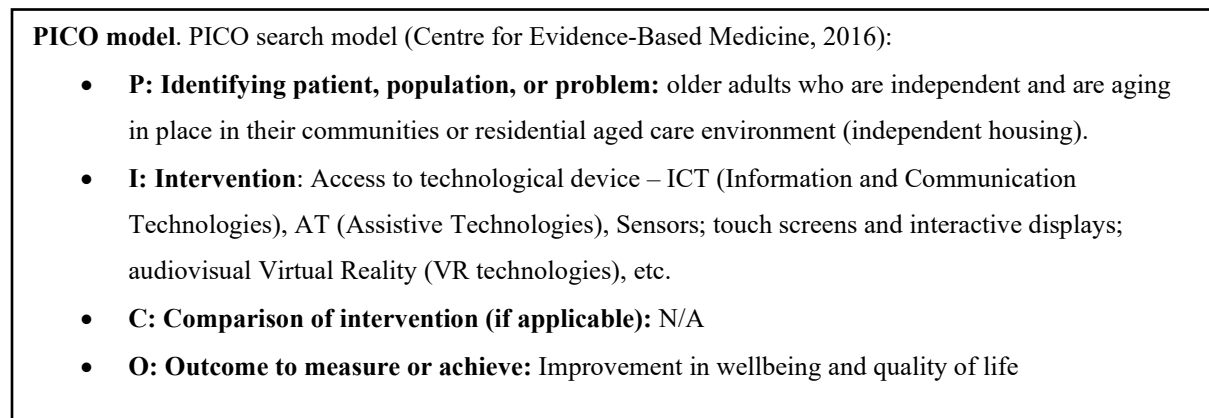


Figure 3.1: PICO search model – Adapted from Lorusso and Bosch (2018).

Abstracts and titles of manuscripts were evaluated for relevance to the topic of technological innovations in fostering social engagement using the following inclusion criteria:

- 1) Empirical qualitative, quantitative, or case studies published in peer-reviewed journals between 2010 and 2020, written in English.
- 2) Study participants had no sign of clinical conditions such as dementia that would require residency in special care facilities.
- 3) Theoretical frameworks for discussing the quality of life, health and wellbeing of older adults were identified and discussed in the research.
- 4) Technological interventions identified in the studies could cover a broad range of devices and services; explorative studies in unraveling perspectives of older adults about technological innovations were included.

Citation lists and abstracts of reviewed articles were also hand searched and included in this study. Keywords such as “technology”, “aging”, “social interaction”, “social connection”, “social network”, “home”, “physical environment”, “built environment”, “interior design”, “neighborhood”, “urban environment” were entered and truncated terms were used as appropriate. Flowchart of the search tactics and organization of the Journal Citation Report (JCR) can be seen in (Figure 3.2).

In case the relevance of the study was not clear based on the initial review, the full manuscript was read to determine its inclusion. Once a group of articles was gathered, the full study texts were reviewed to ascertain their relevance based on the defined inclusion criteria. Ten articles met the criteria, and a JCR flowchart was populated to review study characteristics. The level of evidence for each article and their quality of research was also evaluated following Marquardt, Bueter, and Motzek, (2014) level of evidence for health care design table (Table 3.1). The purpose of this study was to review and explore original empirical studies. As a result, articles assigned levels of evidence 1 (systematic reviews), 4 (professional standards), and 6 (recommendations) were excluded from review in this study.

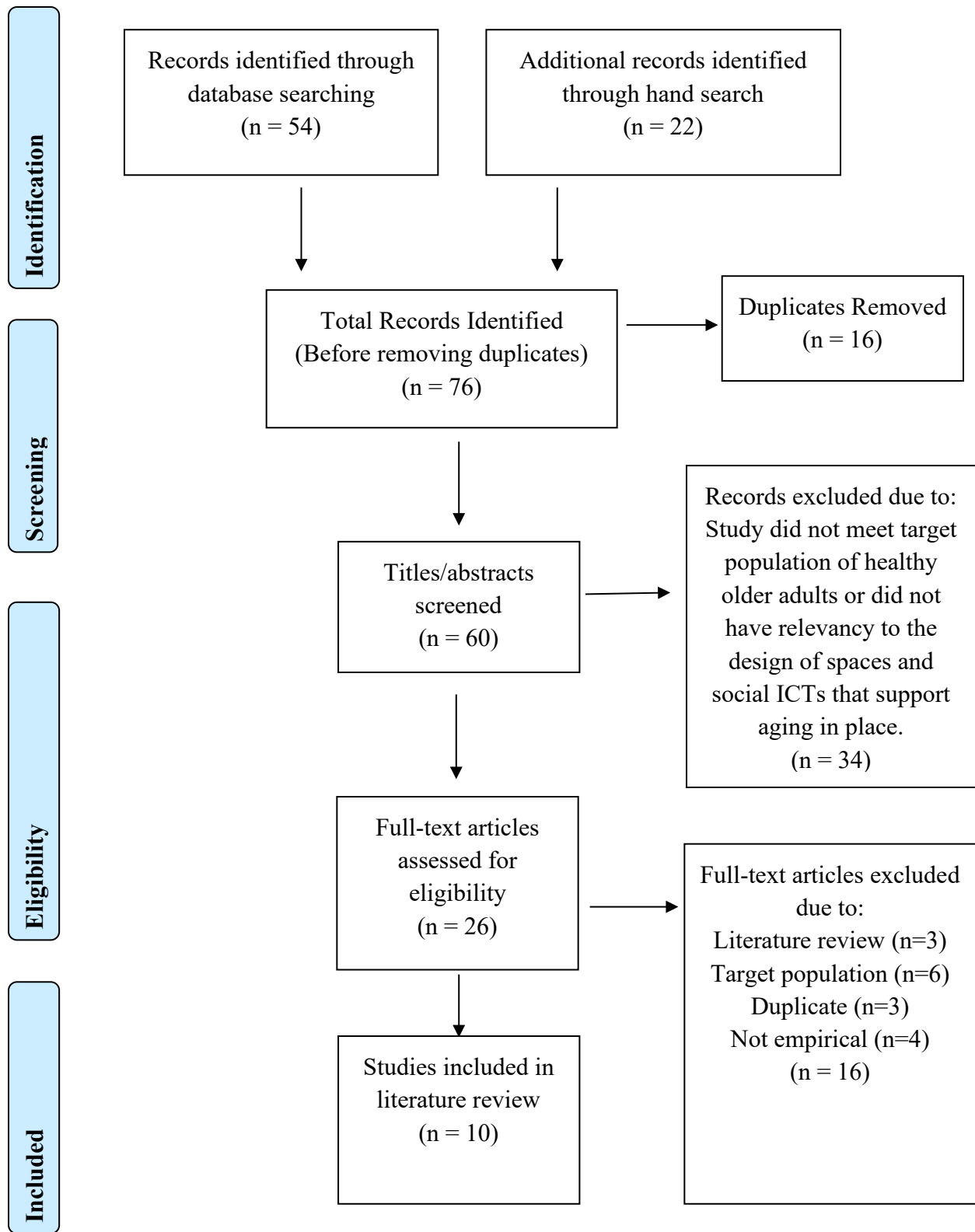


Figure 3.2: Literature review search strategy. Based on Moher, Liberati, Tetzlaff, and Altman (2009).

Table 3.1: Level of evidence for health care design. Adapted from Lorusso and Bosch (2018). Originally by Marquardt, Bueter, and Motzek (2014).

level	Description of quality	Included
1	Systematic reviews and meta-analysis	No
2	Experimental or quasi-experimental studies	Yes
3a	Observational studies	Yes
3b	Cross-sectional studies, qualitative research that includes a literature review, based on a theoretical framework, and clearly reports methodology and diversity of perspectives	Yes
4	Professional standards or guidelines	No
5	Qualitative research that did not meet the criteria described in Level 3b	Yes
6	Recommendations that maybe biased	No

3.4 Results of the systematic review of literature

A summary of the ten articles that met the inclusion criteria for this in-depth review is presented in the following chart (Table 3.2).

Table 3.2: Summary of the ten included studies.

Study number	Year	APA citation
1	2019	Dahl, Y., & Löfström, E. (2019). Supporting social interaction in care environments: Exploring stakeholder perspectives on the potential of interactive technology. <i>International Journal of Human-Computer Interaction, 35</i> (1), 53-64.
2	2015	Peek, S. T., Luijkx, K. G., Rijnaard, M. D., Nieboer, M. E., van der Voort, C. S., Aarts, S., ... & Wouters, E. J. (2016). Older adults' reasons for using technology while aging in place. <i>Gerontology, 62</i> (2), 226-237.
3	2019	Cahill, J., Portales, R., McLoughin, S., Nagan, N., Henrichs, B., & Wetherall, S. (2019). IoT/Sensor-Based Infrastructures Promoting a Sense of Home, Independent Living, Comfort and Wellness. <i>Sensors, 19</i> (3), 485.
4	2012	Petersson, I., Lilja, M., & Borell, L. (2012). To feel safe in everyday life at home-a study of older adults after home modifications. <i>Aging and Society, 32</i> (5), 791.
5	2019	Juul, A., Wilding, R., & Baldassar, L. (2019). The best day of the week: New technology enhancing quality of life in a care home. <i>International journal of environmental research and public health, 16</i> (6), 1000.
6	2018	Roberts, A. R., De Schutter, B., Franks, K., & Radina, M. E. (2019). Older adults' experiences with audiovisual virtual reality: perceived usefulness and other factors influencing technology acceptance. <i>Clinical gerontologist, 42</i> (1), 27-33.
7	2018	Willard, S., Cremers, G., Man, Y. P., van Rossum, E., Spreeuwenberg, M., & de Witte, L. (2018). Development and testing of an online community care platform for frail older adults in the Netherlands: a user-centred design. <i>BMC geriatrics, 18</i> (1), 1-9.
8	2019	Ten Bruggencate, T., Luijkx, K. G., & Sturm, J. (2019). When your world gets smaller: How older people try to meet their social needs, including the role of social technology. <i>Aging & Society, 39</i> (8), 1826-1852.

9	2020	Kim, M. J., Cho, M. E., & Jun, H. J. (2020). Developing Design Solutions for Smart Homes Through User-Centered Scenarios. <i>Frontiers in Psychology, 11</i> , 335.
10	2018	Castro Rojas, M. D., Bygholm, A., & Hansen, T. G. (2018). Exercising older people' s brains in Costa Rica: Design principles for using information and communication technologies for cognitive activity and social interaction. <i>Educational Gerontology, 44</i> (2-3), 171-185.

3.4.1 Highlighting the diversity of research questions in the selected studies

In this section, I will outline the diversity of research questions formulated in the ten reviewed articles. The majority of studies (Yngve Dahl & Erica Löfström (2019); Cahill et al., (2019); Juul, Wilding, & Baldassar, (2019); Kim, Cho, & Jun, (2020); and Castro Rojas, Bygholm, & Hansen, (2018)) were designed to explore multiple stakeholders' perspectives – including older adults – on the potential influence of innovations in technology in supporting health, well-being, and quality of life of the older adults. Roberts, De Schutter, Franks, & Radina (2018), and Willard, Cremers, Man, van Rossum, Spreeuwenberg, & de Witte (2018), decided on a form of ICT platform (i.e., audiovisual virtual reality – VR) as the primary technology and investigated its perceived usefulness towards the promotion of quality of life for older adults.

In their article, Peek et al., (2015) were mainly concerned with the investigation of the factors that were influential in the level of engagement with various types of technology among community-dwelling older adults who were aging in place. Roberts, De Schutter, Franks, & Radina (2018), aimed to unravel the social needs of older adults and the role of social technology in achieving them.

One paper (Pettersson, Lilja, & Borell, 2012) particularly focused on safety and autonomy aspects of health and wellbeing. In this study, the researchers were primarily interested in exploring personal and environmental aspects that contributed to the experiences of safety and

autonomy in daily lives of older adults who had received some form of home improvement and technological interventions to augment safety at home.

Consequently, the majority of the research endeavors are focused on understanding the potentiality of currently developed Social ICTs for older adults' QoL through a multi-disciplinary lens. For a complete summarized list of the characteristics of the included studies (i.e., research questions, research methodologies, settings, limitations, etc.) please look at Appendix A.

3.4.2 Analyzing the study designs and the spectrum of settings identified in the selected studies

Of the ten studies included Peek et al., (2015); Petersson, Lilja, & Borell, (2012); and Bruggencate, Luijkx, & Sturm (2019), used qualitative research design. Of the three qualitative research studies, article by Petersson, Lilja, & Borell, (2012) was particularly influenced by grounded theory and incorporated a hermeneutic interpretative approach in data analysis. In conducting a qualitative explorative field study, Peek et al., (2015); & Bruggencate, Luijkx, & Sturm (2019), used semi-structured interviews as the main tactic for data collection and used Thematic Analysis for analyzing the gathered data (Peek et al., 2015).

Research by Yngve Dahl & Erica Löfström (2019); Cahill et al., (2019); and Juul, Wilding, & Baldassar (2019), used a Case study research design. In the Case Study research design, Juul et al., (2019); Kim et al., (2020); and Castro Rojas et al., (2018) included a mix of qualitative ethnographic fieldwork tools such as participant observation and taking field notes, face-to-face conversations, video ethnography, in-depth semi-structured interviews with residents, family members, and staff of a residential aged care facility. Yngve Dahl et al., (2019) involved a qualitative, participatory, and explorative approach through conducting workshops with multiple stakeholders at a residential care center. As an Action Research study, Cahill et al.,

(2019), used a mix of tactics such as realist ethnography, process mapping, persona-based design, and participatory design in a residential care setting.

Roberts, et al., (2018) used a simulation research design and incorporated immersive virtual experiences to solicit older adults' responses to the VR experience. Focus groups were conducted with participants after the intervention.

Although the studies included in this review provided novel approaches in clarifying the links between human health and social needs, technological interventions, and supportive care environments for aging, some weaknesses were identified.

The growing heterogeneity and diversity of older adults have made any attempts to envision a one-size-fits-all approach an elusive task. As a result, while studies such as the one by Peek et al., (2015); provide useful conceptual models that clarify the influential themes that impact the level of technology used by the older adults in the context of aging in place, the authors identify their research outcomes as an overview that illustrates key areas for further investigations. In that regard, future studies can evaluate and potentially further expand or modify the existing models.

Moreover, studies by Cahill et al., (2019); Roberts et al., (2018); and Bruggencate et al., (2019), call for further attention to the heterogeneity of older adults in their diversity of functional, physical, sensory, and cognitive needs while investigating the impacts of technological interventions and encourage further studies that would incorporate different data collection tactics such as observational strategies (Bruggencate, Luijkx, & Sturm, (2019), survey research (Peek et al., 2015), or quasi-experimental studies that would evaluate the effectiveness of technologies as an intervention (Roberts et al., 2018) in their research designs.

It is also worthwhile to evaluate the reviewed research in terms of the duration of the studies and data collection. Of the ten reviewed nine were conducted as cross-sectional studies, whereas only one study (Petersson, Lilja, & Borell, 2012) was conducted as part of a longitudinal research program that studied impacts of home modifications for older adults in Sweden. In highlighting the shortcomings of cross-sectional research, Peek et al. (2015), encouraged further longitudinal research explorations that can unravel how the changes in the personal, social, and physical environment affect community-dwelling older adults' visions and attitudes regarding utilizing of technology. This suggestion could be applied to other reviewed cross-sectional research towards the exploration of long-term inter-relations between older adults and the surrounding personal, physical, and social settings.

The reviewed studies were conducted in Europe (Norway, the Netherlands, Dublin-Ireland, Sweden), Australia, Costa Rica, South Korea, and the United States. 6 out of 10 of the studies were conducted in a community setting (Peek et al., (2015); Petersson et al., (2012); Willard et al., (2018); Bruggencate et al., (2019); Kim et al., (2020); and Castro Rojas et al., (2018)), while research by others (Yngve Dahl et al., (2019); Cahill et al., (2019); and Juul et al., (2019)) were conducted in a residential aged care facility. One study (Roberts et al., 2018) was conducted in a continuing care retirement community (CCRC) in the United States. The spectrum of living environments for older adults, points to the heterogeneity of the aging population and the corresponding spectrum of plausible technological innovations for healthful aging.

3.4.3 Prioritizing the biopsychosocial model of wellness in developing technological innovations that support health, well-being, and quality of life of older adults

The reviewed studies (Cahill et al., (2019); Yngve Dahl et al., (2019)) adopt the “biopsychosocial” model of wellness rather than medically oriented perspectives on health. According to Cahill et al., (2019), the biopsychosocial theories of health and wellbeing emphasize the interdependence among the biological, psychosocial, and social dynamics in the manifestation of wellness and disease. In adopting this theoretical framework, the technology that promotes interdependence, relationship-centered care, and advocates inter-generational social communication among older adults and their social network can play a key role in supporting a high quality-of-life (Cahill et al., 2019).

The researchers encouraged promising technological development to support older adults’ wellness on biopsychosocial models of wellness, the state of the home/environment, and social relationships between older adults, family members, and the members of the professional caregiving community. The findings draw our attention to the importance of the social and physical context of older adults’ lives while developing any impactful technology that is intended to improve their wellbeing (Petersson, Lilja, & Borell, 2012).

3.4.4 The impact of social environments on older adults’ technology use attitudes and behaviors

Social environments shape and are shaped by the physical as well as virtual settings. The reviewed articles demonstrated an entangled relationship and crucial implication of one’s already-existing social network in their interaction with any form of Social ICTs. Overall, the researchers advocated for “social relational dimensions of technology interventions” in supporting the successful application of any novel technology that aims at improving the health and quality of life of older adults (Juul et al., 2019).

For example, Peek et al. (2015), identified the already-established relationships in the social network of older adult participants as an influential theme on the level of technology use and interaction with Social ICT devices. The influence of the social network of older adults was manifested through offering advice, acting as a co-user, and providing support (Peek et al., 2015). **The authors emphasized that more than a technical issue, adoption of technology among older adults is a social process (Peek et al., 2015).**

Moreover, as a conclusion to a 3-phased study, the researchers Cahill et al. (2019), argued that technology that enables and supports interdependence, and advocates for social communication among key roles in an older adults' social network, including family members, peers, and caregivers, is linked to a high quality of life for older adults. **The authors emphasized the social aspect of human life as an influential factor in our well-being. As a result, the authors advocated for the adoption of “relationship-centered care” as a framework that supports fostering positive social relations in the development of assistive technologies.** In the same line of thought, in Juul et al., (2019), the authors also highlighted the ties among social network and technology and discussed that **for the technologies to enhance the quality of life, and increase meaningful social and physical engagement among residents, they need to be successfully integrated into the daily life and the established social ties between the social network of older adults.**

In Petersson et al., (2012), the researchers focused on the “safety, and autonomy” as constructs of quality of life among the older adults and explored aspects that contributed to the experiences of safety and autonomy in the daily lives of older adults who had received some form of technological interventions to augment safety at home. In the findings, **the authors highlighted the role of the social environment and having a social network to rely on, as a**

prerequisite for feeling safe and benefiting from technology. The prerequisite was mentioned as foundational and if unfulfilled, technology alone could not improve experiences of safety (Petersson, Lilja, & Borell, 2012).

And finally, in exploring the older adults' responses to the audiovisual virtual reality (VR) experience, one theme that researchers highlighted as a step for improving VR technology was promoting social connectivity with family or friends and increasing interactivity in the virtual platform (Roberts et al., 2018).

Any physical or digital environment shapes and is shaped by our social environment. The selected research highlighted the critical role of interactivity and social connectivity embedded within the technical design and architecture of any technological intervention – such as a virtual setting.

3.4.5 The impact of physical surroundings on older adults' technology use attitudes and behaviors

In the previous section, I outlined the critical role of social spheres in older adults' engagement with Social ICTs. In this part, I will highlight the role of physical environments in one's engagement with technologies as discussed in the selected articles.

In the research by Yngve Dahl & Erica Löfström (2019), the authors explored the stakeholders' views on the design of socially inclusive technology in a residential care setting. **“Places” was among the central emerging thematic categories that were identified as critical for mediating the social inclusion technology. The already-established “Hubs” of social activities, with an existing social meaning associated with them, were identified as accessible and suitable locations for implementation of socially inclusive technology and intergenerational interactions. The stakeholders argued that a “social meaning” is attached**

to every hub for social activities in the care environment and the designed social inclusion technology should fit and reflect that connotation.

In addition, Peek et al. (2015), in a deeper look at the interaction of technology with the participants' home environment, **the researchers reported the environment (inside the home as well as the outside and community environment) affected older adults' technology use and their technology-related beliefs and attitudes.** Considerations regarding degrees of intrusiveness of the installed technology, ease of physical access to the devices, and fit of the technology within their domestic setting were identified as influential factors. The authors concluded that in line with the literature on environmental gerontology and health geography, in developing technologies for aging, attention to the physical environment is critical.

Article by Cahill et al., (2019), demonstrated that to foster a positive experience for residents and caregivers and towards supporting relationship-centered care in a residential care setting, researchers conceptualized a sensing framework that would govern the technology development. The framework includes three dimensions of **1) the resident health and wellness 2) the resident's environment 3) care delivery.** The environment is described as an important component that impacts both resident's social and physical health and can be modified according to the changes to the care delivery and the presence of the caregiver in the environment.

As described by Petersson, Lilja, & Borell, (2012) the researchers discussed constructs of "safety and autonomy" as influential factors to a high quality of life among older adults. In addition to the critical role of a social network in allowing one to feel safe, "feeling at home" is identified as another prerequisite for feeling safe and benefiting from any technology that is intended to improve safety and autonomy. **The researchers identified "Feeling at home" as a construct that encompassed both the inside of the dwelling and the surroundings, and**

relates to issues of being in control, and access to supporting surroundings and outdoor environment that would allow for shaping of informal social relations with people.

In addition, Juul et al., (2019) highlighted those interdependent factors, including environmental, organizational, caregiver, patient, and management- & government-related actively influence residents' engagement with the technology in a residential care setting for older adults. In their discussion about environmental factors, the authors mentioned that an amalgam of organizational, management- & government-related factors, as well patient- and caregiver-related ones have the potential to limit or enhance environment's role in allowing for opportunities for physical activity and social interaction among residents and staff to happen – the finding which is in line with the Socio-Ecological Model of health that emphasizes the overarching role of management organizational policies in the shaping of the social and built environment. The authors highlighted the crucial role of government and policymakers in prioritizing increased physical and social activities in residential aged care facilities. This prioritization can have a ripple effect on the creation of physical and technological environments that would stimulate diverse modes of social and physical activities and contribute to the overall wellbeing of older adults.

And finally, in the study by Bruggencate, Lwijk, & Sturm (2019), the authors aimed to investigate the social needs of older adults and the role of social technology in achieving them. In the results of the study, **the authors reported that the dwelling and the close neighborhood become prominent resources of the social connection of older adults as they age. Any loss of these resources can potentially make their world smaller, i.e., loss and shrinking of social connection with peers, family, and neighbors.** Social technology can provide a tool to expand the social network of older adults and “bring the world a little bit closer for those with reduced

resources to have face-to-face social contact (Bruggencate, Luijkx, & Sturm, 2019, p. 1848).”

The authors emphasized two suggestions concerning social networks of older adults and the role of social technology: 1) Supporting and improving participation in the world close by and helping make contact within their neighborhood; and 2) Bringing the outside world a bit closer to their residences to overcome physical distance in the form of improved communication or transportation. Future development of technological interventions to battle social isolation and loneliness should pay attention to these suggestions to improve older adults’ wellbeing and quality of life.

3.5 Discussion

3.5.1 Summary of findings: Efficacy of technological innovations in fostering social engagement among older adults and gaps identified in the literature

Overall, in the reviewed studies the promotion of social communication was identified as a key influencer in supporting the quality of life and health and wellbeing of older adults. The role of the physical environment was also highlighted as influential in shaping one’s social relations.

Supporting social communication in designing technological innovations for aging is in line with the calls for moving beyond adopting the prevalent biomedical models of health in designing technological innovations for aging towards the adoption of biopsychosocial models of wellness. The biomedical perspectives of wellbeing have been a dominating view in technology design research and that has culminated in an abundance of technological innovations with ‘tracking’ as their core function and provision of feedback based on the ‘average person’s’ physical health and well-being (Durick & Leung, 2018). The biomedical perspective of health dominated the field of gerontechnology for some time and in advocating for the adoption of

relationship-based biopsychosocial models of wellness in the development of technologies for aging, a more comprehensive design research framework has been proposed: a framework that acknowledges social practices, cultural and political contexts that encompass the foundational conditions for the design and use of technologies (Durick & Leung, 2018).

Moreover, the reviewed studies highlighted the impact of the physical environment in the forming of older adults' social relations and influencing their wellbeing; a remark that is compatible with the literature on environmental gerontology and health geography. Conceiving 'home' and the domestic environment as a kinetic participant in forming and responding to the older adults' ongoing social relations, socio-physical, emotional and psychological interactions, clarifies trajectories for interdisciplinary collaborations among the fields of architecture, HCI, and gerontechnology (Durick & Leung, 2018). Designing the domestic environment has to transcend a technical endeavor to the 'problem' of aging; it has to enhance and support older adults' abilities and their aging well.

This trajectory for design, that is based on biopsychosocial models of wellbeing, particularly allows for the fields of architecture and Human-Computer Interaction (HCI) to collaborate due to their modes and methods of engagement with social, cultural, and political influences, spatiality, human behavior and psyche, and the role of user and Participatory Design methods, in conceiving the designed outcomes (Durick & Leung, 2018).

In a call for interdisciplinary collaboration among the fields of gerontechnology, interactive architecture, and Human-Computer Interaction (HCI) to further research into designing domestic places for aging well, questions remain to be asked about acknowledging the heterogeneity of older adults while designing physical environments. Moreover, critical inquiry

around the integration of technologies into the pre-existing and sometimes racially and culturally biased structures of healthcare organizations and systems is needed.

While this systematic review revealed that the biomedical model is not the optimal choice to evaluate technologies (Pilotto et al., 2018) only a handful of studies have identified complementary frameworks and design research trajectories for technological innovations for aging. Future exploratory and context-driven studies are needed to further clarify pathways for understanding the unique and heterogeneous personal, social, and cultural needs of older adults and designing technology.

3.5.2 Recommendations for the design of future studies

A close look at the study designs of the reviewed research reveals inconsistencies and clarifies directions for future research. For example, the location and physical environment for studies that ranged between institutional settings to homes of older adults, type of technological intervention (ICT, AT (assistive technologies), VR technology, sensor-based technologies, etc.), and duration of data collection. Future longitudinal studies that will unravel the social needs of older adults from multiple socioeconomic spectra and the role of technological innovations in promoting inclusivity and health equity are encouraged.

3.5.3 Future directions: Equity and human rights in technological design; looking beyond the biomedical model and advocacy for cross-disciplinary collaborations

In the time that the COVID-19 pandemic exposed the shortcomings in the designing of equitable and healthy environments that could protect the health and wellbeing of older adults, further research in exploring designing places for healthy aging and the role of technology becomes critical. The pandemic rendered the detrimental consequences of social isolation for all

age groups – especially older adults – more transparent than ever. Further research questions to be explored in future studies could clarify the role of technological innovation and interdisciplinary spatial design for the health and wellbeing of older adults and their successful aging.

A human rights lens puts people’s lives first while assessing advances in science and technology and can particularly support vulnerable groups’ rights and benefits. Bennett (2019), advocated for and proposed the adoption of a human rights lens in the assessment of the implication of new technologies that promise support of healthy aging. A human rights approach serves as a mechanism for turning concepts of rights and freedoms into competent evidence-based policies and practices Bennett (2019). In line with the author’s propositions, the following questions need to be brought into the fore while evaluating the implications of technology for older adults and assessing whether it has the potential to support the human rights of older users:

- 1) “Who gets to decide whether an older person should use assistive technology?
- 2) Does the use of the technology protect privacy, dignity, and liberty?
- 3) Does the use of the technology foster mobility, companionship, social interaction?
- 4) Is the technology accessible on an equitable basis to all who need it? (Bennett, 2019, p. 4)”

Moreover, Bennett (2019) identifies social engagement, companionship, and mobility as critical factors while assessing the human rights implications of technologies for aging. Mobility and equitable access to transportation and affordability of modes of transportation are fundamental elements in facilitating one’s social engagement outside the home environment Bennett (2019). Technology has the potential to support social engagement by providing access to the physical environment around the older person or through multiple modes, such as

engagement with social robots, voice-activated devices and other innovations in the realm of Social ICTs. As a result, this potential for augmenting one’s social engagement and companionship must be assessed in light of older people’s dignity and privacy Bennett (2019) (Figure 3.3).

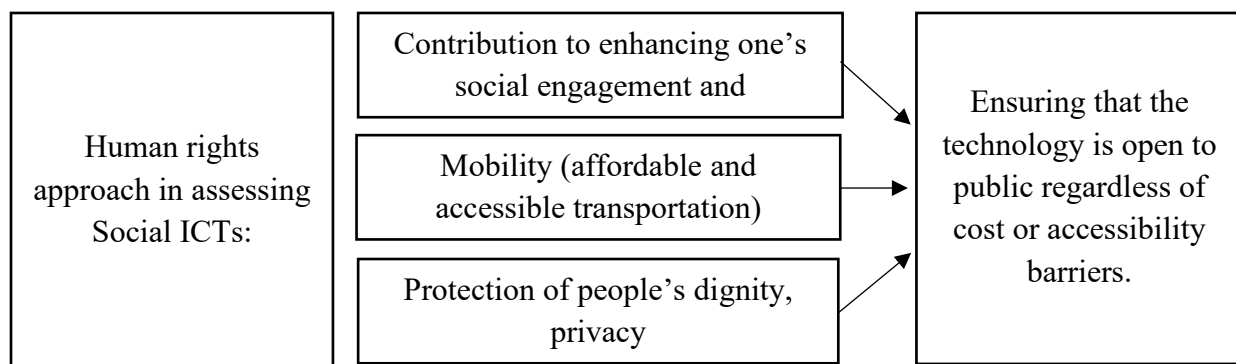


Figure 3.3: A diagram to highlight the important implications of adopting a human rights lens in design and assessment of Social ICTs.

As discussed throughout this chapter, in expanding the biomedical model to recognize and include socio-cultural factors, many researchers identify technological innovations in the areas such as ICT, AT (assistive technologies), and HCI as inherently interdisciplinary topics and call for increased collaboration among a spectrum of stakeholders such as clinicians, engineers, designers, policy experts, computer scientists, end-users towards full integration of technologies into the existing structure of healthcare organizations and systems (Pilotto et al., 2018).

With regard to limitations of the reviewed studies, the empirical studies included in this review were based on qualitative research designs and case studies (limited to one context) from 2010 year to 2020 in English. Comparison of various settings for aging in place and longitudinal studies can provide complementary insights to the reviewed topics including engagements with Social ICTs and the critical role of the environment in supporting older adults’ social health. In addition, understanding engagement with technological innovation for social well-being and the

role of the built environment needs to be studied and expanded upon in the non-Euro-centric sociocultural contexts.

3.6 Conclusion

In this chapter, I reviewed the efficacy of technological innovations in promoting social engagement, and the role of the physical environment in shaping the technological and social spheres were outlined. In addition, directions for improving future environmental interventions that connect technology, space, and public health were discussed. Although designing healthy places for successful aging at home, in the community, and broader societal contexts require more attention, this review provided the first step toward designing social technologies and environments that support older adults' social well-being and their enhanced quality of life. **A lack of design and development of 'preventive' technologies is still transparent.** The dominant legacy of biomedical models and insufficiency of reliance on these models that theorize aging as a problem to be solved perpetuates an 'aging and innovation' discourse that offers technological interventions as a solution to the 'problem' of aging and is counterproductive in moving beyond negative stereotypes of aging (Bennett, 2019, p. 3). The preventive role of technologies needs further investigations.

In addition, as previously highlighted, researchers and designers need to advocate for a human rights approach while designing and in assessing technology – especial attention paid to the role of technology for enhancing one's social engagement, protection of one's privacy and dignity, affordability, and accessibility. Close collaboration among professionals in architecture, HCI (Human-Computer Interaction), gerontechnology and other allied fields towards the creation of equitable and inclusive technologies is encouraged.

Chapter 4 Research Design and Methodology

This study aims to investigate the residential environment of living for older adults while focusing on access to and engagement with Social ICTs (Information and Communication Technologies) within the environments: How can the integration of technology and the residential built environment (and the interplay between them) affect older adults' social connectedness? In recognizing the significance of the environmental design of residential settings for older adults' social life, my overarching explorative research question is: *to what extent does access to Social ICTs and residential spatial features of older adults' homes impact their social connectedness? And more specifically, what is the role of the residential built environment and access to Social ICTs in preventing or encouraging social connectedness for older adults in their homes? And in what ways do spatial features and Social ICTs influence older adults' social connectedness?*

A combined research design strategy – specifically a two-phased research design – that involves combining a correlational research strategy in stage one and a qualitative research strategy in stage two is employed to answer the primary research questions in this research. As described by Groat and Wang (2013), a two-phased design allows for processes associated with each stage to be fully distinct; however, this separation can lead to a lack of connection and coherency if the strategies are not appropriately linked. In Chapter 7, I will tie the results of these two phases together to address this limitation.

Each strategy employed in this research has its advantages and limitations. The correlational research strategy is utilized to “clarify patterns of socio-physical relationships between two or more variables” occurring in their natural setting (Groat & Wang 2013, p. 269). More specifically, in stage one of the research, I aim to clarify the relationships between the environmental design factors, i.e., the built environment of housing and Social ICTs utilized within it, with measures of social connectedness among community-dwelling older adults across the United States. Correlational quantitative research allows for a breadth of information to be gathered; however, the data often lacks depth. Qualitative research design will be utilized to overcome this issue in the second phase of this research. As Groat and Wang (2013) describe, capturing the in-depth, holistic, and multifaceted characteristics of a phenomenon under study as comprehensively as possible is among the primary intentions of qualitative research strategy. In conducting phase two I employ semi-structured in-depth interviews with my participants, I am able to investigate and gain an in-depth understanding of participants’ experiences. Consequently, employing a two-phased research design allows me to gain both a broad and in-depth understanding of my research topic.

In this study, the research questions will be explored in a combined strategy – a two-phased research design. The research questions explored in each stage are outlined below, and each stage will be presented in detail in this chapter.

Stage 1:

To explore the roles of both the residential built environment and access to Social ICTs in preventing or encouraging social connectedness for the older adults in their homes, the following research questions were created to be investigated in the first stage of the research via a correlational research design.

- 1) Which spaces in the older adults' residences were more likely to be utilized for in-person social activities prior to the pandemic? And what are the potential environmental design barriers and facilitators of social engagement within older adults' residences?
- 2) Did older adults engage with video-calling – as a form of virtual communication – to socially connect with their network during the Covid-19 pandemic? What are the potential built environment features that may prevent or encourage virtual socializing?
- 3) How does this sample of my older adult respondents rank regarding their social connection measures? Are there any general patterns of relationships between participants' virtual engagement behavior and their social connection measures?

Stage 2:

In the second stage of this research, the lived experiences of older adults who are aging in place – particularly the interaction between the built environment of their housing and their access and use of Social ICTs for social connectedness during the Covid-19 pandemic is explored. The interplay between access to and use of Social ICTs, residential built environment, and their influences on older adults' social connectedness and, ultimately, their quality of life will be investigated. The research questions that informed the qualitative research design are identified in the following.

- 1) Engagement with Social ICT technologies – What are the systemic, as well as life course experiences and factors that impact the engagement of older adults with Social ICT technologies?
- 2) Perception and access to Social ICT technologies – How do older adults describe their access, interaction with, and sentiments towards ICT devices and technologies?

- 3) An in-depth look at Zoom as an example of a screen-based and voice-activated Social ICT: How do older adults describe their engagement with and criticism of this type of Social ICT? To what extents do older adults express positive potentials of Zoom?
- 4) Body, health, and ability to engage with currently-designed ICT technologies – How do older adults describe health issues that impact their ability to engage with the currently designed ICT technologies?
- 5) Exploring a spectrum of older adults’ jobs, volunteer activities, and the impact of the Covid-19 pandemic on older adults’ social life.
- 6) City life and home spatial design: A look at the spectrum of older adults’ home environments and the interaction of space and technology, and their impact on older adults’ social life in light of the Covid-19 pandemic.

A summary of study design and methods that are used is outlined in Table 4.1.

Table 4.1: Research design summary

Stage	Overarching research goals	Methods of inquiry	Research Strategies and tactic for data collection	Data analysis
1	Goal: To explore the role of the residential built environment and access to Social ICTs in preventing or encouraging social connectedness for older adults in their homes.	<p>Paradigm or system of inquiry: Intersubjective (Groat & Wang 2013, p.78)</p> <p>School of thought: Pragmatism - Groat & Wang 2013, p.89)</p>	<p>Correlational Research: Correlational approach or strategy: Relationship study</p> <p>Tactics: Non-interactive online response to survey questionnaire (n=115) distributed via social media (Twitter) to community-dwelling older adults self-identifying at 55 years old or above across the United States. Questions are attached in Appendix C.</p>	<ul style="list-style-type: none"> - Non-parametric Statistics as appropriate (Descriptive analysis) - Data visualization - Multiple linear regression analysis

2	Goal: the lived experiences of older adults who are aging in place and particularly understanding the interaction between the built environment of their housing and their access and use of Social ICTs for social connectedness during the Covid-19 pandemic will be explored. The interplay between access and use of Social ICTs, residential built environment, and their influences on older adults' social connectedness and ultimately their quality of life will be investigated.	Paradigm or system of inquiry: Intersubjective (Groat & Wang 2013, p.78) School of thought: Combined pragmatism and transformative (Groat & Wang 2013, p.92)	Qualitative Research: Qualitative approach or strategy: Phenomenological inquiry Tactics: Interactive interviews conducted through virtual format (Zoom) as well as in-person format (n=17).	- Inductive Qualitative thematic analysis using NVivo software
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4.1 Stage 1: Correlational Research Design – Relationship study

The strategy of correlational research is utilized to “clarify patterns of socio-physical relationships between two or more variables” as the patterns occur in their natural setting (Groat & Wang 2013, p. 269). In addition to an emphasis on “naturally occurring patterns,” Groat and Wang (2013), discuss two more general characteristics of correlational research that include: measuring specific variables of interest and utilization of statistics to illustrate the patterns.

Two major correlational approaches or strategies are identified within this research design: 1) relationship and 2) causal-comparative (Groat & Wang, 2013). In this study, the research approach is in line with the “relationship” strategy and based upon the fundamentals of correlational research design. In this stage of the research, I aim to clarify the relationships between the environmental design factors – built environment of housing and Social ICTs utilized within it – and measures of social connectedness among community-dwelling older adults across the United States.

Regarding data collection tactics, survey questionnaires are one of the most frequently utilized (Groat & Wang, 2013). Surveys are mainly employed when the researcher aims to gather

broad and extensive – rather than in-depth – amount of information (Groat & Wang, 2013). In this correlational research stage, I use the survey questionnaire tool as the primary data collection tactic. The tool will include non-interactive, online responses to the survey questionnaire. The questionnaire primarily explores the links between the built environment of housing, social engagement, and technologies that may afford it.

4.1.1 Designing and developing the survey questionnaire

Designing and developing the survey questionnaire in this research was informed by two major steps: 1) My involvement in data analysis for the results of University of Michigan's IHPI's (Institute for Health Policy Innovation) 2020 National Poll on Healthy Aging (NPHA) allowed me to gain insights about design of a survey instrument focused on built environment and older adults' health and utilize my knowledge in the crafting of my questionnaire. And 2) Conducting a virtual pilot focus group with five older adults to understand the ways and strategies that young-olds and older adults employed while engaging in safe social connections within their social network and the impact of their home environment and Social ICTs in facilitating this social connection. These two steps will be outlined in the following.

4.1.1.1 Survey questionnaire development step 1: Developing a preliminary draft based on the results of the University of Michigan's IHPI's (Institute for Health Policy Innovation) 2020 National Poll on Healthy Aging (NPHA)

As a research assistant with my committee member Dr. Upali Nanda, I was involved in data analysis and writing a report and a publication manuscript based on the results of the 2020 National Poll on Healthy Aging. In the survey questionnaire that was developed under IHPI's supervision, respondents were asked about (1) whether they had access to spaces that can support

well-being and resilience during the Covid-19 pandemic, (2) whether they were engaged in activities that promote health and well-being, and (3) reporting the frequency of feeling isolation or a lack of companionship since the start of the pandemic (See the [Appendix B](#) for IHPI's complete survey questions about the built environment). Informed by the literature and inspired by the IHPI questionnaire, I drafted an initial version of my survey. However, in order to get a more accurate sense of the relevancy of the topics, I conducted a virtual pilot focus group to polish my instrument design.

4.1.1.2 Survey questionnaire development step 2: Conducting a virtual pilot focus group

In this virtual focus group, I aimed to clarify the ways and strategies that young-olds and older adults employed while engaging in safe social connection with their friends and family and the impact of their home environment and Social ICTs in facilitating this social connection. In the following open-ended question, I asked about their social connection both before and during the pandemic:

Social connection and home environment:

- 1) Could you please describe your home environment? (single-family home/ apartment building/ condominium/ etc.)
- 2) Could you please let me know about the make-up of the people that live with you?
(Living alone, spouse or partner, children, grandchildren, etc.)
- 3) Could you tell me about your socialization with your friends/family before the pandemic?
 - Where would you engage in socialization in your home environment?
 - What activities would you typically engage in?
 - Did you modify your home to facilitate your social activities?
- 4) How did your socialization change because of the pandemic?

- 5) Did you manage to continue any of the typical social activities that you were previously engaged in via any modified/different format?

Social ICTs:

- 6) What kind of technology is available to you at your home to facilitate your social connection with family/friends?
- Did the pandemic have any impact on your engagement with a specific form of technology?
 - Did you modify your home as a result of accommodating this form of technology?
- 7) What are some of the issues (both usability & spatial concerns) of using such technology?
- 8) What kind of technology do you wish to have access to in order to enhance your social connection?

I reached out to the community-dwelling young-olds (55 years old or above) who lived across the United States via the Twitter social media platform and asked for their voluntary participation in my virtual focus group about the potential implication of using technology in the home setting for social connection and quality of life. I scheduled a virtual focus group with eight volunteers on Saturday, March 27th, 2021, via Zoom. Five people showed up, and we started the conversation based on the questions that are discussed above (Questions received UofM IRB exempt status HUM00196141). The participants' age range was between 62-67.

The focus group provided me with details and nuances that older participants employed to stay socially connected to their loved ones during the quarantine and physical-distancing orders from health experts. For example, 'views to nature' was identified by several participants as an environmental factor that could potentially encourage social connection among older adults

and their network. I utilized the results of this focus group to revise successive drafts of my survey questionnaire.

The final designed survey questionnaire is attached in Appendix C. As described earlier, the questionnaire was crafted to answer the following research questions:

- 1) Which spaces in the older adults' residences were more likely to be utilized for in-person social activities prior to the pandemic? And what are the potential environmental design barriers and facilitators of social engagement within older adults' residences?
- 2) Did older adults engage with video-calling – as a form of virtual communication – to socially connect with their network during the Covid-19 pandemic? What are the potential built environment features that may prevent or encourage virtual socializing?
- 3) How does this sample of my older adult respondents rank regarding their social connection measures? Are there any relationships between participants' virtual engagement behavior and their social connection measures?

Statistical measures are employed to describe the patterns and establish relationships between spaces and Social ICTs that older adults engage with and their social connection behaviors. The following section portrays the overview of the variables utilized in the survey questionnaire.

4.1.2 Independent variables: Spatial characteristics of older adults' residential environment and their engagement and access to Social ICTs within their homes

To answer the first and second research questions, the survey questions were created to understand 1) older adults' engagement in in-person social activities in their home environment prior to the pandemic; and 2) older adults' engagement in virtual video-based communication in their home environment during the pandemic. Based on the results of my literature review, and

the two stages of survey development explained in the previous section, the following categories were identified as potentially influential spatial characteristics of older adults' residential environments that may impact their social connectedness (both in-person & virtual) behavior.

Environmental features that may influence in-person social connectedness:

- Indoor air quality
- Acoustics and noise
- Lighting
- The layout of home furniture
- The layout of the unit (kitchen size, living room size, availability of a guest bedroom, adequate spaces for group activities, etc.)
- Privacy
- Visitability (can your home be visited by people with disabilities?)
- Views and access to nature (through windows, porches, or balconies)

Environmental features that may influence virtual social connectedness:

- Lighting and glare
- Acoustics and noise: Sound quality and communication within the home and the degree to which it facilitates video-calling
- Privacy
- Access to internet infrastructure and Wi-Fi
- Elements of architecture and degree to which they allow/restrict video-calling: for example, no adequate surface to set up a tablet or screen for video-calling

- Circulation within the home environment and the degree to which it allows for video-calling while moving inside the home
- Video calling and its connection to the outdoor spaces of one's residence (such as a garden)
- Video-calling and spaces for creative work (how much video-calling allows for communication while cooking, playing games, playing music, or any other DIY creative act)

4.1.3 Dependent variable: Social connectedness

To answer the third research question, the survey questions were crafted to understand older adults' social connectedness prior to, and during the pandemic. In this section, the key measures that capture the main dependent variable of social connectedness will be explained.

The measures for social connectedness that I used in this study are: loneliness scale (3 Qs: UCLA Loneliness Scale) adopted from Hughes et al. (2004), the Companionship Scale (3 Qs: Companionship Scale) adopted from Hahn et al. (2014), Social Participation Scale (6 Qs: Social Participation Scale) adopted from Cornwell et al. (2008) and Cornwell and Waite, (2009), Sense of Community in Physical Space (7 Qs: Sense of Community in Physical Space) adopted from Iciaszczyk (2016), and Sense of Community in Virtual Space (6 Qs: Sense of Community in Virtual Space).

4.1.3.1 Loneliness Scale

The measure of loneliness involves three questions adopted from Hughes et al. (2004), and it is a widely used and highly reliable scale. Respondents were asked about the frequency of 1) 'feeling left out'; 2) 'feeling that you lack companionship'; and 3) 'feeling isolated'. The

possible choices were ‘never’, ‘sometimes’, ‘about half the times’, ‘most of the time’, and ‘always’.

4.1.3.2 Companionship Scale

The companionship scale adopted from Hahn et al. (2014), measures older adults’ perceived social connectedness and perceived sense of strong social ties. Respondents were asked about the frequency of access to someone for the following three items: 1) have a good time with; 2) get together with for relaxation; 3) do enjoyable activities with. The possible choices were ‘never’, ‘sometimes’, ‘about half the times’, ‘most of the time’, and ‘always’.

4.1.3.3 Social participation scale

Measure of social participation involves six items adopted from Hahn et al. (2014). The indicator captures various social activities that older adults may participate in, and frequency of their engagement. The six items include: 1) socializing with friends and family; 2) participating in neighborhood and community activities; 3) participating in activities of organized groups; 4) volunteering; 5) participating in physical activities or sports involving people; 6) participating in other activities involving people. Respondents were asked about frequency of their participation in the questionnaire and the possible responses were ‘rarely/never’, ‘once a month’, ‘once a week’, ‘2-3 times a week’, ‘4-6 times a week’, ‘daily’.

4.1.3.4 Sense of Community in physical space

Sense of community in physical space indicator is comprised of seven questions adopted from Iciaszczyk (2016). Three items asked about participants’ degree of agreement with the following: 1) access to many in-person visitors every day; 2) socializing a lot within your building, community, or neighborhood; 3) presence of a strong feeling of belonging at your place

of residence. The choices ranged from ‘not at all’, ‘sometimes’, ‘often’, and ‘very much’. Four additional items asked about participants’ degree of agreement with the following statements: 1) I know the people next door very well; 2) I know the people in my neighborhood very well; 3) My neighbors are always concerned with helping and supporting one another; 4) My neighbors always acknowledge one another when passing in the hallway/street. And the choices ranged from ‘strongly disagree’, ‘somewhat disagree’, ‘somewhat agree’, and ‘strongly agree’.

4.1.3.5 Sense of community in virtual space

Regarding sense of community in virtual space, I developed six items due to the significance of virtual relations during the Covid-19 pandemic. The questionnaire is distributed online to the participants and gauging their sense of community in virtual space is an important topic. Four items asked about participants’ degree of agreement with the following: 1) getting many virtual calls/visits every day; 2) socializing a lot with your friends on social media; 3) access to an online community of friends concerned with helping and supporting one another; 4) having a strong feeling of belonging to your virtual community. The choices ranged from ‘not at all’, ‘sometimes’, ‘often’, and ‘very much’. Two additional items asked about participants’ degree of agreement with the following statements: 1) I know people that I socialize with virtually very well; 2) I know people in my friends list on social media platforms very well. And the choices ranged from ‘strongly disagree’, ‘somewhat disagree’, ‘somewhat agree’, and ‘strongly agree’.

4.2 Distribution of Survey and limitations faced during the Covid-19 pandemic

Once the questionnaire was finalized and was ready to be distributed, it should be emphasized that due to taking the social distancing precautionary measures recommended during the time of my data collection, the distribution of my survey was through Twitter – a social

media platform. I created a post that invited older adults to participate voluntarily in my survey. The post was only visible to people self-identifying as 55 years old or above across the United States. All the data were gathered during September 2021 through the University of Michigan's Qualtrics online questionnaire platform.

It should also be noted that although gathering participants virtually allowed me to connect with community-dwelling older adults across the United States, this method of data collection limited my participants to be among the older adults who were already users of this social platform. As a result, the sample of 115 respondents to my online survey questionnaire does not necessarily capture the heterogeneity and diversity of the aging population across the United States. In the further steps of conducting in-depth qualitative interviews to capture nuances of utilizing Social ICTs among lower-income older adults, additional participants will be recruited to enrich my data.

4.3 The statistical model implemented in the quantitative data analysis and the variables involved

The three main research questions that comprised this exploratory correlational research are the following: 1) Which spaces in the older adults' residences were more likely to be utilized for in-person social activities prior to the pandemic? And what are the potential environmental design barriers and facilitators of social engagement within older adults' residences? 2) Did older adults engage with video-calling – as a form of virtual communication – to socially connect with their network during the Covid-19 pandemic? What are the potential built environment features that may prevent or encourage virtual socializing? And 3) How does this sample of the older adult respondents score regarding their social connection measures? Are there any relationships between participants' virtual engagement behavior and their social connection measures?

Answering the first two questions is straightforward and can be done via basic descriptive statistics and graphic charts (detailed analysis is completed in the next chapter – Chapter 4). On the other hand, to answer the third question, a statistical model is needed to portray the relationship between the two variables while controlling for respondents’ demographic characteristics. Multiple linear regression in SPSS software was used to assess the relationships between the frequency of video-calling and the outcome of interest – self-reported loneliness – adjusted for demographic variables, including age, gender, and marital status as well as internet quality, and having an extended family in the same city or town as the current residences of respondents. The model illustrated in Figure 4.1 demonstrates the association.

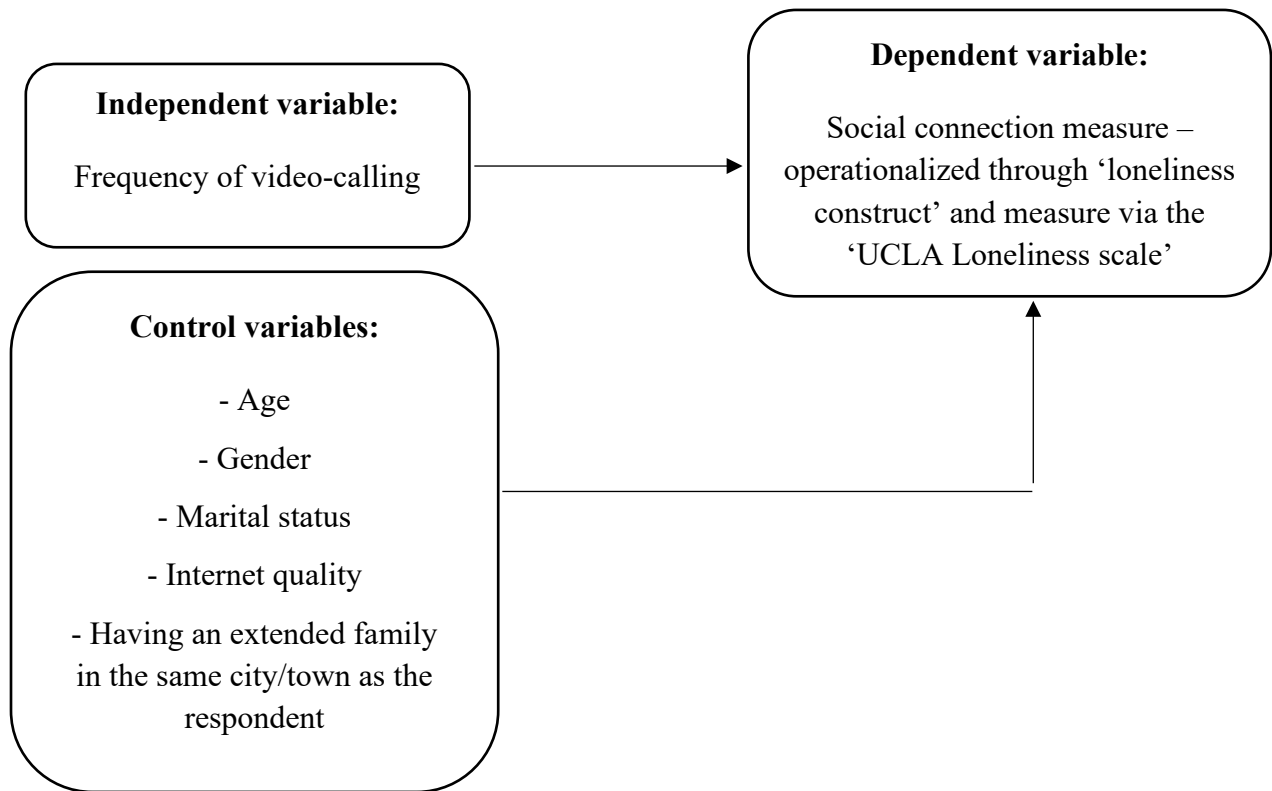


Figure 4.1: Model to explore the relationship between frequency of video-calling and the outcome of interest – self-reported loneliness – adjusted for demographic variables

Here is a summary of how each construct is operationalized in this research regarding research question three:

Independent variable:

- Frequency of video-calling (Rarely, Sometimes, Frequently)

Control variables:

- Age (50-59, 60-69, 70+)
- Gender (Female, Male, Non-binary)
- Marital status (Single, Married/living with a partner, Divorced/windowed)
- Internet quality (No or minimal access, intermittent access, reliable access)
- Having an extended family in the same city/town as the respondent (Yes, No)

Dependent variable:

- UCLA Loneliness scale

The results of the multiple linear regression conducted in SPSS software will be presented in Chapter 5 in more detail.

4.4 Participant Selection: Describing the process of selecting participants for in-depth qualitative interviews based on the results of conducting K-means Cluster Analysis and Multidimensional Scaling (MDS) on the survey data

As previously mentioned, the depth of information is mainly lost in correlational research designs. To supplement findings with a more in-depth understanding of findings discovered in my initial stage of distributing the survey questionnaire, I proceeded with generating a qualitative research strategy – frequently employed to achieve in-depth understanding. I planned to conduct in-depth interviews with selected participants once I gathered 115 responses to my survey questionnaire. The process for selecting participants for the in-depth qualitative interviews

comprise of conducting ‘k-means cluster analysis’ and ‘multidimensional Scaling (MDS) analysis’ on the survey data and will be discussed in the following sections.

4.5 K-means Cluster Analysis

Cluster analysis techniques are among the data reduction methods and are exploratory tools designed to group similar observations in a dataset together (Everitt et al., 2011). These groups can reveal any present patterns or characteristics of any underlying structure in data (Everitt et al., 2011).

The purpose behind utilizing cluster analysis methodology was to find groups of older adults who participated in my survey and shared similar social connection traits across 5 variables: The UCLA Loneliness Scale, Companionship Scale, Social Participation Scale, Sense of Community in Physical Space, and Sense of Community in Virtual Space. The cluster analysis technique allows me to choose participants from each cluster to conduct further in-depth qualitative interviews. Consequently, ‘K-means method of Cluster Analysis’ was chosen because it creates groups from data points by minimizing Euclidean distances between them (Everitt et al., 2011).

4.5.1 Standardizing values of different measures of social connectedness via Z-score

K-means cluster analysis utilizes the calculation of distance between data points, consequently, the variables (here, the scores for each measure of social connectedness) must be standardized so that they are all within the same range. Z-score standardization is utilized to avoid any one variable dominating others.

4.5.2 SPSS Software output and clusters

In conducting k-means cluster analysis, the researcher is required to specify a priori the number of clusters, k (Everitt et al., 2011). It is suggested that the decision about the number of clusters should be carefully considered and be driven by theory (Breakwell et al., 2006; Everitt et al., 2011). In the case of this research, I conducted k-means cluster analysis to create three, four, and five clusters. After a careful review of the results, it was decided that four separate clusters create meaningfully different groups of older adults with distinct traits regarding their social connection behavior for my next step, qualitative interviews with participants. The SPSS output for k-means cluster analysis and the figure representing the four final groups is outlined below (Tables 4.2 – 4.5, and Figure 4.2).

Figure 4.2 that illustrates the four distinct clusters of participants according to their social connectivity measures can be summarized as:

Cluster 1: Participants who scored high on the loneliness scale, low on social participation, low on companionship scale, and low on sense of community in physical and virtual space. In sum, participants who are lonely and not socially connected.

Cluster 2: Participants who scored low in the loneliness scale, low on social participation, low on companionship scale, and low on sense of community in physical and virtual space. In sum, participants who are not lonely and not socially connected.

Cluster 3: Participants who scored low in the loneliness scale, high on social participation, high on companionship scale, and high on sense of community in physical and virtual space. In sum, participants who are not lonely and socially connected.

Cluster 4: Participants who scored low in the loneliness scale, low on social participation, low on companionship scale, and high on sense of community in physical and virtual space. In

sum, participants who are minimally socially connected (they have a high virtual sense of community) and are not lonely.

Table 4.2: K-means cluster analysis with normalized Z-score - Initial cluster centers

	Initial Cluster Centers			
	Cluster			
	1	2	3	4
Sense of Community in Physical Space	-1.98022	-.86738	1.35828	1.13571
Sense of Community in Virtual Space	-.81781	-1.94836	1.66942	.99109
Companionship Scale	-1.37521	1.23286	2.10222	.07372
UCLA Loneliness Scale	2.37832	-1.01226	-1.01226	1.53068
Social Participation Scale	.04978	.04978	4.44286	-.86545

Table 4.3: Iteration History performed by SPSS software

Iteration	Iteration History ^a			
	Change in Cluster Centers			
	1	2	3	4
1	1.419	1.766	2.349	1.747
2	.505	.092	.719	.352
3	.119	.119	.282	.086
4	.062	.127	.180	.050
5	.077	.062	.067	.058
6	.087	.113	.142	.097
7	.076	.068	.085	.086
8	.000	.071	.000	.082
9	.000	.000	.000	.000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 9. The minimum distance between initial centers is 4.079.

Table 4.4: Final cluster centers

	Final Cluster Centers			
	Cluster			
	1	2	3	4
Sense of Community in Physical Space	-.54590	-.51870	.90387	.42350
Sense of Community in Virtual Space	-.35721	-.81781	.68961	.67453
Companionship Scale	-.83857	-.07118	1.41398	-.20448
UCLA Loneliness Scale	1.41557	-.49426	-.67085	-.23243
Social Participation Scale	-.58071	-.09056	1.11754	-.38221

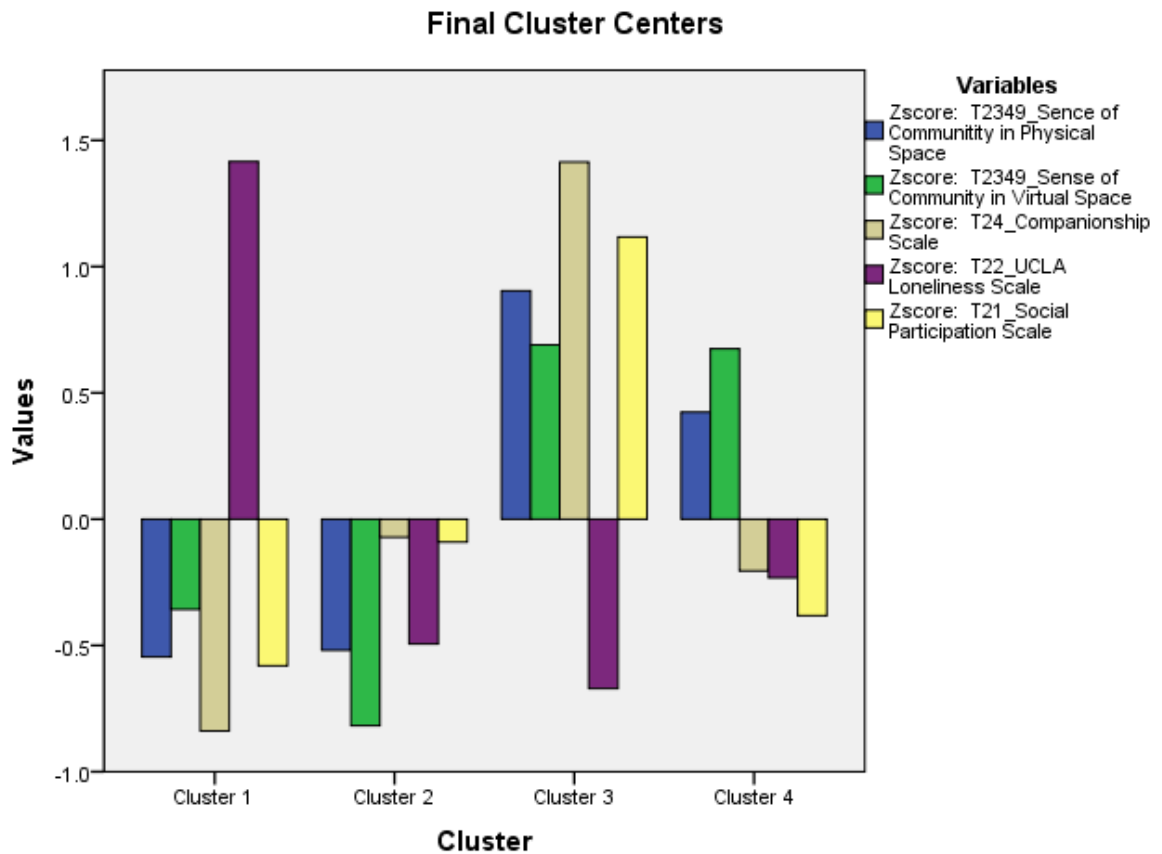


Figure 4.2: Final four clusters

Table 4.5: ANOVA output for cluster analysis

ANOVA						
	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Sense of Community in Physical Space	13.391	3	.607	102	22.076	.000
Sense of Community in Virtual Space	15.431	3	.580	102	26.624	.000
Companionship Scale	22.671	3	.378	102	59.929	.000
UCLA Loneliness Scale	24.521	3	.301	102	81.332	.000
Social Participation Scale	14.322	3	.579	102	24.728	.000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

4.6 Multidimensional Scaling (MDS) and examining the data structure

Multidimensional Scaling (MDS) is a multivariate data analysis approach and a technique for examining data structures (Breakwell et al., 2006). It is used to visualize data spatially while plotting data variables as points in n-dimensional space (Breakwell et al., 2006). The distance between the plotted variables represents the similarity among them (Breakwell et al., 2006).

“Two points (variables) in close proximity mean that these variables represent a similar pattern of responses; distant points (variables) on the plot represent a dissimilar pattern of responses or observations (Groat & Wang, 2013, p. 307). Conducting MDS is mentioned as ideal in exploratory research (Breakwell et al., 2006).

In this research, in order to visually illustrate the results of MDS and k-means cluster analysis on the five variables of social connectivity, R Software was utilized. As the number of clusters was decided as four based on the results of k-means cluster analysis, the visual representation of MDS and k-means cluster analysis (4 clusters) generated and mapped via R Software is plotted in Figure 4.3. Each participant is coded via a number in this research – ranging from 1 to 115 – and the participants' codes are shown in the clusters. The MDS analysis allowed for the illustration of participant codes that are closely related to one another.

The R code utilized for the production of Figure 4.3 is outlined in Appendix D. The code is based on Classical MDS algorithm (`cmdscale()`) which preserves the original distance metric between participant points (Wang, 2012). In addition, the R code for creating 4 color-coded groups using k-means clustering follows the Classical MDS code.

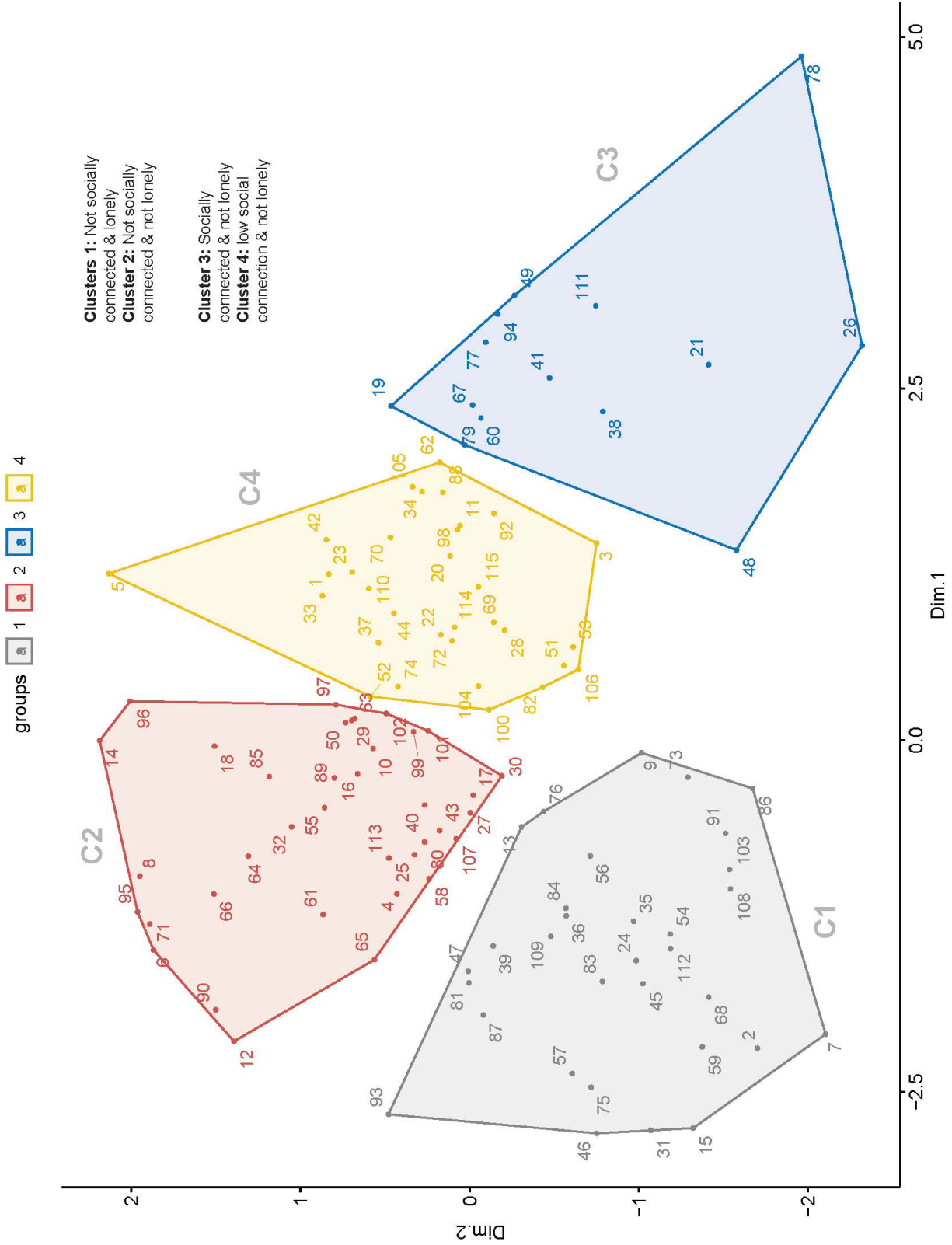


Figure 4.3: R software output to visually illustrate the results of MDS and k-means cluster analysis on the five variables of social connectivity.

4.7 Selection of participants for Qualitative Interviews

After finalizing the four distinct groups of older adults based on their distinct social connection traits, I examined their survey responses and contacted all participants that demonstrated their availability for a virtual follow-up interview after filling the survey. 8 participants demonstrated their willingness.

One participant dropped out due to the progression of her Primary lateral sclerosis (PLS) disease. Overall, I was able to conduct 7 virtual interviews via Zoom (Table 4.6). The name and email addresses of participants have been omitted to protect their privacy.

Table 4.6: Individuals who participated in in-depth qualitative interviews and their respective clusters.

Cluster	Interview number	Participant code	Location	Date completed
C1: Not socially connected and lonely				
	1	56	Baton Rouge – LA	02/18/2022
	2	47	Falls Church – VA	03/01/2022
C2: Not socially connected and not lonely				
	3	113	Saint Paul – MN	02/24/2022
	4	101	Seattle – WA	Canceled
C3: Socially connected and not lonely				
	5	21	Downingtown – PA	02/23/2022
	6	111	Raleigh – NC	02/16/2022
	7	60	Chicago – IL	03/10/2022
C4: Low social connection (high virtual sense of community) and not lonely				
	8	23	Saint Louise – MO	02/22/2022

4.8 Stage 2: Qualitative Research Design

As described by Groat and Wang (2013, p. 218), qualitative research strategy involves “an interpretive, naturalistic approach to its subject matter.” Qualitative research design is based on an inductive process (Groat & Wang, 2013), and one key component of this research design is

“an emphasis on natural settings.” This point requires me to engage community-dwelling older adults within the context of their home environments. Even though adhering to the physical distancing precautionary measures during the Covid-19 pandemic required me to remotely conduct parts of my qualitative research, I was still able to engage participants in their home settings and elicit photos of their residential environment whenever appropriate. In addition, in order to capture the nuances of access, availability, and utilization of technologies for social connection among low-income older adults, I was able to visit the site of affordable independent housing in the city of Detroit – The village of Woodbridge Manor. And it was possible to conduct (n=10) in-person interviews with residents of the Village of Woodbridge. Consequently, I was able to know the living conditions of my participants by understanding their everyday living environments and experiences.

Groat and Wang (2013) emphasize “a focus on interpretation and meaning” and “a focus on how the respondents make sense of their own circumstances” in a qualitative research design. The first point refers to the important role that researchers play in interpretation and making sense of the data, in addition to the gathered empirical realities of interviews and observations data (Groat & Wang, 2013). In conducting my semi-structured in-depth interviews with my participants, I was able to become part of the engagement and communication process to investigate and understand participants’ experiences. And as Groat and Wang (2013) discuss, the detailed coding processes of the interview texts are dependent on the researcher’s interpretative skills – making her a fundamental part of the research. The second point emphasizes the importance of portraying the phenomenon under study as explained and detailed by the participants (Groat & Wang, 2013). “The use of multiple tactics” and “significance of inductive logic” are other characteristics of qualitative research (Groat & Wang, 2013).

In conducting qualitative research in architectural and environmental research, Groat and Wang (2013) refer to three schools of thought: 1) ethnography; 2) phenomenological inquiry; and 3) grounded theory. I identify the qualitative approach employed in this research to be close to 'phenomenological inquiry' due to its emphasis on lived experiences of older adults while engaging with social technology and spaces that afford social connectivity. Experience as described by John Creswell and cited by Groat and Wang (2013, p. 227) is referred to as containing "both the outward appearance and inward consciousness based on memory, image, and meaning" and the goal of this inquiry as identified by Schwandt (1998) in Groat and Wang (2013, p. 228) is "seeking an understanding of the complex world of lived experience from the point of view of those who live it."

Regarding tactics for data collection in qualitative research, Groat and Wang (2013), identify four main categories of "Interviews and open-ended response formats", "observations", "artifacts and sites", and "archival documents." Interactive, virtual and face-to-face in-depth interviews with participants is the main tactic employed in this stage.

4.8.1 Development of data collection instrument

As discussed above, the primary goal to conducting qualitative research design in this phase of research is to elicit community-dwelling older adults' lived experiences with regard to using Social ICT and interpretations of their residential settings in their own terms. Centered around the constructs revealed through the review of the literature stage, conducting initial focus group discussion, and the survey questionnaire developed in the previous stage, I developed an interview protocol that unpacks the ongoing interplay between the spatial and virtual environments in everyday lives of older adults. The interview protocol was organized around the following sections: 1) introductory questions about the participant's social network and social

life before, and during the pandemic; 2) motivation to engage with Social ICTs for social connection; 3) investigation of the role of the built environment in facilitating remote social connection and the interaction of Social ICTs, built environment, and human health and ergonomics; 4) assessment of changes in experiences of in-person & virtual social connection; 5) general attitudes towards utilizing Social ICTs for connection and 6) final thoughts. The interview data collection instrument is included in Appendix E. The interview protocol was revised for clarity, content, and length. And it was administered and tested with two older adults for further revisions and clarity. Upon finalizing the semi-structured interview protocol, I proceeded to participant selection step outlined in the following section.

4.8.2 Participant selection for qualitative interviews

As explained in the Sections 4.4 to 4.7 of this chapter, the results of conducting MDS and k-means cluster analysis on the measures of social connectedness that I gathered through the questionnaires allowed me to reach out to eligible prospective participants via an initial introductory email. I was able to gain access to participants' email addresses from those willing to share via the survey questionnaire. In the introductory email, upon clarifying the voluntary nature of participation in the virtual interviews, I also attached the interview protocol as a reference for their review. I received (n=7) positive replies from participants who were willing to share their experiences in scheduled virtual interviews via Zoom. The participating older adults connected virtually via Zoom for our conversation from their homes, and interviews did not take more than one hour and a half. Interviews were scheduled during February and March 2022.

In addition to conducting virtual interviews with the community-dwelling seniors of varied socio-economic backgrounds from the pool of my survey participants, I intended to expand my understanding of access and use of social technology among an additional diverse

group of older adults. In capturing the nuances of access, availability, and utilization of technologies for social connection among low-income older adults, I conducted (n=10) interviews with residents of affordable independent housing in the city of Detroit – Village of Woodbridge Manor.

I had previously collaborated with the Woodbridge site on another research project and was able to establish rapport with the administration that kindly accommodated my stay for the first week of April 2022 on-site to conduct interviews with volunteers. I utilized the same interview protocol and conducted (n=10) interviews with volunteer residents.

4.8.3 Qualitative Data Analysis: Thematic Analysis

As Groat and Wang (2013) describe, capturing the holistic and multifaceted characteristics of a phenomenon under study as comprehensively as possible is among the primary intentions of qualitative research strategy. And to reach such depth of analysis, qualitative data gathered via interview transcripts needs to be examined to identify distinct categories and themes, reduced to primary codes (Groat & Wang, 2013). ‘Thematic analysis’ is used in this research for analysis of the qualitative data. Thematic analysis, as described by Braun and Clarke (2006), is a flexible research tactic used for portraying rich, complex, and detailed accounts of data by identifying, analyzing, and reporting patterns (themes) in data. A key ‘Theme’ captures an essential point in the data in relation to the research question and portrays some level of meaning or patterned response in the data set (Braun & Clarke, 2006, p. 82). It is also important that the researcher pays attention to the inductive vs. theoretical thematic analysis. The inductive or ‘bottom up’ approach is based on the assumption that the identified themes have strong links to the data themselves, and it is a process of coding without any attempt to fit in and conform to the researcher’s analytic preconceptions or a pre-existing coding scheme

(Braun & Clarke, 2006). Consequently, the inductive thematic analysis can be thought of as ‘data-driven’ (Braun & Clarke, 2006). In contrast, ‘theoretical thematic analysis’ tends to be more explicitly influenced by the researcher’s interest in a theoretical framework in the area (Braun & Clarke, 2006). Although, as described by Braun and Clarke (2006), in conducting an inductive thematic analysis, researchers cannot dismiss their theoretical and epistemological values and commitments, for the purpose of this research, my analysis follows the data-driven inductive approach to thematic analysis.

In addition, Braun and Clarke (2006) identify two approaches to thematic analysis and the ‘levels’ at which themes will be discerned: the ‘Semantic or explicit’ level and the ‘latent or interpretive’ level: A semantic approach or level of analysis focuses on the surface or explicit meanings of the data, and the latent approach is based on examining the underlying assumptions and ideas that shape the semantic content of the data (Braun & Clarke, 2006). The authors also draw attention to the importance of realizing the research epistemology that informs the researcher about theorizing meaning in the qualitative research and discuss that the thematic analysis can be conducted in either a realist/essentialist or constructionist paradigm (Braun & Clarke, 2006). In a realist/essentialist paradigm, due to the assumption that the link between the meaning and experience and language is mostly simple and unidirectional, theorizing the relationships between motivations, experience, and meaning is straightforward (Braun & Clarke, 2006). In contrast, in a constructionist paradigm, meaning and experience are socially produced (Braun & Clarke, 2006, p. 85). As a result, thematic analysis within a constructionist paradigm does not seek to focus on individual accounts; it rather seeks to theorize the structural and sociocultural contexts that are essential to enabling the individual account (Braun & Clarke, 2006).

In my research, to explore my research questions, a ‘semantic’ level of analysis is utilized in most instances; however, if appropriate, a ‘latent’ level of analysis is also used to explore in-depth, underlying layers to a research question. And regarding the paradigm in my research, depending on the research question, either the realist/essentialist or constructionist paradigm is utilized.

4.8.3.1 Steps involved in conducting thematic analysis

Regarding the steps, while conducting the thematic analysis, the process starts with transcribing the interviews and creating my initial raw data. Next, I followed the steps as outlined by Braun and Clarke (2006, p.87): “1) familiarizing yourself with your data; 2) generating initial codes across the entire data set; 3) searching for themes and gathering all data relevant to each potential theme; 4) reviewing themes; 5) defining and naming themes; and 6) producing the report.”

In order to store the interview transcripts, manage, and code the interview texts for the themes that are salient in the data, the NVivo software was used. Due to the flexibility of thematic analysis, I was able to answer my research questions while paying attention to the overarching epistemologies and paradigms that guided me during the analysis.

In the next chapters, the results and subsequent discussion of the processes involved in this two-phased research design will be discussed in detail.

Chapter 5 Quantitative Research Findings

In this chapter, I explain utilization of a correlational research strategy (Groat & Wang, 2013) to understand older adults' social engagement behavior during the Covid-19 pandemic, and spaces and social ICTs that afforded social connection in their residences. It should be emphasized that due to taking the social distancing precautionary measures recommended during the time of my data collection and as previously explained the chapter (4 – research methods chapter), distribution of my survey was through Twitter, a social media platform, across the United States. This method of data collection limited my participants to be among the older adults who were already users of this social platform. To conduct this exploratory correlational research, the following research questions were formulated and allowed for the crafting of my questionnaire document:

- 4) Which spaces in the older adults' residences were more likely to be utilized for in-person social activities prior to the pandemic? And what are the potential environmental design barriers and facilitators of social engagement within older adults' residences?
- 5) Did older adults engage with video-calling – as a form of virtual communication – to socially connect with their network during the Covid-19 pandemic? What are the potential built environment features that may prevent or encourage virtual socializing?
- 6) How do this sample of my older adult respondents rank regarding their social connection measures? Are there any relationships between participants' virtual engagement behavior and their social connection measures?

To answer these questions, descriptive statistical measures as well as multiple linear regression analysis are performed on my sample of 115 respondents. All the data were gathered during September 2021 through the University of Michigan's Qualtrics online questionnaire platform. Initially, an overview of the participants' demographic characteristics will be provided followed by a description of their residences and living arrangements. Next, research questions (2) and (3) will be answered by providing descriptive statistics followed by a multiple linear regression analysis to conclude research question (3). Finally, I will close this chapter by providing concluding thoughts and potential directions for future scholarship.

5.1 Respondents' demographic characteristics

Among the 115 respondents, ages of 50-59 represented 27%, 60-69 represented 48.7%, and above 70 represented 21.7%. Frequencies and percentages of the age groups of respondents is documented in Table 5.1. 69.6% were female (Table 5.2), and of the categories of race and ethnicity, 93% were White/Caucasian, and only 3.5% were people of other races and ethnicities (Table 5.3). 61.7% reported being married or living with a partner, 11.3% single, 16.5% divorced, and 6.1% widow/widower (Table 5.4). 60.9% reported having annual income of above \$70,000 (Table 5.5) and more than half (57.3%) reported having a Bachelor's or a Master's degree (Table 5.6). 53% of the respondents reported having extended family in the same city or town as the current residences of the respondents (Table 5.7). And more than half (73.9%) reported having access to a reliable quality for the internet connection at their homes (Table 5.8). More than half of the respondents (53.9%) self-reported very good/excellent physical health (Table 5.9) and 53.1% self-reported very good/excellent mental health status (Table 5.10). Geographic spread of the respondents across the United States is documented in Table 5.11.

Consequently, this sample of older adults does not represent the diversity of the aging population across the United States in terms of race/ethnicity and socio-economic status. And I want to acknowledge this limitation that is present throughout any further analysis with an impact on the chapter’s conclusion and recommendations. In the next chapter, I will include perspectives from interviewing the residents of a low-income independent housing community in Detroit to add diverse voices and thoughts to my research.

Table 5.1: Age groups of respondents.

		Frequency (n)	Percent (%)
	50-54	13	11.3
	55-59	18	15.7
	60-64	30	26.1
	65-69	26	22.6
	70-74	16	13.9
	75-79	7	6.1
	80+	2	1.7
	Total	112	97.4
Missing		3	2.6
Total		115	100.0

Table 5.2: Reported gender identity of respondents.

		Frequency (n)	Percent (%)
	Male	30	26.1
	Female	80	69.6
	Non-binary	1	.9
	Prefer not to say	1	.9
	Total	112	97.4
Missing		3	2.6
Total		115	100.0

Table 5.3: Reported race/ethnicity of respondents.

		Frequency (n)	Percent (%)
	African American/ Black	1	.9
	Hispanic / Latin(x)	2	1.7
	White/ Caucasian	107	93.0
	Others (Please specify):	1	.9
	Total	111	96.5
Missing		4	3.5
Total		115	100.0

Table 5.4: Marital status of respondents.

		Frequency (n)	Percent (%)
	Single	13	11.3
	Married	65	56.5
	Divorced	19	16.5
	Widow/Widower	7	6.1
	With partner	6	5.2
	Others (please specify):	1	.9
	Total	111	96.5
Missing		4	3.5
Total		115	100.0

Table 5.5: Annual income of respondents.

		Frequency (n)	Percent (%)
	Below 30,000	8	7.0
	30,000 to 70,000	27	23.5
	70,001 to 120,000	31	27.0
	120,001 to 185,000	19	16.5
	More than 185,000	20	17.4
	Total	105	91.3
Missing		10	8.7
Total		115	100.0

Table 5.6: Education levels of respondents.

		Frequency (n)	Percent (%)
	High School or equivalent (for example: GED)	3	2.6
	Some college, but no degree	11	9.6
	Associate degree (for example: AA, AS)	8	7.0
	Bachelor's degree (for example: BA, BS)	31	27.0
	Master's degree (for example: MA, MS, MEng, MEd, MBA)	36	31.3
	Professional degree (for example: MD, DDS, DVM, LLN, JD)	7	6.1
	Doctorate degree (for example: PhD, EdD)	13	11.3
	Others (please specify)	1	.9
	Total	110	95.7
Missing		5	4.3
Total		115	100.0

Table 5.7: Having extended family living in the same city or town as the current residences of the respondents.

		Frequency (n)	Percent (%)
	Yes	61	53.0
	No	51	44.3
	Total	112	97.4
Missing		3	2.6
Total		115	100.0

Table 5.8: Reported ratings of the quality of respondents' internet access at their homes (10 representing excellent quality).

		Frequency (n)	Percent (%)
	1.00	2	1.7
	3.00	2	1.7
	4.00	1	.9
	5.00	1	.9
	6.00	2	1.7
	7.00	13	11.3
	8.00	30	26.1
	9.00	23	20.0
	10.00	32	27.8
	Total	106	92.2
Missing		9	7.8
Total		115	100.0

Table 5.9: Respondents self-reported physical health.

		Frequency (n)	Percent (%)
	Poor	2	1.7
	Fair	20	17.4
	Good	25	21.7
	Very good	36	31.3
	Excellent	26	22.6
	Total	109	94.8
Missing		6	5.2
Total		115	100.0

Table 5.10: Respondents self-reported mental health.

		Frequency (n)	Percent (%)
	Poor	7	6.1
	Fair	5	4.3
	Good	30	26.1
	Very good	40	34.8
	Excellent	21	18.3
	Total	103	89.6
Missing		12	10.4
Total		115	100.0

Table 5.11: Geographic spread of the respondents (US States).

	Frequency (n)	Percent (%)
Missing	8	7.0
AK	1	.9
AZ	1	.9
CA	12	10.4
CT	1	.9
FL	10	8.7
IA	2	1.7
ID	1	.9
IL	7	6.1
IN	5	4.3
KS	2	1.7
LA	2	1.7
MA	2	1.7
MD	5	4.3
MI	6	5.2
MN	7	6.1
MO	1	.9
MS	1	.9
NC	5	4.3
NM	1	.9
NY	3	2.6
OH	6	5.2
OK	3	2.6
OR	4	3.5
PA	2	1.7
SC	2	1.7
TX	4	3.5
VA	3	2.6
WA	6	5.2
WI	1	.9
WV	1	.9
Total	115	100.0

5.2 Description of respondents' residences and their living arrangements

With regard to the respondents housing types, more than half (54.7%) reported living in a free-standing single-family home with a yard/garden, and only 20% reported living in an apartment building or condominium with/without a balcony (Figure 5.1). Other housing types that participants reported included: single family home with rural acreage, modular home in park garden, mobile home with garden, and apartment building with garden.

41.44% of respondents reported living in their current residential setting for more than 10 years and 21.62% reported living in their current homes for less than 5 years (Table 5.12). In addition, regarding living arrangements, 43.48% reported living only with a spouse or significant other, 26.96% reported living with family including children or grandchildren, and 26.96% reported living alone (Figure 5.2).

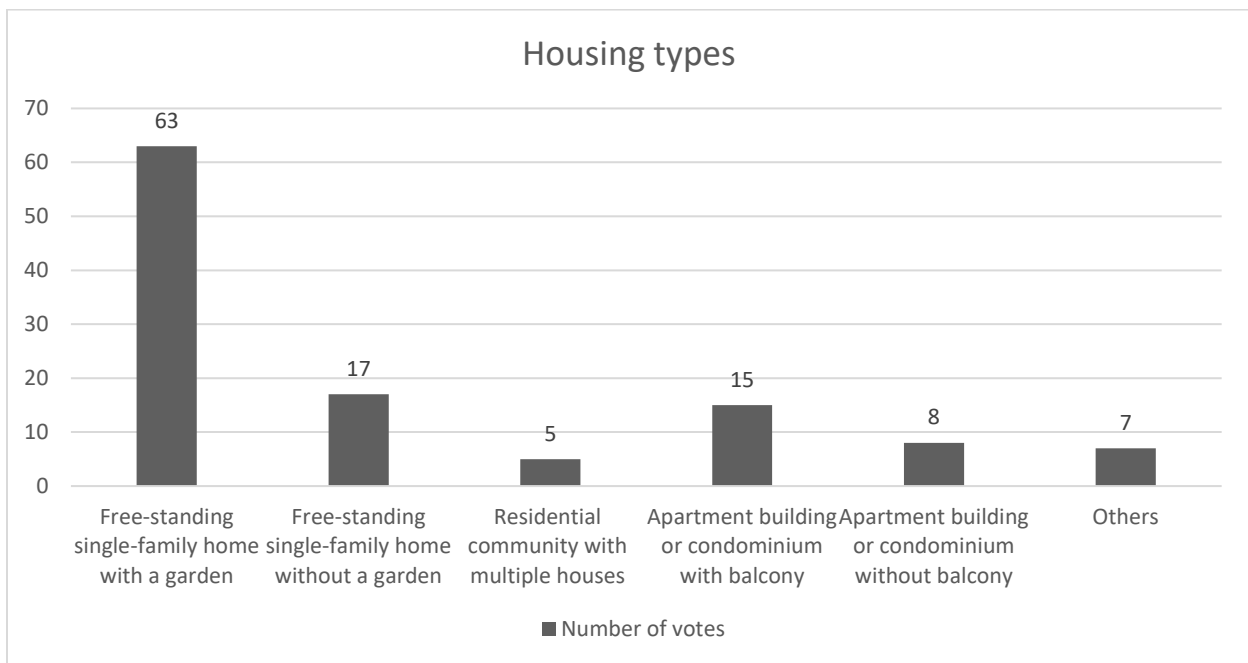


Figure 5.1: Participants' responses for the housing type that they live in.

Table 5.12: Participants' duration of living at their current home.

		Frequency (n)	Percent (%)
	0-4	24	20.9
	5-9	24	20.9
	10-14	17	14.8
	15-19	14	12.2
	More than 20	32	27.8
	Total	111	96.5
Missing		4	3.5
Total		115	100.0

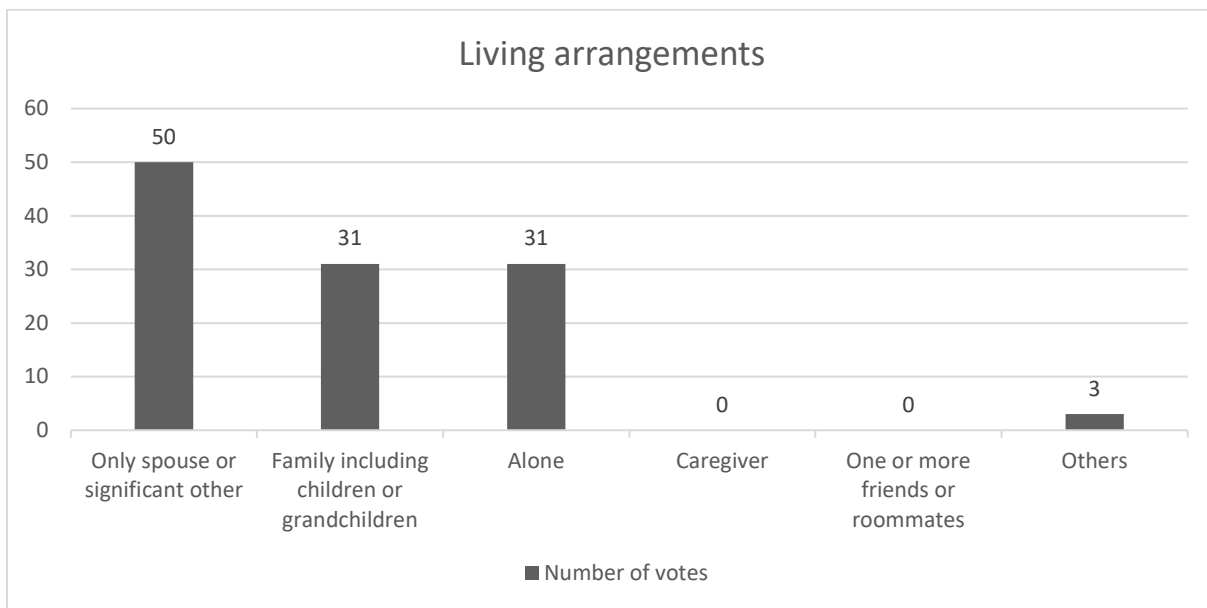


Figure 5.2: Participants' current living arrangement.

5.3 Descriptive Statistics regarding residential spaces for in-person socializing prior to the pandemic, and the potential environmental design barriers and facilitators of social engagement within older adults' residences

Kitchen (56.25%), living room (49.57%), dining area (46.01%) were identified as the most frequently utilized spaces for in-person socializing by the participants prior to the pandemic (Figure 5.3). Attention to inclusive design, accessible features, natural ventilation of these spaces, and provision of access to outdoors are among the environmental design strategies to allow for safe social interactions during a respiratory pandemic.

Adopting a human rights lens while designing residential spaces for our aging population is key to creating a higher quality of life for them. The Covid-19 pandemic exacerbated the global epidemic of loneliness and social isolation among the older generations that had already been declared in 2017 (D'Cruz & Banerjee, 2020). While physical distancing measures and isolation in their residences hindered older adults' social engagements and social participation in their communities, inclusive, accessible, and healthy design of home environments becomes more important than ever.

Yards or gardens (59.47%) and porches (42.86%) are among the exterior spaces that were reported as most frequently utilized for in-person socializing prior to the pandemic (Figure 5.4).

It should be highlighted that access to outdoor open space is a valuable resource for older adults' social wellbeing, particularly during the highly contagious Covid-19 respiratory pandemic, and we learned that access to this resource is not equitable among the older generations. For example, nursing homes located in dense urban environments, such as New York City, were among the hardest hit during early stages of the pandemic (Powell et al., 2020). Design of the built environment that incorporates outdoor spaces and natural ventilation into

consideration, particularly in the context of residences located in dense urban spaces, is critical for quality of life and health of older adults. In addition, it should be highlighted that according to the research investigating the relationship between urban density and the spread of highly contagious Covid-19, Hamidi et al., (2020) described that pandemics are deadlier in low-density areas, due to limited access to quality healthcare and limited transportation and connectivity. As a result, planning and advocating for compact spaces is still critical, and designers and planners need to take into account equitable access to green common spaces and outdoors for residents' social as well as physical wellbeing.

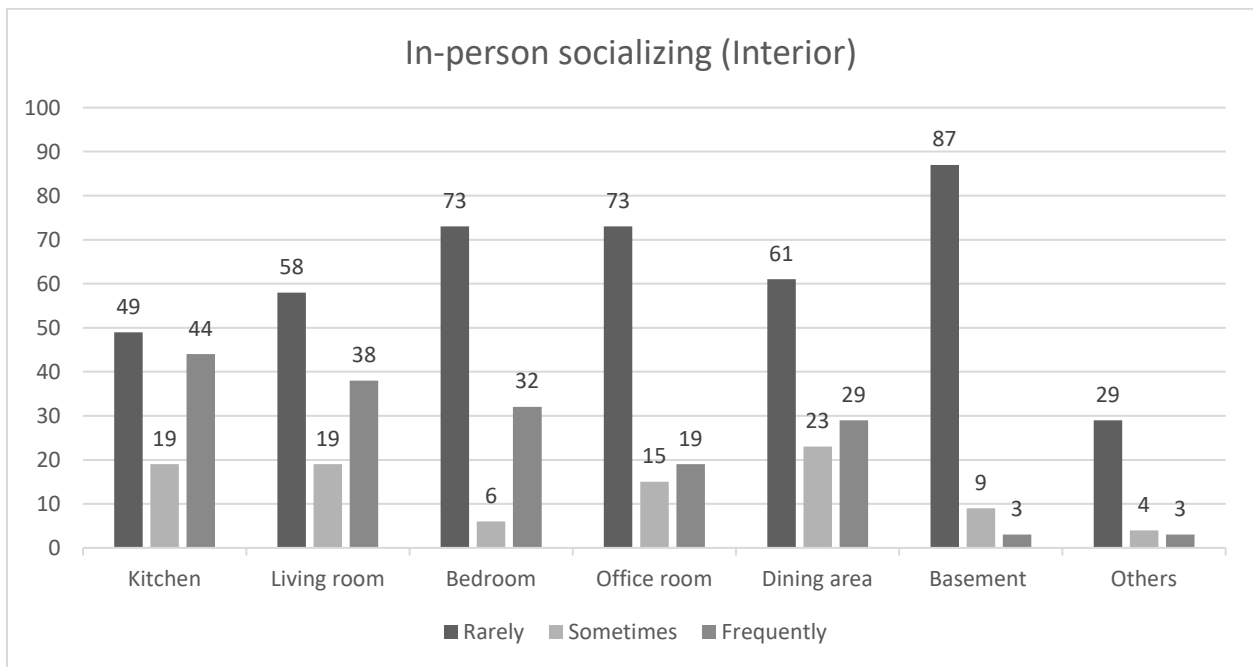


Figure 5.3: Interior residential spaces that participants reported to use for engagement in in-person social activities before the Covid-19 pandemic.

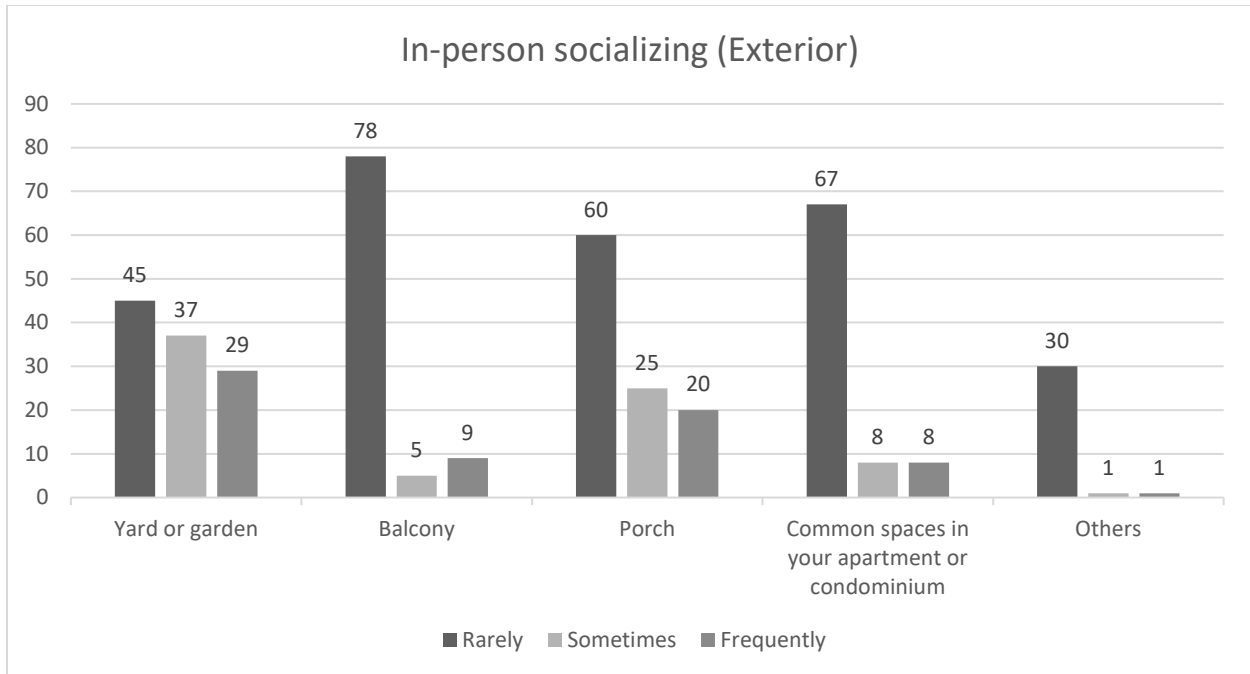


Figure 5.4: Exterior residential spaces that participants reported to use for engagement in in-person social activities before the Covid-19 pandemic.

The following two points were identified as spatial features within one’s residence that may prevent them to engage in in-person social activities (Figure 5.5):

- More than one third of participants identified lack of inclusive and accessible design of the home as their first choice: My home can’t be visited by people who have trouble with steps or who use wheelchairs or walkers (36.28%)
- Home’s spatial layout: Layout of the unit (lack of adequate space inside home, such as: small kitchen, small living room, small guest bedroom, etc.) (27.19%)

Attention to inclusive design and accessibility are discussed in literature while planning for an aging population (Carr et al., 2013). Features such as step-free access to the home, barrier free spaces, and ground-level access to bedrooms and bathrooms have been extensively discussed in the literature for ensuring equitable accessibility for people across the life span

(Wellecke et al., 2022). This research shows that inclusive and accessible design features are also critical for social health of older generations as they age in place.

In addition, more than half of the participants identified: access to daylight, as well as adequate space for a group activity (67.54%) as the top built environment features that may encourage their in-person socialization (Figure 5.6). Views to nature (61.40%) and having a porch or balcony (58.93%) were ranked third and fourth.

Social interaction is an important component of psychosocial health for older adults and literature supports that access to common outdoor green spaces is associated with creation of stronger social networks among older adult residents of inner-city communities (Kweon et al., 1998; Traynor et al., 2013). In line with the findings from literature, this research also supports that access to daylight and nature, views of nature, and access to spaces that afford group activities are among spatial features that can encourage older adults' participation in social activities.

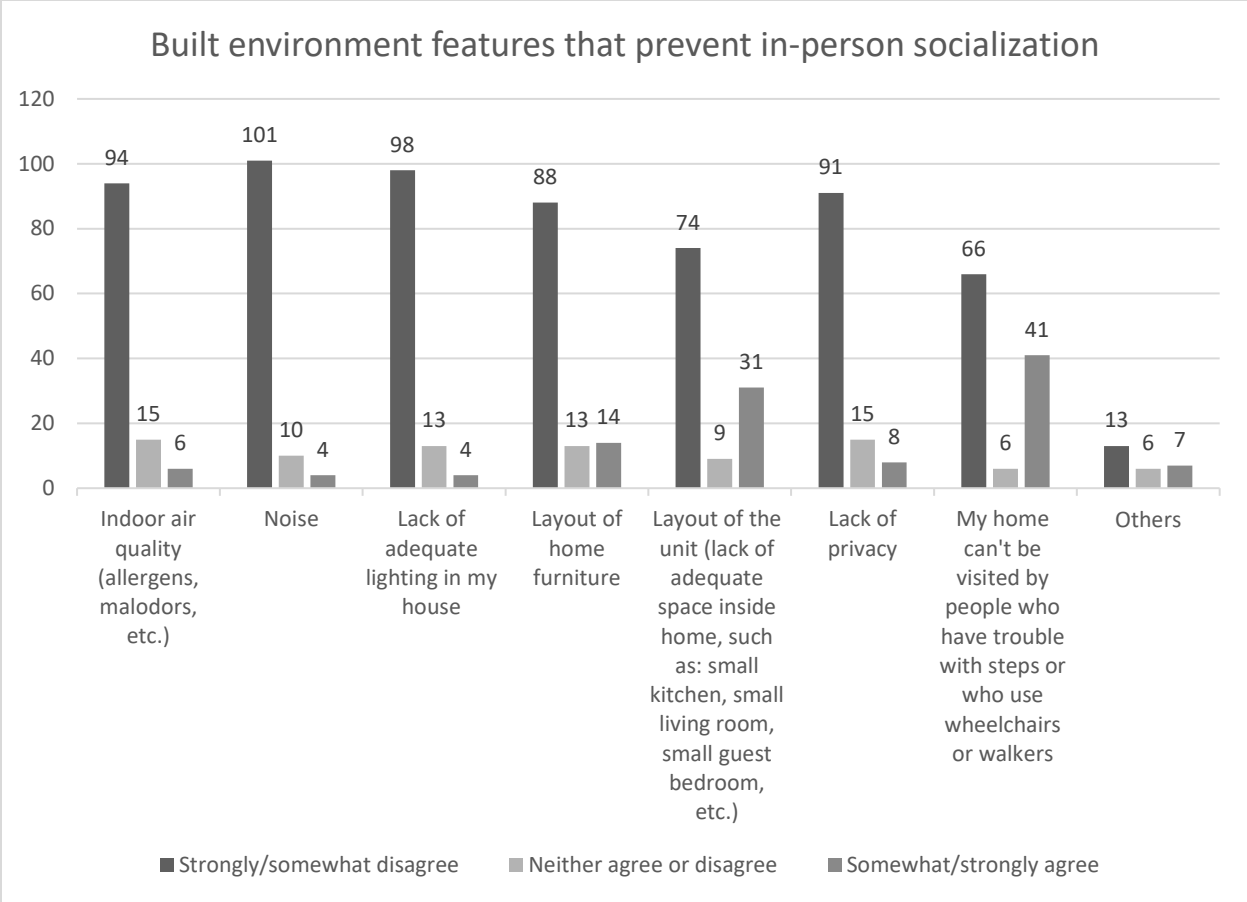


Figure 5.5: Built environment features that can potentially prevent in-person socialization.

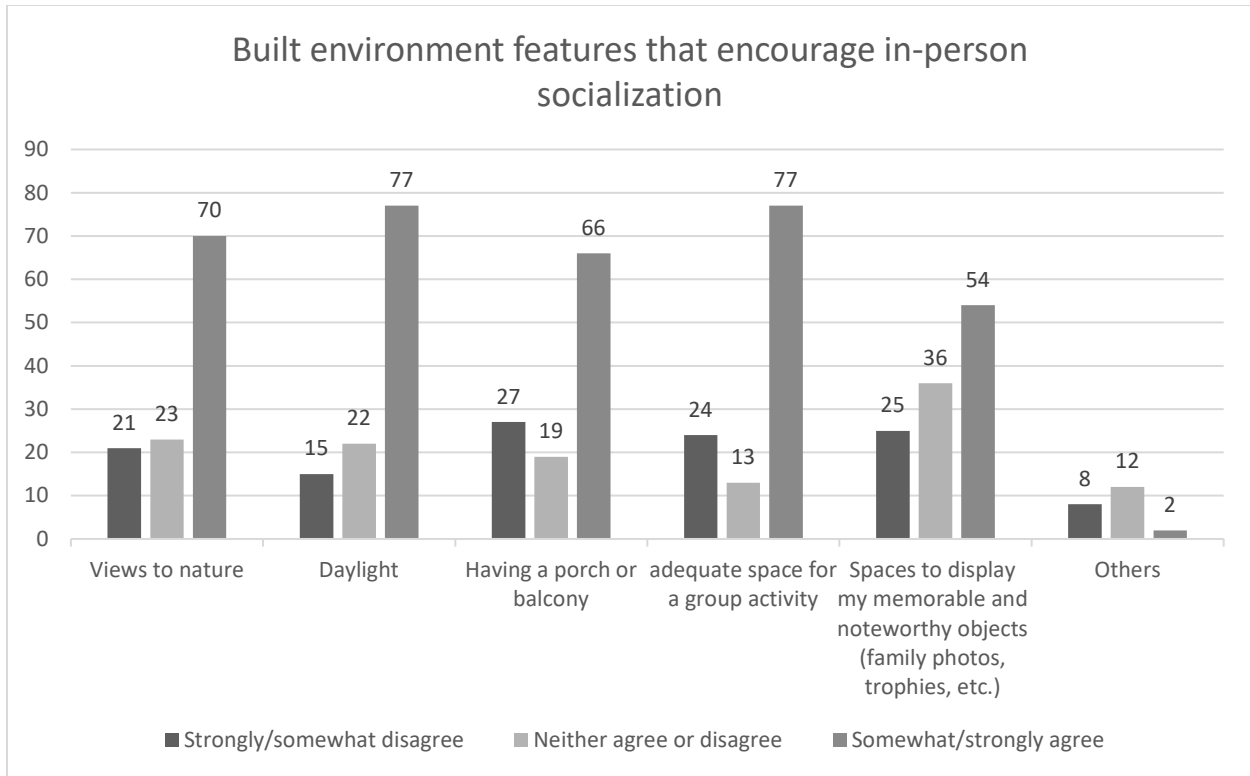


Figure 5.6: Built environment features that can potentially facilitate in-person socialization.

5.4 Descriptive Statistics regarding older adults’ engagement with video-calling – as a form of virtual communication – to socially connect with their network during the Covid-19 pandemic, and the potential built environment features that may prevent or encourage virtual socializing

In my inquiry about whether the participants engaged in video-calling for virtual social activities during the pandemic, 80.87% responded positively (Figure 5.7). More than half reported using video-calling at least once a week (53.92%) (Figure 5.8). And 88.52% reported some benefits in virtual engagement for socialization including maintaining close relationships with family and friends (Figure 5.9).

While the physical distancing measures taken during the Covid-19 pandemic was a necessary contingency plan, research points to the harmful impacts of isolation and extreme loneliness among residents of long-term care facilities (Eghtesadi, 2020). Access to Social Information and Communication Technologies (Social ICTs) has been proposed and advocated for at the policy-making decisions and resource allocation levels due to its benefits for psychosocial wellbeing and quality of life of the older adults (Eghtesadi, 2020). The results of my survey also point to the benefits of access to Social ICTs for older adults as a resource for battling isolation and loneliness. And I want to emphasize that access to this resource is not equitable among the older adults, and echo the recommendations made by Eghtesadi, (2020) to advocate for governments’ incentivizing and subsidizing access to social ICTs, especially among the marginalized populations and the times of public health crises.

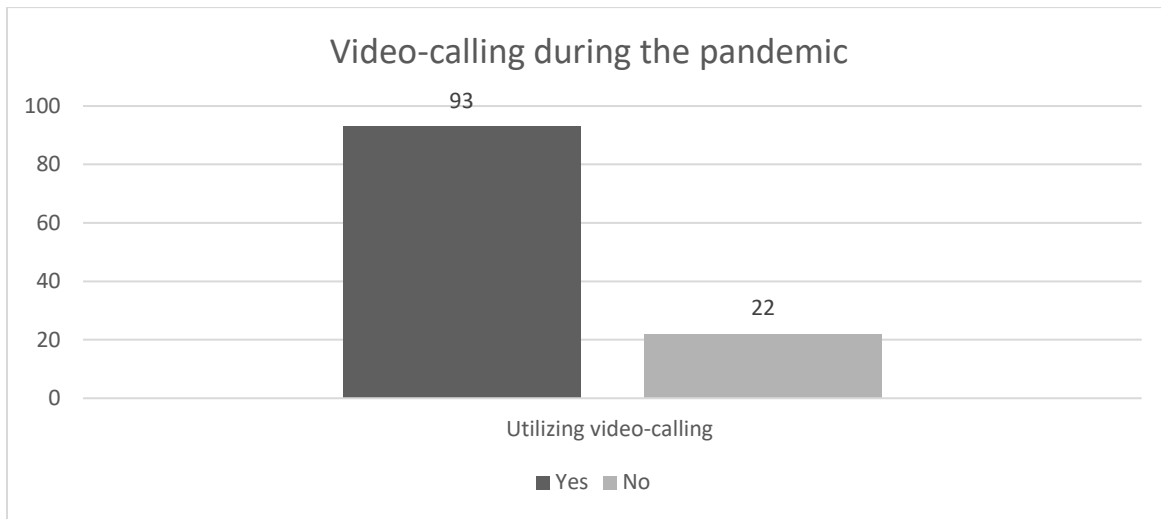


Figure 5.7: Utilizing vide-calling via various Apps for virtual social connection during the pandemic.

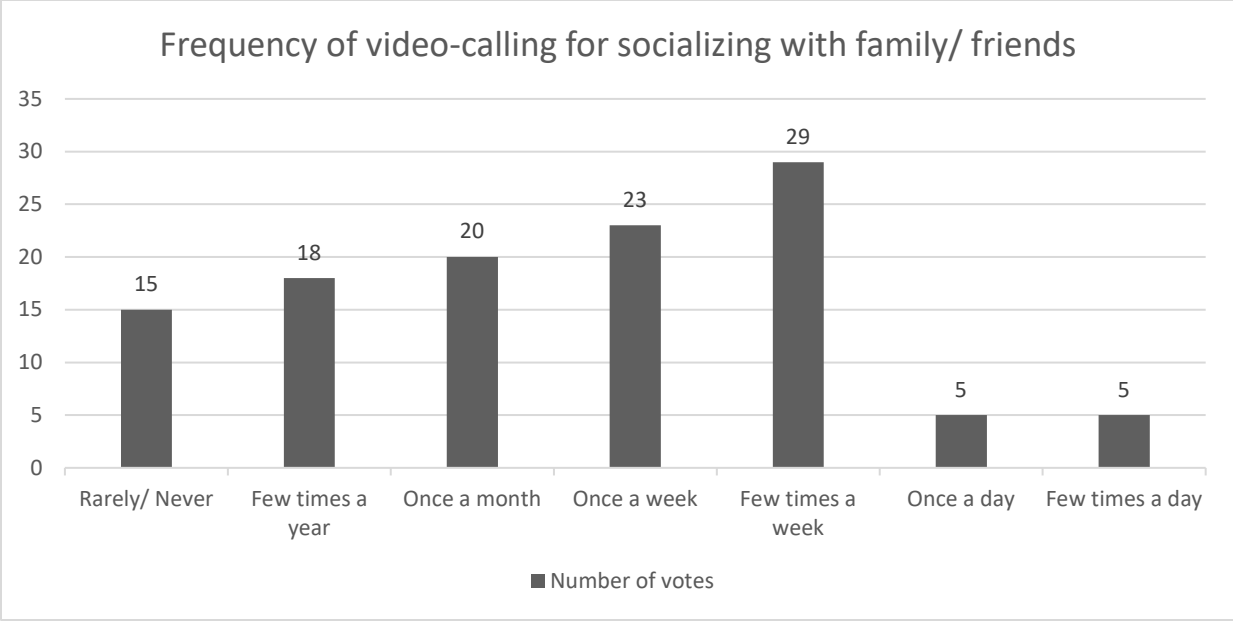


Figure 5.8: Frequency of vide-calling for socializing with family or friends during the pandemic.

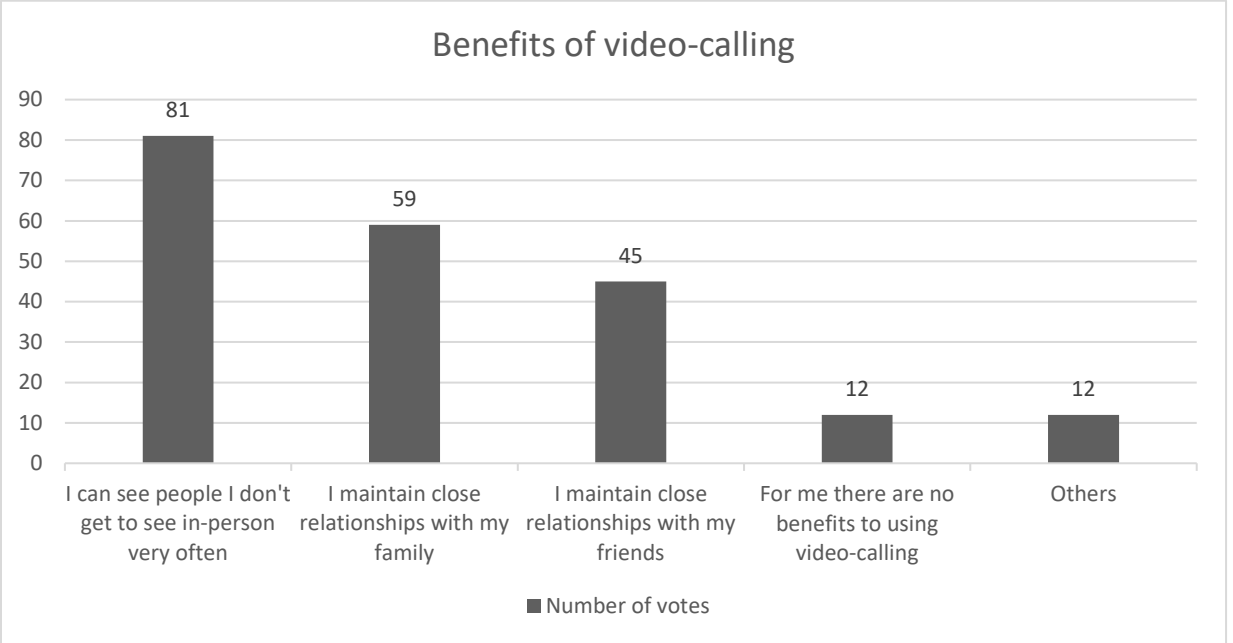


Figure 5.9: Potential benefits of vide-calling.

Living room (35.79%), office room (29.12%), and dining area & kitchen (21.48%) were identified as the most frequently utilized spaces that the participants occupied while video-

calling with their loved ones (Figure 5.10). This finding can allow designers to strategically design features in these spaces that would facilitate virtual engagement for older persons.

The majority of the participants indicated that they did not use the outdoor spaces of their homes for virtual engagement (Figure 5.11). Only 12.15% identified using their yard or garden while video-calling. The barriers to immersion in green outdoor spaces or locating near a window while engaging in virtual social activities need to be explored in future research. It is also possible that the respondents have easy access to parks and communal green outdoor environments for safe and in-person social activities with their social network; and this access may have eliminated the need for utilization of outdoor spaces while video-calling.

The benefits of in-person immersion in green spaces for psychological and physical well-being of older adults is well documented (Pleson et al., 2014; Hooper et al., 2020). Markevych et al. (2017), illustrated three biopsychosocial pathways that exposure to nature impacts our health: 1) reducing harm by buffering exposure to heat, noise, and air pollution, 2) capacity for attention restoration and recovery from stress, 3) enhancing physical and social capacities by encouraging social cohesion and physical activity. While engagement with Social ICT devices can result in attention and psychological fatigue, the positive impacts of proximity to outdoor green spaces for older adults while engaging in virtual social activities requires further explorations.

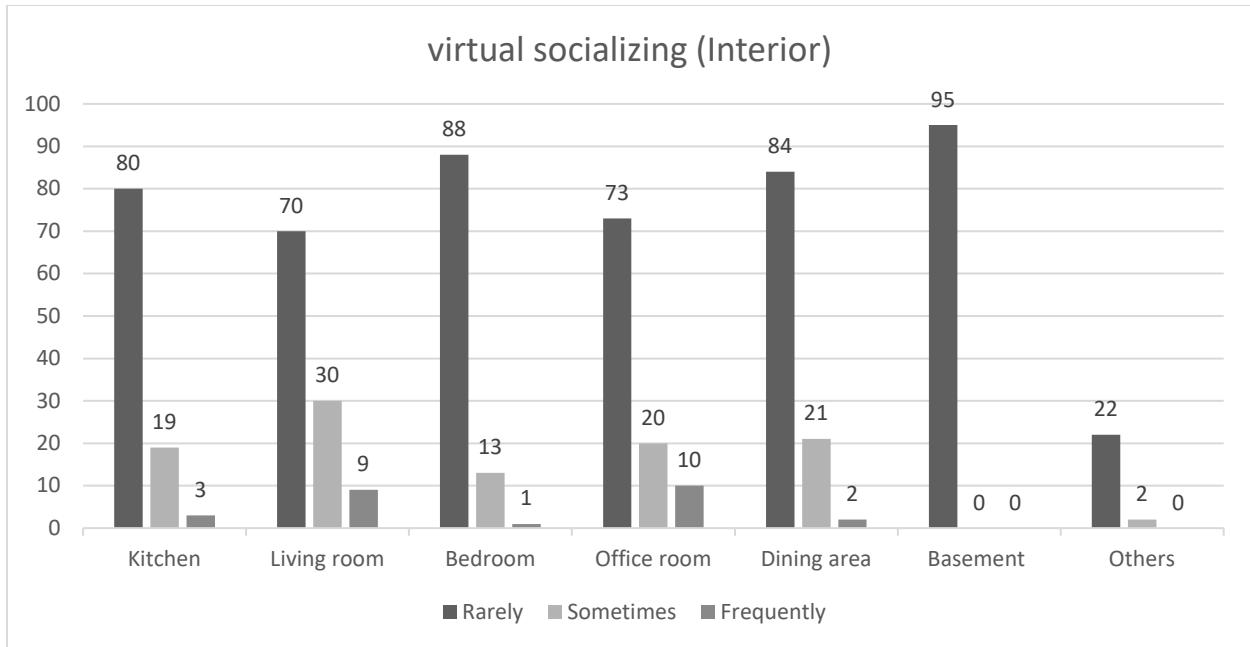


Figure 5.10: Interior residential spaces that participants reported to use for engagement in virtual social activities during the Covid-19 pandemic.

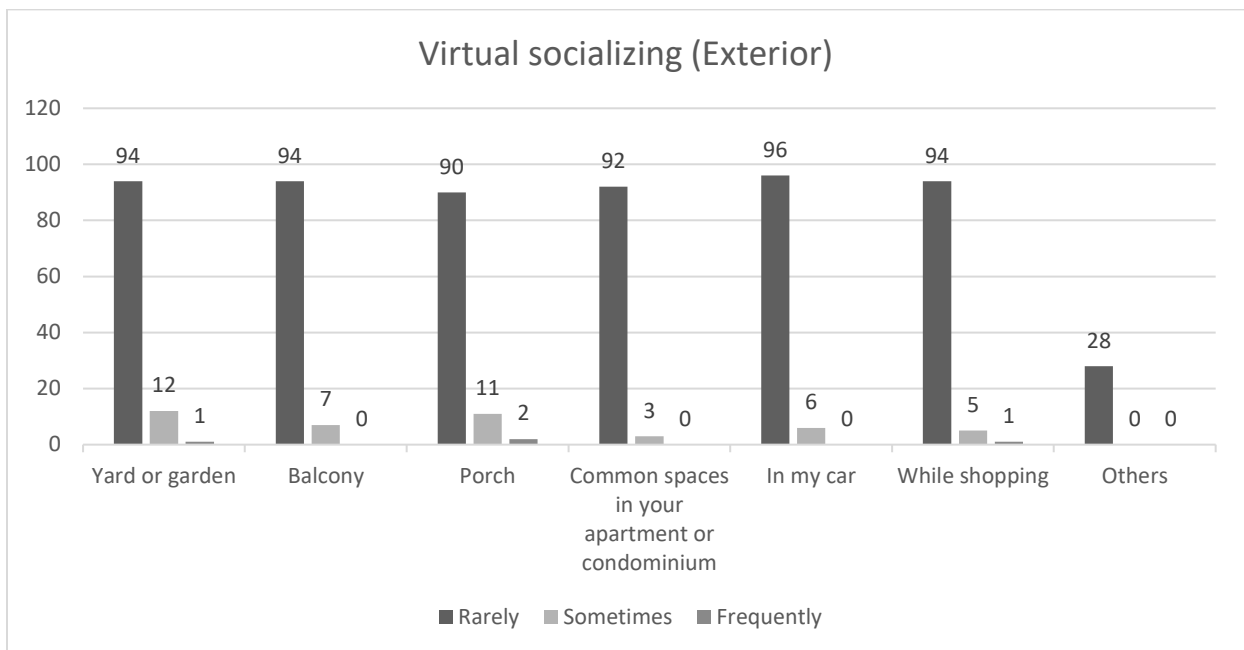


Figure 5.11: Exterior residential spaces that participants reported to use for engagement in virtual social activities during the Covid-19 pandemic.

Participants generally did not indicate built environment features as barriers to their engagement with virtual modes of communication. Although poor lighting and glare were among the top chosen features (15.04%), it appears that other underlying conditions may play critical roles in preventing one from virtual socialization (Figure 5.12). I will explore this topic in greater depth in the next chapter which outlines the results of my qualitative interviews.

In my inquiry about features of the built environment that may encourage the participants to engage in virtual socializations about half of the participants (49.55%) identified ‘ability to engage in creative virtual activities and/or games with others (creating music, cooking food, or any other DIY activities’, as their top choice (Figure 5.13). ‘Ability to share live views of my window or flowers in my garden’ were the second most chosen option (48.21%). In addition, between 33% to 50% of respondents rated somewhat/strongly agree with the built environment features that I included as potentially encouraging for engagement in virtual activities. This demonstrates a need for recognition of 1) the importance of experiential sharing and creative activities while engaging with Social ICTs and the supporting role of the built environment; and 2) the importance of recognizing ‘integration’ of technological features with the built environment features for an enhanced experience. However, the other half of the respondents chose ‘strongly/somewhat disagree’ and that may be attributed to access and utilization of only hand-held portable devices and limited engagement with such devices.

A systematic literature review on the influence of technological games that include exercise and physical activity demonstrates positive mental wellbeing impacts such as improved mood, depression, self-esteem, and reduced stress and apathy (Fernandes et al., 2022). Consequently, the environmental design features that can facilitate older adults’ participation in

creative virtual social activities and virtual games needs to be highlighted while designing spaces for seniors.

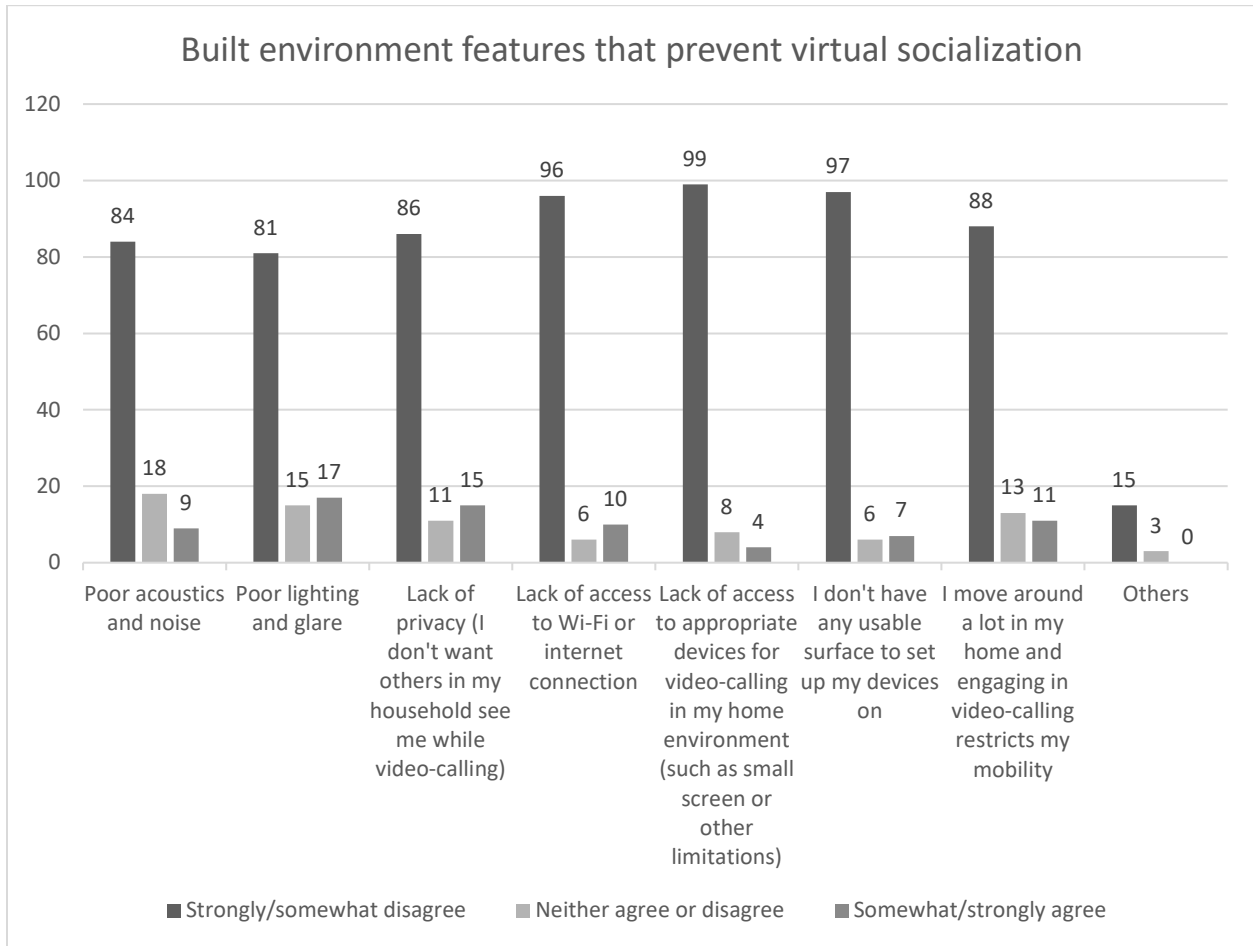


Figure 5.12: Built environment features that can potentially prevent virtual socialization.

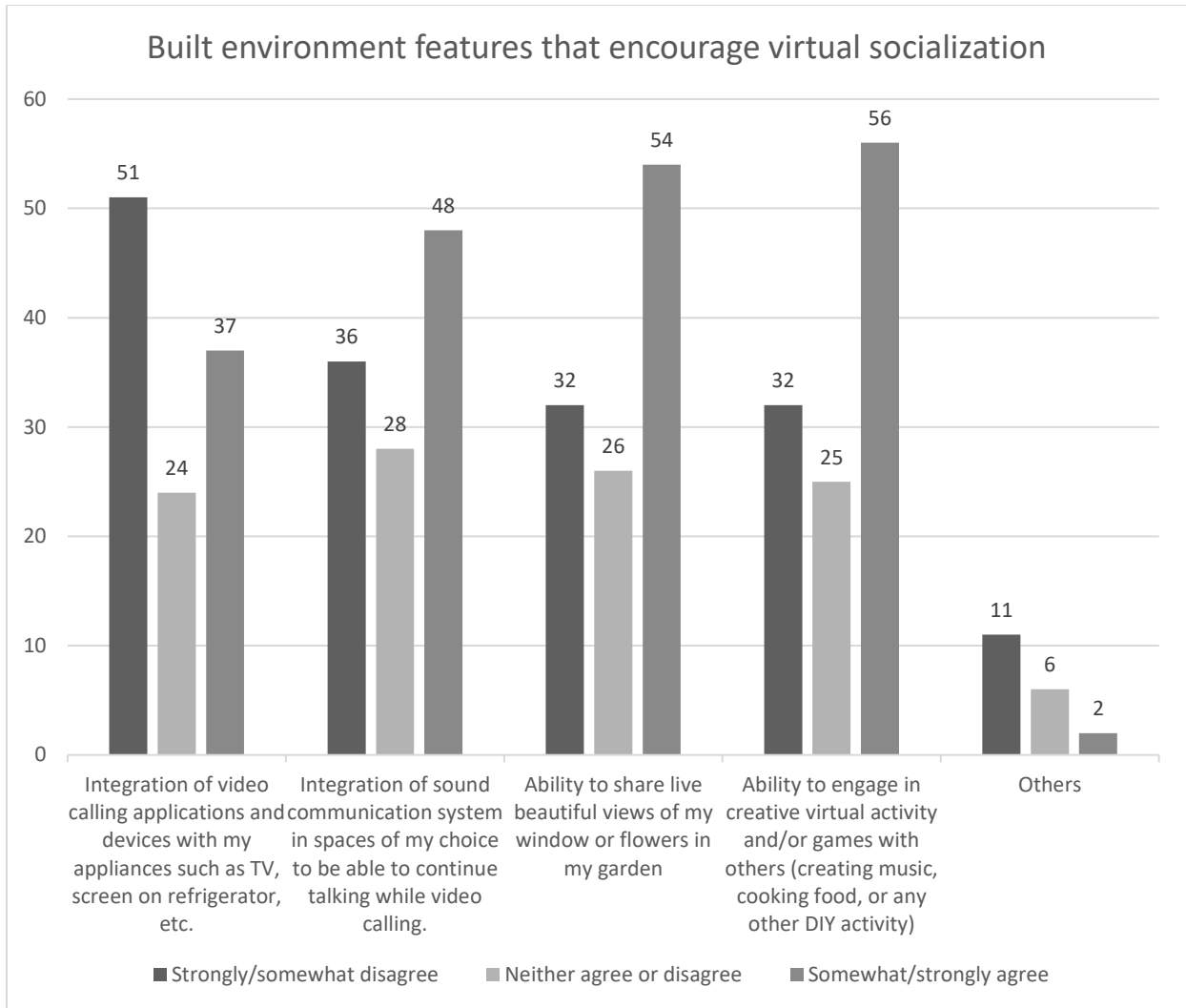


Figure 5.13: Built environment features that can potentially facilitate virtual socialization.

5.5 Analysis of Social Connection Measures

The measures for social connectedness that I used in this study are: loneliness scale (3 Qs: UCLA Loneliness Scale) adopted from Hughes, et al., (2004), the Companionship Scale (3 Qs: Companionship Scale) adopted from Hahn et al., (2014), Social Participation Scale (6 Qs: Social Participation Scale) adopted from Cornwell et al., (2008) and Cornwell and Waite, (2009), Sense of Community in Physical Space (7 Qs: Sense of Community in Physical Space) adopted

from Iciaszczyk (2016), and Sense of Community in Virtual Space (6 Qs: Sense of Community in Virtual Space). The participants' responses correspond to the time the survey was administered in September 2021.

5.5.1 UCLA Loneliness Scale

The median score for the participants is 6 (Figure 5.14, left). The scale ranges from the minimum of 3 (demonstrating not feeling lonely at all) to a maximum of 15 (demonstrating feelings of extreme loneliness). The Box Plot is right skewed, illustrating that the majority of my respondents have scored low on the loneliness scale and only a few are on the extreme loneliness spectrum (Figure 5.14, left). In addition, the box plot on the right in Figure 5.14, demonstrates lower median (4) compared to the box plot on the right (6) – demonstrating that the level of loneliness rose slightly during the pandemic. However, it should be noted that collecting the data at a point prior to the pandemic and then comparing it to the data gathered during the pandemic, would result in a more reliable comparison – a form of pre and post research design could be employed. Access to self-reported data that relies only on the participants' memories can result in unreliability in data.

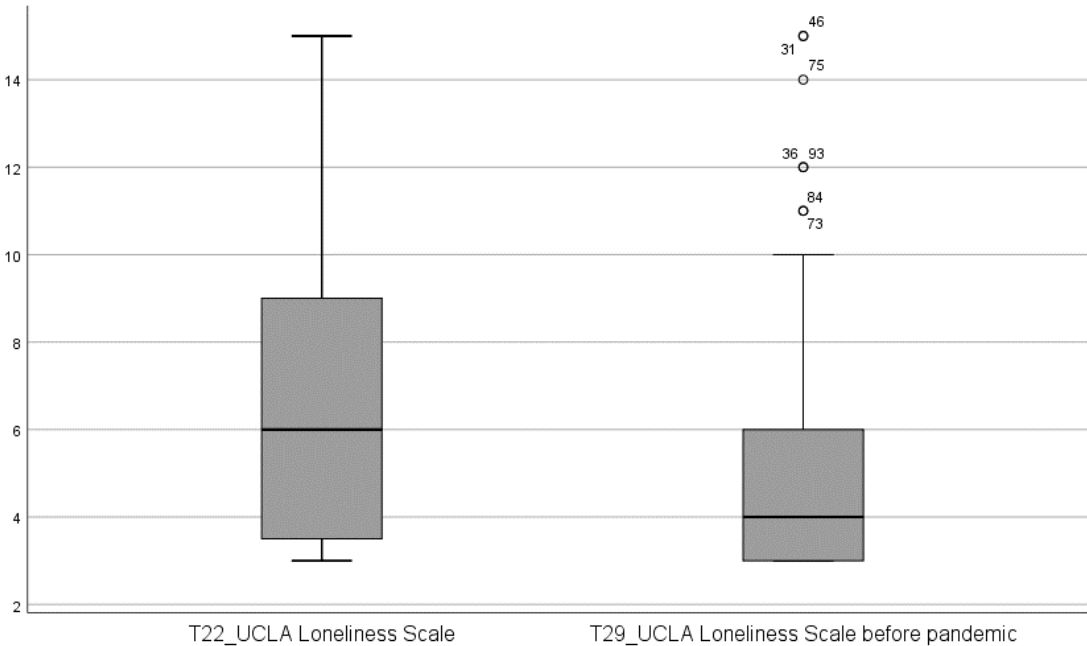


Figure 5.14: Box plots illustrating the results of the administered UCLA Loneliness Scale both reported at the times of data collection (left) and self-reported prior to the pandemic (right).

5.5.2 *Companionship Scale*

The median score for the participants is 6 (Figure 5.15, left). The scale ranges from the minimum of 3 (demonstrating no companionship) to a maximum of 15. The Box Plot is right skewed, illustrating that the majority of my respondents have scored low on the companionship scale and only a few are on the extreme spectrum of scoring high on the scale (Figure 5.15, left). This finding from this sample of older adults is in-line with findings on the national level as reported by the University of Michigan’s September 2020 National Poll on Healthy Aging. The national report notes that two in five adults aged 50-80 (41%) reported feeling a lack of companionship during the early months of the pandemic (Piette et al., 2020).

In addition, the box plot on the right in Figure 5.15 (showing self-reported companionship data prior to the pandemic), demonstrates higher median (11) compared to the

box plot on the right (6) – demonstrating that availability of companions drastically dropped during the pandemic as reported by the older adults who participated in my survey. The cautionary note about reliance over participants’ memories that I discussed while interpreting the outcomes of the UCLA loneliness scale applies here as well.

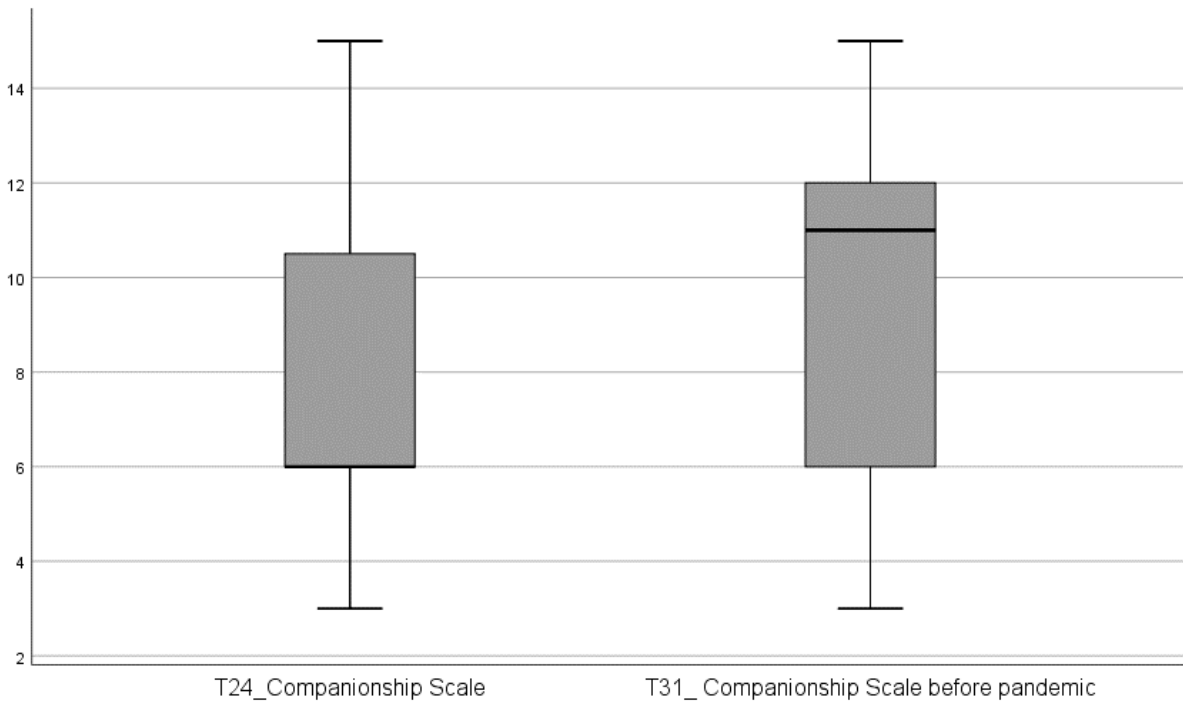


Figure 5.15: Box plots illustrating the results of the administered Companionship Scale both reported at the times of data collection (left) and self-reported prior to the pandemic (right).

5.5.3 Social Participation Scale

The median score for the participants is 11 (Figure 5.16). The scale ranges from the minimum of 6 (demonstrating no social participation) to a maximum of 36. The shape of the Box Plot in Figure 5.16 demonstrates low variability in this group of participants regarding their scores on the social participation scale. Overall, the Box Plot illustrates that 75% of participants

ranked below 15 in the scale, demonstrating an overall low social participation during the pandemic.

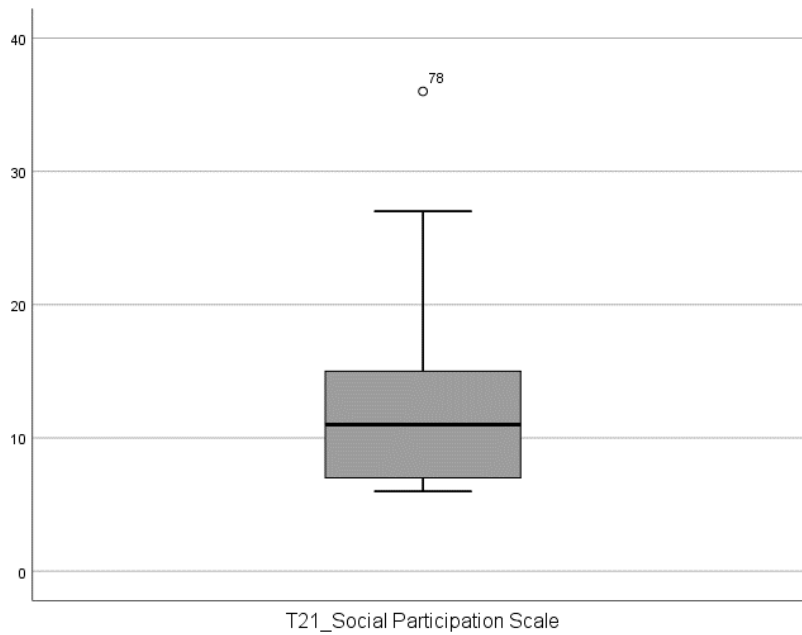


Figure 5.16: Box plot illustrating the results of the administered Social Participation scale.

5.5.4 Sense of community in physical space & Sense of community in virtual space

The median scores for both the sense of community in the physical and virtual spaces for the participants are 16 (Figure 5.17). The scale for sense of community in the physical spaces ranges from the minimum of 7 (demonstrating no sense of community) to the maximum of 28. The scale for sense of community in the virtual spaces ranges from the minimum of 6 to the maximum of 24 (Figure 5.17).

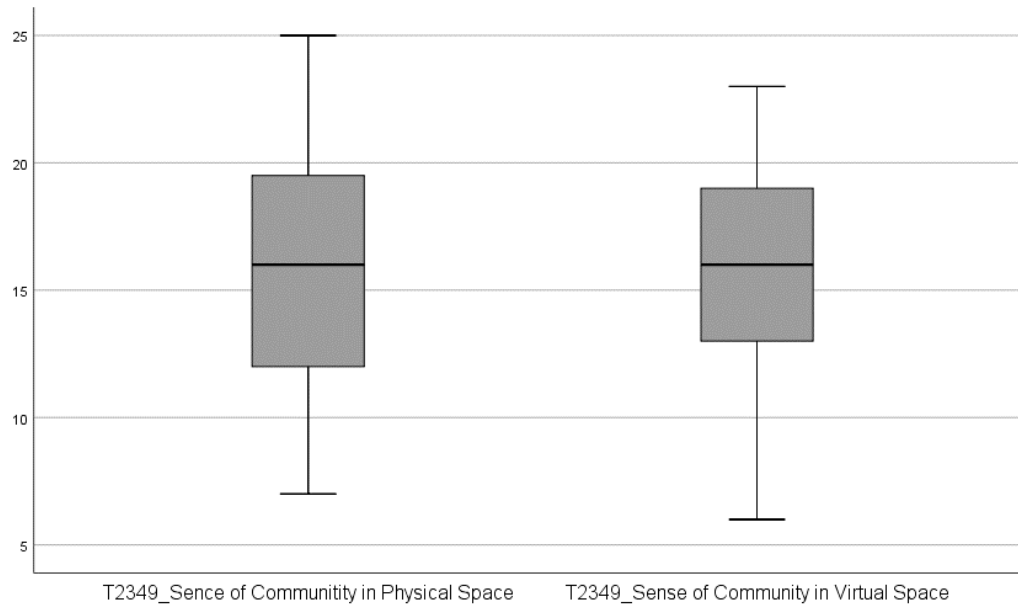


Figure 5.17: Box plot for illustrating the results of the administered Sense of Community in the physical and virtual spaces.

5.5.5 Discussion about the analysis of social connection measures

The results of the survey demonstrated that participants ranked low on having a companion and were generally not able to participate in in-person social activities among their communities and loved ones during the Covid-19 pandemic. In addition, even though they ranked higher on the level of loneliness during the time of survey administration compared to prior to the pandemic, participants loneliness levels were generally low.

Low loneliness levels, while ranking low on companionship, and low participation in in-person social activities among my sample, points to existence of one or more buffering measures that protect the participants from the harmful consequences of loneliness among the older adults. Literature demonstrates that extreme loneliness is associated with many poor health outcomes among the older adults including stress, depression, worsening dementia, and malnourishment (Donini et al., 2003; Sutin et al., 2020). As a result, further research in understanding buffering

factors becomes necessary. All of the participants in my research were adopters of social technology and were Twitter users. In that regard and based on my gathered data, I make a conjecture that access and engagement with a form of Social ICT is among the buffering factors against the harmful impacts of loneliness among the older adults.

To take an initial step, I utilized Multiple Linear Regression Analysis to assess the relationship between frequency of video-calling (as a form of engagement with Social ICTs) and self-reported loneliness among my survey participants – the model was adjusted for demographic variables, including age, gender, and marital status as well as internet quality, and having an extended family in the same city or town as the current residences of respondents. I will explore the results of this analysis in the following section.

5.6 Multiple Linear Regression Analysis

Multiple linear regression in SPSS software was used to assess the relationships between frequency of video-calling and the outcome of interest – self-reported loneliness – adjusted for demographic variables, including age, gender, and marital status as well as internet quality, and having an extended family in the same city or town as the current residences of respondents. Subsequently, gender was omitted from the model as it was not a significant contributing factor, and its omission improved the adjusted R squared of the model.

The results of the multiple linear regression revealed a statistically significant association between ‘frequently’ or ‘sometimes’ using video-calling to socialize with family and friends and decreased loneliness levels among the older adults while controlling for: age group, marital status, quality of internet access, having extended family in the same town/city as the respondent (B = 2.54, 95% CI: (0.91, 4.163), p= 0.002) (B = 1.78, 95% CI: (0.19, 3.38), p= 0.028) (Tables 4.13, 4.14, 4.15).

In addition, the results also demonstrate that age groups of 50-59 and 60-69 felt lonelier at the time of survey administration compared to the age groups of above 70 (B = 1.99, 95% CI: (0.16, 3.82), p= 0.033) (B = 1.82, 95% CI: (0.15, 3.48), p= 0.033).

Table 5.13: SPSS output for Between-Subjects Factors.

Between-Subjects Factors			
		Value Label	N
Age Groups	1	50-59	30
	2	60-69	51
	3	70+	24
Do you have extended family living in the same city or town where you currently live?	1	Yes	54
	2	No	51
Marital status	1	Single	12
	2	Married/ partner	67
	3	Divorced/ windowed	26
Internet quality	1	No or minimal access	4
	2	intermittent access	3
	3	Reliable access	98
Frequency of video-calling	1	Rarely	31
	2	Sometimes	39
	3	Frequently	35

Table 5.14: SPSS output for the tests of Between-Subjects Effects.

Tests of Between-Subjects Effects					
Dependent Variable: UCLA Loneliness Scale					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	314.325 ^a	9	34.925	3.267	.002
Intercept	827.132	1	827.132	77.376	.000
Age Groups	62.728	2	31.364	2.934	.058
Access to extended family	17.440	1	17.440	1.631	.205
Marital status	69.532	2	34.766	3.252	.043
Internet quality	19.125	2	9.562	.895	.412
Frequency of video-calling	110.864	2	55.432	5.186	.007
Error	1015.522	95	10.690		
Total	6050.000	105			
Corrected Total	1329.848	104			
a. R Squared = .236 (Adjusted R Squared = .164)					

Table 5.15: SPSS Output for parameter estimates.

Parameter Estimates						
Dependent Variable: T22_UCLA Loneliness Scale						
Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.409	1.116	3.950	.000	2.193	6.625
Age Group 50-59	1.994	.924	2.159	.033	.160	3.828
Age Group 60-69	1.821	.840	2.168	.033	.153	3.488
Age Group 70+	0 ^a	.	.	.	.	.
Having extended family in the area	.857	.671	1.277	.205	-.475	2.189
Not having extended family in the area	0 ^a	.	.	.	.	.
Marital status= single	.020	1.229	.016	.987	-2.419	2.459
Marital status= married/partner	-1.780	.832	-2.140	.035	-3.431	-.129
Marital status= Divorced/widowed	0 ^a	.	.	.	.	.
Internet Quality= no or minimal access	1.846	1.743	1.059	.292	-1.615	5.307
Internet Quality= intermittent access	1.757	2.081	.844	.401	-2.375	5.888
Internet Quality= Reliable access	0 ^a	.	.	.	.	.
Frequency of video-calling (Rarely)	2.540	.818	3.106	.002	.916	4.163
Frequency of video-calling (Sometimes)	1.787	.803	2.226	.028	.194	3.381
Frequency of video-calling (Frequently)	0 ^a	.	.	.	.	.
a. This parameter is set to zero because it is redundant.						

5.6.1 Future direction about exploring possible associations

Previously, I made a conjecture that access and engagement with a form of Social ICT is among the buffering factors that can mitigate the harmful impacts of loneliness among the older

adults – especially during times that our access to in-person social support can be limited or non-existing. The results of the regression analysis in this survey demonstrated that higher frequency of video-calling is associated with decreased loneliness levels among the participants while controlling for demographic factors. To test the claim further, access to participants’ health data such as anxiety levels, depression levels, etc. is required. In addition, longitudinal studies can help us understand the long-term impacts of engagement with Social ICTs on older adults’ loneliness levels as well as other quality of life measures.

In addition, in this research participants were rarely located in or near a green outdoor environment while video-calling. As previously discussed, the benefits of in-person immersion in green spaces for psychological and physical well-being of older adults is well documented (Pleson et al., 2014; Hooper et al., 2020). A potentially promising association to explore in the future studies could be based on investigating the relationship between video-calling while having access to views from the outside, or sitting at/near a yard, garden, balcony, or porch, and participants mental wellbeing and quality of life measures. Understanding this relationship can have important implications for the design of virtual experiences that happen within physical settings.

5.7 Conclusion

The research questions that informed the correlational research strategy were answered in this chapter. Understanding older adults’ social engagement behavior during the Covid-19 pandemic, and spaces and social ICTs that afforded social connection in their residences, were critical to formulating the following research questions explored in this chapter.

- 1) Which spaces in the older adults' residences were more likely to be utilized for in-person social activities prior to the pandemic? And what are the potential environmental design barriers and facilitators of social engagement within older adults' residences?
- 2) Did older adults engage with video-calling – as a form of virtual communication – to socially connect with their network during the Covid-19 pandemic? What are the potential built environment features that may prevent or encourage virtual socializing?
- 3) How do this sample of my older adult respondents rank regarding their social connection measures? Are there any relationships between participants' virtual engagement behavior and their social connection measures?

Regarding the first question, Kitchen, living room, and dining area, were identified as the most frequently utilized indoor spaces for in-person socializing by the participants prior to the pandemic. Attention to inclusive design, accessible features, natural ventilation of these spaces, and provision of access to outdoors are among the environmental design strategies to allow for safe social interactions during a highly contagious respiratory pandemic. In addition, yards or gardens, and porches were among the exterior spaces that were reported as most frequently utilized for in-person socializing prior to the pandemic. It should be highlighted that access to outdoor open space is a valuable resource for older adults' social and physical wellbeing, particularly during the public health crisis times, and we learned that access to this resource is not equitable among the older generations. Designers and planners need to adopt a human rights lens while planning cities and consider equitable access to communal green spaces for residents' well-being throughout their life course.

Regarding barriers to in-person social activities, more than one third of participants identified a lack of inclusive and accessible design of the home as their first choice. Attention to

inclusive design and accessibility are discussed in literature while planning for an aging population (Carr et al., 2013). Features such as step-free access to the home, barrier free spaces, and ground-level access to bedrooms and bathrooms have been extensively discussed in the literature for ensuring equitable accessibility for people across the life span (Wellecke et al., 2022). This research shows that inclusive and accessible design features are also critical for the social health of older generations as they age in place. In addition, more than half of the participants identified access to daylight, as well as adequate space for a group activity, as the top built environment features that may encourage their in-person socialization. Views to nature, and having a porch or balcony, were ranked third and fourth.

Regarding the second question, in my inquiry about whether the participants engaged in video-calling for virtual social activities during the pandemic, 80.87% responded positively. More than half reported using video-calling at least once a week (53.92%). And 88.52% reported some benefits in virtual engagement for socialization including maintaining close relationships with family and friends. Access to Social Information and Communication Technologies (Social ICTs) has been proposed and advocated for at the policy-making decisions and resource allocation levels due to its benefits for psychosocial wellbeing and quality of life of the older adults (Eghtesadi, 2020). The results of my survey also point to the benefits of access to Social ICTs for older adults as a resource for battling isolation and loneliness. And I want to emphasize that access to this resource is not equitable among the older adults, and echo the recommendations made by Eghtesadi, (2020) to advocate for governments' incentivizing and subsidizing access to social ICTs, especially among the marginalized populations and the times of public health crises.

The majority of the participants indicated that they did not use the outdoor spaces of their homes for virtual engagement. The barriers to immersion in green outdoor spaces or locating near a window while engaging in virtual social activities need to be explored in future research.

And finally, regarding the last research question, the results of the survey demonstrated that participants ranked low on having a companion and were generally not able to participate in in-person social activities among their communities and loved ones during the Covid-19 pandemic. In addition, even though they ranked higher on the level of loneliness during the time of survey administration compared to prior to the pandemic, participants loneliness levels were generally low.

Low loneliness levels, while ranking low on companionship, and low participation in in-person social activities among my sample, points to existence of one or more buffering factors that protect the participants from the harmful consequences of loneliness among the older adults. Literature demonstrates that extreme loneliness is associated with many poor health outcomes among the older adults including stress, depression, worsening dementia, and malnourishment (Donini et al., 2003; Sutin et al., 2020). I made a conjecture that access and engagement with a form of Social ICT is among the buffering factors that can mitigate the harmful impacts of loneliness among the older adults – especially during times that our access to in-person social support can be limited or non-existing. The results of the regression analysis in this survey demonstrated that higher frequency of video-calling is associated with decreased loneliness levels among the participants while controlling for demographic factors. To test the claim further, access to participants' health data such as anxiety levels, depression levels, etc. is required. In addition, longitudinal studies can help us understand the long-term impacts of

engagement with Social ICTs on older adults' loneliness levels as well as other quality of life measures.

Chapter 6 Qualitative Research Findings

Conducting a qualitative strategy is necessary for elucidating the everyday engagement of older adults with the environmental and technological attributes in their homes that can enhance their social connectivity. The aims for this in-depth understanding of the engagement of older adults with social ICTs (Information and Communication Technology) and building on socio-ecological theories of aging were discussed in Chapter 3. The research questions that informed the qualitative research process are identified as:

- 1) Engagement with Social ICT technologies – What are the systemic, as well as life course experiences and factors that impact the engagement of older adults with Social ICT technologies?
- 2) Perception and access to Social ICT technologies – How do older adults describe their access, interaction with, and sentiments towards ICT devices and technologies?
- 3) An in-depth look at Zoom as an example of a screen-based and voice-activated Social ICT: How do older adults describe their engagement and criticism of this type of Social ICT, as well as speculations about positive potentials of it?
- 4) Body, health, and ability to engage with currently-designed ICT technologies – How do older adults describe health issues that impact their ability to engage with the currently designed ICT technologies?
- 5) Exploring a spectrum of older adults' jobs, volunteer activities, and the impact of the Covid-19 pandemic on older adults' social life.

6) City life and home spatial design: A look at the spectrum of older adults' home environments and the interaction of space and technology, and their impact on older adults' social life in light of the Covid-19 pandemic.

The first three research questions are structured to capture the critical factors that impact access and engagement with the Social ICT technologies – starting with the broad societal forces that shape their perception and ending with looking at a specific example of Social ICT. The fourth research question is structured to investigate health issues common as we age and whether the current ICT technologies available to older adults are designed while considering them. The fifth research question is structured to reveal challenges of social life after retirement (volunteering or continuation of involvement in the work force) in light of the Covid-19 pandemic. And finally, the sixth question is formulated to reveal the urban and the domestic spatial contexts that allow for social interactions to form considering the Covid-19 pandemic – whether through Social ICT technologies or in-person participation in city/community life.

6.1 Systemic and life course influences on older adults' engagement with Social ICT technologies

In this section, I will initially discuss the broad economic stressors that the participants identified as a critical factor that directly impacts their ability to engage and participate – either virtually or in-person – in the social activities that they prefer. Second, I will highlight that inequity in access to internet infrastructure is another determining systemic factor that impacts widening digital literacy gaps in the old age and directly impacts one's level of engagement with Social ICTs. And finally, I will illustrate some of the determining life course experiences,

especially relative to our education and experiences in the workforce, as well as the role of ‘heuristics’ and their influences on older adults’ engagement with social ICTs.

6.1.1 Theme 1) Broad social, economic, and systemic issues and stressors, and their interaction with older adults’ social life

6.1.1.1 Economic stressors, income disparities, and their impacts on the affordability of participating in social activities

During my interviews with the residents of the Village of Woodbridge Manor in Detroit – A member of the Presbyterian Villages of Michigan (PVM) that provides independent housing for low-income older adults above 60 – participants often reflected upon economic stressors as a critical force in shaping their choices about access to and engagement with Social ICT devices and technologies.

Residents explained that affordability of Social ICT devices is among important hurdles that actively limit their engagement with technology: *“When you can talk to a device and it will happen, that’s the best thing in the world! But you got to have the device! That costs, you know! As people get older, the money is not there! Some people have to take care of their medication first, and if they do, they cannot eat! If they eat, they cannot take care of their medication! The system is so messed up, as far as old people is concerned, it is very bad and we live in a country where it should not be like that!”*

The residents who live on fixed income noted that their ability to access food, medicine, and housing as the top three priorities for spending their money. In my inquiry about the availability of any means of virtual connection to friends and family, another resident responded: *“None of that [pieces of technology used for virtual communication] is available to me because fixed income puts those way out of reach! I would love to have something like that you know, but*

affordability is a very big issue. Tablets and computers cost! And when you are on a fixed income, money is not there! Same thing with medication! Even with insurance, my co-pay is \$500 and medication alone is very expensive for me! That plays on the mind, you know! I say to myself you aren't old, go back to work! It gives me a heart attack just to think about it! What am I gonna do next month?"

While affordability of the Social ICT technologies poses a major obstacle for access to virtual social connection, even in presence of some programs that subsidize access to internet infrastructure for older adults, the application process that does not consider older adults' abilities and levels of familiarity can alienate and further discourage them to engage with the internet and Social ICT technologies. One resident mentioned: *"A program through Comcast offers a discount for internet for older adults. Filling forms online and uploading ID online are necessary steps in the process; but how do I "upload"? I don't have access to a computer to fill out forms online! This alienates people! Some people get reclusive when they cannot figure it out or get embarrassed! They say I'll never figure it out or never never understand that, so they don't try and give up! It seems another stress on the person who is already stressed about life and all the difficulties and intentionally adding another stressor is maybe what stops people!"*

Consequently, economic stressors, affordability, and the incongruous design of some programs that aim to offer economic support for accessing the internet infrastructure are among the important factors that alienate many older adults from engaging with social ICTs.

In addition, economic stress not only acts as an obstacle to accessing Social ICT devices, but it also prohibits many older adults in difficult economic conditions from participating in many in-person social events due to the sometimes-considerable costs of attendance. In my conversation with one of the participants that I recruited online, the female respondent had a passion for

movies and film festivals. She mentioned that her temporary job loss during the early stages of the Covid-19 pandemic put her in a difficult financial situation and impacted her life in many aspects. I inquired about her participation in in-person social activities and the impact of Covid-19 on her attendance. She mentioned: *“Prior to Covid I used to go to the Turner Classic Movies Film Festival in Hollywood, but they didn’t schedule it for the last two years, it was virtual. And I cannot go this year because I need the money! It is not a cheap vacation! Because just attending is \$700 and then you got to fly there and get a place to stay, you know. So, I just can’t afford it this year!”* Her distress points to the negative economic impact of job loss that was experienced by many households as well as by many older adults in the US and across the world.

6.1.1.2 Lack of access to internet and technology infrastructure during the life course that translates to digital literacy gap and digital exclusion

During my conversation with one of the participants about systemic obstacles that the male respondent speculates may lead to digital exclusion and broadening digital literacy gaps at the old age, he discussed some of the ongoing issues regarding access to Wi-Fi and data infrastructure in the city of Detroit for younger generations and illustrated the digital inequities that can follow one to the old age: *“Everybody assumes you have a computer and can afford it! The number of students in the city of Detroit with no access to the internet at home is 70%! There are a lot of kids in the city of Detroit that don’t have access to a computer, Wi-Fi, or any data infrastructure! However, in private schools they give every kid a computer! When I talked to the kids in the city while I taught Tennis, there might be only one computer, a desktop, for everyone in the house! And that’s ‘maybe,’ right? How can this kid compete with those (the ones in private school)? What I hate about it is that it is so insensitive! It is so sad because a lot of*

people fall through the cracks because of that. And once you fall into cracks, there's no recovery because there's no help!"

His remarks point to the issue of inequities in access to data and internet infrastructure as well as to the devices and computers that translate into digital inequities in old age. Investments in this sector can have life-long critical impacts for generations.

6.1.2 Theme 2: Life course factors and heuristics involved in older adults' feelings of empowerment and familiarity while engaging with technologies

As discussed above, lack of access to digital and data infrastructure creates a ripple effect for many that translate to digital exclusion and digital literacy gaps in old age and the alienation of many older adults even while one can afford to purchase a device. This effect can become much more pronounced if, during the life course of an older adult, their previous job(s) did not include any training or interaction with technology. In my discussion with one of the participants from the Woodbridge community, he described that recently companies are eliminating paper-based instruction sheets that used to accompany many ICT devices and its negative impact on the ability to engage with the devices: *"Now instead of instructions, it says 'go to our website!' Many seniors do not have any idea how to do that and are not familiar with the language of 'open the App or go to your browser! They are instructed to copy and paste a link in a web browser, but many ask: 'what is a browser?'"*

Another participant also discussed the reluctance that many older adults might experience due to the newness of engaging with ICT equipment: *"For a lot of older people, the new technology is great, but they like the education about the technology! They are afraid of technology! They are afraid to even attempt! Because it is something new and something different!"*

In contrast, I interviewed other older adults recruited online whose academic training and job(s) during their life course required continuous interaction with many forms of ICT equipment. And this translated into ease of adopting and engaging any form of Social ICT devices and technologies. For example, one participant discussed her extensive background and participation in the pharmaceutical industry that led her to still accept remote contract jobs even after her retirement: *“The job I did recently was in the same industry that I’ve always worked in – the pharmaceutical industry – since 1981 for drug developments. I spent 22 years with them through different mergers and acquisitions and then I got a severance package, I went back to school to become a secondary education science teacher!”* Her experiences illustrate the importance of support experienced through economic stability, continuing education, and work requirements as important contributors to closing the digital literacy gaps for older adults during their life course.

One of the participants from the Woodbridge community highlighted the importance of community-based educational programs such as ‘Operation ABLE of Michigan’ –a non-profit employment and training organization serving adults over 40 as they seek help to re-enter the workforce (Operation ABLE of Michigan, 2022) – for closing the digital literacy gap for older populations: *“I am comfortable with navigating websites and Apps because I just started getting on the computer in 2007. I went to a program called Operation ABLE of Michigan. They have a six-week computer program course. At first, it was hard, but now I know what I am doing! I can navigate it! During the pandemic, it has been a blessing to be able to do many things online! Connecting with family, shopping online, paying my bills online!”* Her story is testimony to the importance of community-based education programs that allow continued learning during one’s life course and provide equitable access to education in the realm of ICT.

“The old way – you knew what you see and you knew what you did; Now it’s all in the air!”: It should be highlighted that throughout our lives heuristics play crucial roles in our decision-making and problem-solving (Lockton, 2012). Heuristics are “rules of thumb” or “shortcut strategies” that guide us while making decisions or judgments and can lead to cognitive bias (Lockton, 2012). In my inquiries about possible design pathways that can empower older adults to utilize and engage Social ICT, some participants mentioned that in many instances, changes to the ICT devices and equipment have been too radical such that newer devices no longer match people’s heuristics and mental maps. The radical changes in the design and operation of a piece of technology can have a lasting impact on one’s lack of confidence while engaging the equipment and can result in further deepening of the digital gap for the older adults: *“I remember when I wanted to change the channel on TV, I’d grab a knob and turn! Very simple! Now you got to click X, wait for a menu to come up, and then you need to find the guide! What happened to the knob? I want to watch TV but it’s not possible for someone like me who’s old school!”*

Another participant also touched on heuristics, and criticism of cognitive bias in a way that drew my attention to its importance for older adults’ engagement with ICT: *“I see in people of my age a sort of reluctance; they don’t think much beyond what is presented to them! They develop an expectation based on heuristics of previous uses! For example, cutting and pasting in making newspaper collages creates a form of expectation while we utilize the cut and paste functions in the digital world!”*

As a result, life course experiences (especially relative to continued education and work force trainings and requirements) have critical influences in older adults’ level of engagement with Social ICT, and designers of digital and environmental experiences need to consider the

broad range of familiarity, education, and abilities among the older adults, as well as the role of heuristics while designing Social ICTs.

6.1.3 Discussion on the economic, systemic and life course experiences that impact older adults' engagement with Social ICTs

The findings of my research revealed the critical role of economic stressors as a significant obstacle in older adults' access and use of Social ICTs. This finding is in-line with literature that investigated inequalities in access to varied forms of capital – economic, social, and cultural – and identified affordability as an initial step in providing access to ICTs for older persons (Renaud & Van Biljon (2008), Tan & Chan, 2018).

In addition, the lack of access to broadband internet infrastructure and its contribution to the expansion of the digital divide as cited in the literature complements the results of my research that encourages support from the policies, programs, and stakeholders (such as health systems) towards expanding access to the internet infrastructure (Eruchalu et al., 2021). Government and health systems' investments in the broadband internet can help in combatting the digital redlining of economically distressed neighborhoods. In addition, leveraging community and social infrastructure in public spaces, such as public libraries, community centers, and schools to install broadband internet, have been identified among impactful strategies that can help in expanding access to the internet infrastructure (Eruchalu et al., 2021). During the Covid-19 pandemic, we witnessed the powerful role of telemedicine and the fact that digital access is now being identified as one of the social determinants of health (Eruchalu et al., 2021). Consequently, addressing disparities in broadband access remains an important task so as to enhance the health and quality of life of populations throughout their life course.

Lack of clarity, instruction, and support have been identified in the literature as obstacles in adopting Social ICT technology by many older adults (Vaportzis, Giatsi Clausen, & Gow, 2017). This research also reinforces the same findings and refers to older adults' life course factors (i.e., presence or absence of continued education and work force trainings and requirements) as critical in shaping their engagement with the Social ICT devices and technologies. In addition, the role of 'heuristics' and attention to its implementation while designing technology for older adults was reinforced in this research. The critical role of heuristics in the design of technologies for older adults and the importance of testing with the senior user to identify any heuristic-based usability challenges have also been emphasized in the literature (Le et al., 2014). A broad range of familiarity, education, and abilities among older adults, as well as the role of heuristics, need to be considered while designing Social ICTs.

6.2 Perception and access to Social ICT technologies – Description of access, interaction with, and sentiments towards ICT devices and technologies

In this section, I will illustrate the preferred modes of social communication that the participants identified in my research and point to some underlying incompatibilities between the design of devices and processes, versus users' capabilities and health status that can have potential negative impacts on adoption and engagement with varied modes of social ICTs. In addition, the development of the information technology infrastructure that provides easy and immediate access to telemedicine and healthcare infrastructure will be outlined as an important potential direction for the evolution of social ICTs that also serves the goals of aging in place policies.

6.2.1 Theme 1) Widely used modes of remote communication among the participants: Looking at experiences

Talking on the phone and texting are described by participants as the two preferred modes of remote social engagement. Zoom or FaceTime as audio-visual ICTs are not described as widely used in connecting with friends or family social instances – Their utilization is mostly discussed for occasions such as organizing volunteer classes, community engagement, and job requirements that necessitate communication with clients, colleagues, or students (to be discussed in detail in the following Section 5.3 – an in-depth look at engagement with Zoom). When I inquired about their preferred mode of connection through ICTs, I got the following responses:

“I don’t do Zoom very much except for meetings and we’re running a class of Master Gardeners right now, and that has to be on Zoom because of Covid. I mostly use texting for connecting with friends. The joke here with me is if I don’t text you back in 15 minutes call the cops! Something has happened to me!” Another participant described: *“I have one sister who I’m really close to and I talked to her on the phone regularly, but we have had a couple of family Zoom around holidays, where you know there’s eight of us in terms of kids so we’ve had some big things with family just to kind of catch up a couple of times during the pandemic. I do a lot of Zoom for work with clients, but not that much socially; it is mostly phone calls and texts.”* In addition, one participant highlighted that hearing her family members’ voices were critical in conveying emotions: *“I use texting if I have to. I prefer hearing their [family members] voices! You can always tell if something is wrong by their voices!”* Participants’ responses illustrate a wide range of preferences in using different modes of social ICTs while talking on the phone and texting remain the mostly used modes of remote communication.

In my conversation with the participants from the Woodbridge community, one participant highlighted the fact that due to the incompatibilities between the design of a phone,

and the health status of many seniors exposes them to experiencing weakened eyesight and motor skills, texting is not a possible mode of communication for them: *“I connect with my family through phone call; I like to text but when you are old, it’s hard to see! I am hitting so many letters I am sending the wrong stuff!”* Another participant from the Woodbridge community discussed that he preferred talking on the phone and blamed his old age as a determining obstacle that prohibits him from texting: *“Talking on the phone is the best thing for me, you know, texting is somehow hard because you have to make sure you send the right words. Because of really not being up on that as far as seniors are concerned. I don’t know how to send things. I try to ask if I don’t know something. If you don’t ask, you won’t know!”* I particularly like to highlight this incompatibility between design and the ability to engage a piece of technology from the user perspective because I believe the designers of the experience need to be educated on the health issues that naturally accompany all of us during old age. Awareness and designing with all the context in mind are critical in the creation of an enriching experience for the users.

6.2.2 Theme 2) “Google, call my doctor, please” – Utilizing Social ICT infrastructure for enhancing access to telemedicine for older adults

In my conversations about available social ICT devices with participants from the Woodbridge community, a participant discussed that Google Nests were provided to some residents by building management. However, the internet infrastructure, training, and user support had not been adequately provided: *“The Google Nest is just sitting there. We haven’t been able to get it to work. I’d love to use it to connect with my doctor. I’d say: Google, call my doctor, please! And instead of trying to go through the phone, reception, holding and getting frustrated, Google Nest could connect me to my doctor in some emergency.”* Her remarks point

to an important direction for the development of information technology infrastructure for aging in place and older adults' needs for easy and immediate access to telemedicine and healthcare. The provision of telemedicine requires a comprehensive strategy from the healthcare, health policy, and public health sectors to allow for successful aging in place to happen for older adults with a spectrum of health needs.

6.2.3 Discussion on the experiences of engagement with Social ICTs and the potential direction of telemedicine

The incompatibilities between design and the ability to engage a piece of technology from the older user perspective were identified as a barrier to engaging technology in this research. As previously discussed, testing with primary stakeholders (i.e., older adults) can be beneficial in identifying heuristic-based usability challenges with the design (Le et al., 2014). The highlighted finding regarding the need to access telemedicine through Social ICTs echoes the literature pointing to the potential of telemedicine and telecare in addressing emerging problems in public health due to the worldwide aging of the population (Peng, Man, Chan, & Ng, 2022). Research on investigating factors that facilitate telecare acceptance among older adults in Hong Kong demonstrated that using telecare services is potentially sensitive to one's socioeconomic status and seniors from very low socioeconomic status were more likely to use telecare services (Peng, Man, Chan, & Ng, 2022). Consequently, attention to the affordability of telecare infrastructure and services in the US can potentially benefit older adults from very low socioeconomic status to address their health issues in a timely manner. It should be highlighted that, in addition, to support from the government level incentives, health policies and health systems, the presence of a network of family and friends to support the older person while they

engage with telecare services and technologies can positively influence seniors' engagement with them (Peng, Man, Chan, & Ng, 2022).

6.3 An in-depth look at Zoom as an example of a screen-based and voice-activated Social ICT: Speculations about positive potentials and criticism towards this type of Social ICT

Zoom's utilization is mostly discussed for occasions such as volunteer classes, community engagement, and the job that requires communication with clients, colleagues, or students. Participants from the Woodbridge Community used Zoom on limited occasions, and its usage was more prevalent among participants recruited online who were already engaged in social platforms such as Twitter.

Initially, I will discuss the potentially positive and empowering aspects of utilizing social ICTs – namely, bridging social engagement between generations, a vehicle for maintaining relevancy throughout old age, and a vessel for participation and activism in the community. In addition, I will outline the criticisms and potentially negative aspects of engagement with Zoom as an example of an audio-visual social ICT; aspects such as loss of human-to-human connection and social bonds, perpetuating Lookism and Classism, and contribution to physical inactivity.

6.3.1 Them 1: Zoom's potential for empowering older adults

A potentially positive influence of Social ICTs that I identified through my interviews is offering opportunities for mentorship as well as conversations leading to the transfer of knowledge among different generations to occur. A participant described one of her memorable Zoom experiences with her niece involving mentorship and offering career advice: *“I have a niece who is in a tough transition between jobs and my husband and I got involved in conversations with her on Zoom to help her. We helped her talk through a big change in her life.*

She is going to take her stellar Bachelor of Arts degree and she is going to get a Registered Nurse degree because she wants to help people and she has always wanted to help. She is a peace corps returning and other things. So we met with her a lot over Zoom and used Google Docs to keep our notes together on this and so that seemed like in a way, formal office work almost!”

In addition, Social ICTs allow for mentorship and conversations between the younger generations and elders in a particular industry to form. Younger generations can immensely benefit from the career advice and guidance of elders; for example, in my interview with a renowned retired chef, she identified her interaction with young chefs and remote mentorship that can form over Zoom or phone: *“They [young chefs] always ask for my opinions about the industry. I am now considered an elder in Native American culture. In Native American life, you can never call yourself an elder unless two separate people have to call you an elder before you can assume the title. And I have now been called elder by many, and so I just had a talk with a chef who’s having difficulty, trying to reconfigure his thinking about his restaurant and he said to me I call you because you are the Elder.”*

And finally, a participant from the Woodbridge community who is a graduate of culinary art school, described that she uses Zoom to transfer her culinary knowledge to her daughter: *“I explained to my daughter and showed her how to make Crème Brule over Zoom. She had her pot, and I had my pot. I showed her how to do it. I explained that she should not stop stirring the eggs until the custard is ready! and she was able to check the steps with me over Zoom. We have tried Crème Brule a couple of times over Zoom, she was at home, and I was at my apartment here. And I always tell her, remember, you cannot stop stirring the eggs!”* All comments

expressed by the participants support this potentially positive thematic concept of Social ICTs acting as a bridge for mentorship and transfer of knowledge among generations.

6.3.1.1 Social ICTs as a vehicle for maintaining relevancy and participation in society throughout the old age

Utilizing social ICTs for maintaining relevancy in society was an important theme and potentially positive impact of these technologies. One of the participants described her social life and the ways that an incident leading to temporary physical limitation and disability during old age can drastically alter one's social life: *"I was very social, very gregarious. I am well-known in the culinary world. So, I was very busy when I closed my restaurant – the documentary about the closing of my restaurant was in 48 film festivals around the country. And I traveled with it, too. I think 31 or 32 of them. I wrote a cookbook memoir, and so I was on a book tour for a long time. Also, I did a lot of traveling for companies that hired me to speak about breakfast at food conferences around the country. And so, I was quite busy and quite happy and grateful. So, I still had this face-to-face connection with all the people that I loved and then in December of 2018, I fell and broke my polio leg. I had surgery and a very long walk down for recuperation. And I had to sort of drop out of the world. So, my world became smaller, and my life became much smaller. And then we went into Covid lockdown in 2020 and then in 2021. So, I had three years of a life unknown to me and without technology, I would not be the happy person I am."*

She also emphasized the role of Zoom and other Social ICTs in maintaining relevant and engaged in society: *"So I was able to maximize the ability to connect with people through that [Zoom]. I have a friend who just passed, but she was 96 and she was an avid user of technology, Facetime, Zoom, etc. She was a Ph.D. therapist and even up until the 95th year she would have clients that she was able to meet virtually and without technology, she wouldn't be able to do it."*

She was sharp until the day she passed. I love it that there's a way to be involved and continue to do something you love virtually. It also adds to maintaining relevancy. People forget about people. As we age young ones forget. And it [technology] adds to the relevancy."

In addition, another participant who is a professional social worker also referred to the benefits of utilizing Zoom for continuing her job and online patient visits: *"I've gotten very used to Zoom and actually in my private practice, I see clients through Zoom. Very few of them want to go back to the office because of the traffic and they would rather do it through Zoom now. I do group therapy as well as individual therapy through Zoom. I do miss some aspects of in-person sessions, but the convenience really overrides it and also not having to get out in the traffic. If I have a client that I feel like I don't have a really good sense of you know, and I really need to see them, I have an office available that I still pay for, just in case I need it."* As a result, the ability to maintain relevance in society through virtual engagement with society can empower older adults.

6.3.1.2 Social ICTs as a vehicle for participation, community activism, and an organizing tool for the events toward positive community impact

Another potentially positive impact of Zoom revealed in my analysis is that it acts as an additional platform to expand access to community engagement and activism for older adults that will be discussed in the following instances.

1) Fighting ageism through conducting virtual workshops in the community: In my interview with one of my participants – a professional Social Worker and an adjunct professor of Social Work at Louisiana State University, she described the power of virtual engagement to gain more exposure in the community: *"It [Zoom] has allowed me, because one of my interests is ageism and elimination of older adults, so being able to do workshops virtually has given me*

more exposure. I've been able to have more exposure in the community and in my social work community as well."

2) An instance of community activism: Another participant also referred to the power of Zoom as a tool for community activism, and organizing community events: *"I engage more frequently with a friend who is a community activist in Minneapolis and the content of our recent discussion was our families and people we knew in common but on every conversation to this day, I talked to her last week, hinges on the question of Police response in Minneapolis and Black Lives Matter movement. She was very involved in trying to change the charter for the police in Minneapolis and she is also a Buddhist, so she was very involved in this spiritual component to be added into the conversation about community. So, there was an immediacy you know month by month. We'd keep up you know and hear about an upcoming meeting or decision making and she was on Zoom all the time. I mean she had to; that's how they communicated to meet up in a neighborhood park in the evenings, even in the winter, to like check on different neighborhoods and engage the community. I mean really it felt like I was almost there for her! And that was by far my strongest sort of Zoom communication and an outlet for somebody who was virtually always on the front lines there. It was an enriching kind of Zoom!"* Overall, adaptation to Zoom and utilizing it as a platform for community engagement and activism for older adults, points to a promising avenue for the development of such technologies.

6.3.2 Theme 2: Criticism of engagement with Zoom

6.3.2.1 Loss of human-to-human connection and social bonds

As previously discussed, Zoom as a form of audio-visual ICT allowed for the continuation of many activities such as educational classes that older adults participate in as part of community engagement and volunteer activities. Although this mode of communication and

engagement empowers and provides agency to older adults, almost all the participants who utilized this mode of ICT mentioned that the social bond formed while we engage in in-person social activities is completely lost. This loss of social bonds will be discussed in different situations as experienced and expressed by different participants – situations ranging from teaching and participation in classes, social events with colleagues, social events with loved ones in rehab and recovery programs, and finally engaging an audience while speaking publicly on Zoom.

One participant who is a Master Gardener volunteer with the North Carolina State Extension program mentioned that due to the Covid-19 pandemic, many activities of the gardening class switched to the online format over Zoom. She described the loss of human connection especially for new members of the class as a significant loss: *“Covid has depressed my activities there [Master Gardener volunteer program] but I’ve kept in touch! We are running a class on Zoom, and we all hate it! Because we are all touchy-feely and kind of **an important social aspect of our class is team building, which involves bringing new people on board, allowing them to feel welcome, to feel part of the group,** and it is nearly impossible on Zoom! Everybody is a little bit different in terms of their technology abilities and/or their familiarity to manipulate Zoom so that has been really challenging, not to mention teaching people about Botany and Entomology and plant diseases! We got some feedback from our class members that they feel isolated! Personal touches are lost and it’s really hard!”*

Another participant, a professional Social Worker and an adjunct professor of Social Work at Louisiana State University, also described a lack of human-to-human connection while teaching: *“I do a lot with the community, and I am on several boards but I retired and then the pandemic hit! I went into teaching and probably about six months later, I had to learn a lot*

about being online and virtual and it was very difficult! As an adjunct professor at the Louisiana State University, I was teaching an Aging and Social Work course and then the pandemic hit, and I had to learn how to teach virtually through Zoom! I had many difficulties in transition, and it was very stressful. I feel my skills are in presentation and being with people, talking to them. And being at this kind of distance, not being able to see my students, not seeing their reaction, was very difficult!”

In addition, loss of human connection left one participant feeling excluded from the virtual social event: *“I participated in a Zoom happy hour, it was with some old colleagues. I have to say it was very weird because when I got on the call, no one even acknowledged I was there! And I was like Hello I’m here! And I felt like I hadn’t seen people for maybe almost a year, and no one asked me how are you doing? What are you doing? And I wasn’t sure if it was just because it was just the video format and you know that it was harder to have this kind of interaction or, then I was like well, maybe people just don’t like me! They don’t care what I’ve been doing for the past year, you know, so that was weird and kind of awkward and was a negative experience that I remember. In one in-person meeting that I went to, it was really nice and I was realizing the contrast like how nice it was to actually be in the room and talking with colleagues.”*

In another instance, while inquiring about virtual connection to family or friends, a participant from the Woodbridge community mentioned with one of her sisters staying in a rehabilitation facility during the Covid-19 pandemic, she missed connecting with her and supporting her in-person: *“I wish I could go in-person to be with her. Human contact was lacking when we connected online. I am glad rehab is finally open for visitors.”*

Another participant who was part of a twelve-step program for staying in recovery illustrated her experience with virtual meetings as a substitute for in-person gatherings and expressed the difficulties associated with them due to the absence of human-to-human connection: *“I am a thirty-year participant in a twelve-step program that could no longer meet in-person during the pandemic. And I want to tell you that only one day after the shutdown, my friends in the program had set up Zoom meetings! We lost no time maintaining our service to each other and our own. **We were able to do a seamless transition to Zoom. However, I will say it is absolutely not the same thing as bouncing around, drinking coffee, and saying ‘how are you feeling?’ Judging what people’s posture is, like, say you look like this (showing sadness through body language) and you say I’m fine! But you aren’t fine, you know! But meeting over Zoom helped a lot of people to stay in recovery and that helped me a lot!”***

And finally, in my conversation with a participant who frequently speaks at charitable events, she also identified the changes in engaging the audience while switching over to a virtual presentation platform: *“the trick is how do I engage them with this visual distance, you know, a screen. I have to sometimes reorder my conversation, the talk that I give, I find that I have different pauses. I can lean in when I want to make a point and I can lean back and let it settle – you know whatever I’ve just said. But in person, I can be much more animated and look around the room as I am speaking to see if they follow it. To not lose them in the virtual format, I change my talk a bit in terms of its speed and the physical distance to the screen.”*

Consequently, I should highlight that having the virtual option of continuing many social activities during the Covid-19 pandemic certainly helped with their continuation; however, the quality of social bonds and human-to-human connections were certainly lost and negatively affected.

6.3.2.2 Perpetuating Lookism and Classism

Issues of lookism and classism were among the negative impacts and consequences of interacting with an audio-visual social ICT such as Zoom. In my interviews, I identified that some participants were discouraged from utilizing this type of technology for enhancing their engagement with their social network due to their appearance or representation of their background environment while on Zoom. One participant mentioned that: *“Sometimes I avoid Zoom, and I realized with Zoom there’s that immediacy, some people, like me, can plainly think: ‘I am less than I am not going to be treated right! I have weird smile, or my house looks funny!’ or you know!”*

In my discussion with a participant from the Woodbridge community, the visual interface of Zoom or Facetime as a commonly used form of social ICT, discouraged her from virtually socializing with her loved ones: *“I don’t know what it is, but you see so many imperfections! I don’t do Facetime, because I have to first do my eyebrows, do my eyes, and put some lipstick on, and I don’t like it when someone catches me off guard! The first time that my daughter called me on Facetime, I clicked and her face showed up! I told her to never do that again! I looked at myself because she caught me looking bad! No vanity or anything!”*

Consequently, older adults’ physical appearance as well as the environment that they are immersed in while engaging with audio-visual social ICTs are identified as critical to their willingness to participate in virtual engagement with their loved ones.

6.3.2.3 Contribution to physical inactivity – “Sitting all day, it makes you lazy!”

New technologies in our lives have always been developed with the goals of efficiency, making activities of daily living less labor intensive, and consequently more sedentary (Woessner et al., 2021). Coupled with advances in medicine that has substantially increased

population life expectancy, sedentary behavior has resulted in people living longer life but in poor health conditions and reduced quality of life (Woessner et al., 2021). Zoom as an audio-visual form of ICT is no exception and the shift to virtual activities that happened during the early stages of the Covid-19 lockdown left many older adults with minimal opportunities for physical activity. One of the participants who taught remotely via Zoom during the pandemic pointed out the negative impact of physical inactivity on her health: *“I weigh 155 lbs. now from sitting at home and I was weighing probably 140 lbs. before the pandemic. I am concerned about weakness in my legs! I don’t feel like I get up enough! I don’t feel like I am strong enough and I am very concerned about that!”*

Lack of physical activity was mentioned by another participant when I inquired about her job and access to different mediums of ICT: *“Since I am a writer, I work on my computer all day. I also do most of my entertainment on this computer because I actually don’t have a TV – I stream everything. So, I pretty much sit here all day!”*

In addition to physical inactivity, a participant from the Woodbridge community identified that over-reliance on ICT technology can have potentially negative consequences: *“Your body gets used to sitting so you don’t get up and walk as much so your bones get cracking! It is stiff! And to the truth, these devices make people lazy! They forget stuff because you count on the phone! And you don’t get as much exercise! Now I’m thinking to myself, if I fall down and don’t have my phone, I couldn’t think of one of my sisters’ phone numbers!”*

In sum, research demonstrates that sedentary behavior and physical inactivity is prevalent among older adults (Mcewan, Tam-Seto, & Dogra, 2017). The findings in this section demonstrated that Zoom as an audio-visual form of ICT has contributed to older adults’ sedentary time. Despite the documented benefits of physical activity, increased sedentary

behavior is associated with a diverse range of poor health outcomes in older adults, and designers of environmental and technological experiences need to consider the important role of design in the prevention of sedentary behavior and improved quality of life for older adults.

6.3.2.4 Discussion on the potentially empowering role of an audio-visual Social ICT (Zoom) and the criticisms of engaging with such technologies

Lack of rich non-verbal cues and their negative impacts on users' interpretation of messages can hinder mutual understanding in online communication and result in cognitive fatigue (Okabe-Miyamoto, et al., 2021; Walther, 1992). In line with the literature, this research on the potential of utilizing Social ICTs for social connectivity among older adults illustrated that the social bond formed while engaging in in-person social activities is lost when older adults engaged in virtual connections through Zoom. And human-to-human connections are essential to feelings of social connectedness. However, the empowering and positive impacts of socially connecting through Zoom should also be highlighted. This research demonstrated that Social ICTs could assist in bridging social engagement between generations, become a vehicle for maintaining relevancy throughout old age, and a vessel for participation and activism of older adults in the community.

In addition, older adults' physical appearance as well as the environment that they are immersed in while engaging with audio-visual social ICTs are identified as critical to their willingness to participate in virtual engagement with their loved ones. Zoom screens can reveal different modes of inequities – from access to broadband infrastructure to disparities in income.

And finally, the negative consequences of sedentary behavior, in the form of cardiovascular and various chronic diseases, are well-documented in the literature (Chodzko-Zajko et al., 2009; Mcewan, Tam-Seto, & Dogra, 2017). The findings in this section

demonstrated that Zoom as an audio-visual form of ICT has also contributed to increased sedentary time among the aging population. This can negatively affect older adults' health conditions and quality of life. Designers of environmental and technological experiences need to consider the important role of design in the prevention of sedentary behavior and improved quality of life for older adults.

6.4 Body, Health, and ability to engage with currently designed ICT technologies

Health issues pertaining to eyes, sedentary behavior and physical inactivity (discussed above in section 5.3.2: Criticism of engagement with Zoom), joint and shoulder pain, and mental well-being were the most important health problems identified by the participants while discussing the utilization of social ICTs and older adults' health. I should highlight that the critical impact of socio-economic status on health at the old age was prominent: participants from the higher socio-economic status who lived in single-family homes were enjoying healthier old age compared to the participants from the Woodbridge community – an independent housing community for low-income older adults above 60. For example, one of my participants from a high socioeconomic status described her health: *“It is wonderful, and I am having a happy and healthy and what I hope is a long old age, both my parents lived into their 90s and I am taking better care of my health than they did, so I hope I will too.”* In contrast, a participant from the Woodbridge community described her health: *“I have arthritis, carpal tunnel, and I notice for my shoulder and for my eyes, I continually go to the doctor. I have cataract on one eye.”* Although this is only one instance of the critical impact of socioeconomic status on health, this issue is well documented (Barnett, et al., 2012; Chan et al., 2019). Cumulative stressors throughout life can culminate in poor health at the old age (Chen et al., 2022).

In addition, health care inequity in diagnosis and treatment was highlighted in one of my interviews with an African American Woodbridge resident. In my inquiry to her about any health issue that may negatively impact her ability to virtually connect to her loved ones via Social ICT technologies, she pointed out having an eye problem that bothered her and consistently caused her pain. She visited numerous ophthalmologists, and no one was able to help her with her condition. Luckily on one of her visits, she met a doctor with experience in treating patients in Africa. She immediately recognized the issue – a prevalent eye disease in people of African descent that if left untreated could lead to blindness. She was able to prescribe medication for her and help her to control the disease. Her experience highlighted an instance of health care inequity that is present in our current medical world and leads to misdiagnosis or improper treatment of minorities. Although my initial inquiry aimed to uncover health issues that are potentially neglected while designing Social ICT technologies for older adults, it opened my eyes to an important issue of racial and ethnic discrimination in medical education and practice. In line with the findings of Nelson (2002), continued research and awareness will be required towards creating a more respectful health care delivery.

In Section 5.3.2: ‘Criticism of engagement with Zoom’ I discussed the lack of physical activity and sedentary behavior as a consequence of engagement with Social ICTs. Physical inactivity due to engagement with Zoom is a theme that was numerously highlighted. And I want to emphasize its negative influence on older adults’ health and well-being in this section as well. One participant compared the experience of working in an office with working remotely over Zoom from home and highlighted the sedentary behavior as a result of remote work from home: *“When I worked from home, I found that I would get so engrossed in something that I didn’t realize I hadn’t stood up in several hours and when you’re in an office with somebody walking*

by, and they say let's grab a cup of coffee and you walk down to the coffee place, then you walk over to the printer or you walk to the ladies room. When you're sitting in your own house, hours and hours can go by, when you are sitting a certain position without standing up or walking!"

Moreover, it should be noted that digital applications (Apps) that include a social sphere for the promotion of healthy eating and diet are embedded in our current social, political, and cultural systems, and neglecting this point can contribute to unintentional unhealthy decisions about the population's health and well-being. As an example, in my discussion with one of the participants from the Woodbridge community about access to Apps that promote health and healthy eating, he drew my attention to the socially-constructed meaning of healthy eating and the broader issues pertaining to the production of food that occurs in the US economic system: *"The Apps that tell you how to eat healthier, and ask you to listen to, but ain't it true that they make food with chemicals? What about the fresh stuff that comes from the earth? Aren't they adding too many chemicals to the soil? So what you put in your body are chemicals! For example, there are certain types of apples with genetically modified sources with added chemicals with no nutrition! None! And now we just put some instructions in some App to eat healthier foods; This doesn't make sense!"* Consequently, the effects of the world capitalist system on population health, disease etiology, and even systems of food production are critical and the political and economic determinants of health and disease should always be considered in discussions around designing for health and wellbeing (Frumence et al., 2014).

6.4.1 Discussion on the role of older adults' health status and ability to engage with currently designed Social ICTs

Our health and quality of life throughout the life course is a function of many entangled environmental, cultural, social, political, and economic factors. Health problems associated with

weakness in the eyes and sedentary behavior were among the most identified issues that older adults referred to while discussing their impacts on their ability to engage with Social ICTs. Physical activity has documented health benefits; however, sedentary behavior due to engagement with Zoom and other forms of Social ICTs is a theme that was numerously highlighted in my research. It should be noted that research by Rueggeberg et. al., (2012) demonstrated that older adults with high levels of perceived stress and little exercise experienced worse physical health symptoms. Consequently, attention to the health benefits of physical activity is a necessity that designers of physical and digital experiences need to consider while creating experiences for the older generations.

My inquiries about eye problems with one participant took me on a journey that opened my eyes to an important issue of racial and ethnic discrimination in medical education and practice. She was suffering for a long time from an eye issue prevalent in people of African descent that if left untreated could lead to blindness. Despite visiting many ophthalmologists, no one was able to help her with her condition until one doctor, experienced in treating patients in Africa, was able to correctly diagnose her issue. Her experience calls for more awareness around health issues that people of color and minorities experience and in line with the findings of Nelson (2002), continued research and awareness will be required towards creating a more respectful health care delivery.

6.5 Exploring a spectrum of older adults' jobs, volunteer activities, and the impact of Covid-19 pandemic on older adults' social life

Volunteering is cited among the constructive pathways to successful aging and social health and engagement of older adults (Rowe & Kahn, 2015). During my interviews with seventeen older adults from a spectrum of socio-economic backgrounds, I identified that income

insecurity and older adults from lower socio-economic backgrounds could not easily transition into and contribute to volunteer work while they faced many obstacles during their participation in the labor force and after retirement. Obstacles such as poor health and lack of physical and mental strength accompanied many older adults that I interviewed coming from minority and lower socio-economic backgrounds; in addition, lack of assistance, volunteer-work or part-time position opportunities that offer training while respecting one's age, gender, health status, and backgrounds from the government sector was also obvious. I engaged in a conversation with a participant who lived in the Woodbridge Community – a retired African American factory worker on a fixed income – and he mentioned that he needed financial support to pay his bills and he was able to find support from the non-profit organization called the Detroit Urban League. The organization provides training and offers career development programs for African Americans and other persons of color (Urban League of Detroit & Southeastern Michigan, 2022): *“I got a part-time job at the Urban League. It is a program for the community. It's nice and keeps me busy. They got a senior citizens program, and they have jobs for senior citizens. So, I do maintenance and janitorial work and I go about four or five hours a day, Monday to Friday. It helps me with my income and gives me a little extra leeway to help me with my rent.”* Consequently, the presence of organizations such as the Urban League and accessibility of such networks of support especially for older adults from minority backgrounds and people of color can be instrumental in the wellbeing and social health of older adults.

Another participant – an African American retired woman – described the poor health conditions that deter her from any volunteer work after retirement: *“I worked at a wellbeing center working with mentally disabled people, I was secretary. I came down with termers and had to stop working!”* Her comments demonstrate one of many disabilities that older adults face,

especially those from disadvantaged backgrounds, that can significantly reduce their participation in volunteering and many forms of social activities.

Regarding some participants from higher socio-economic backgrounds, after retirement from their full-time positions, some expressed that they continued their participation in the work force as independent consultants, and some took on volunteer activities such as varied roles in Master Gardeners programs, conducting workshops in the community regarding topics in social work and older adults' care, and keynote speaker roles for humanitarian causes such as eradicating Polio. In addition, one's religious background also impacted their participation in volunteer activities. One participant emphasized her religious background while talking about her volunteer role: *“My religious background is Roman Catholic and I've been raised with a big interest in what we call social justice, making sure that people have safe places to live and food to eat and a fair wage and so on and so forth. Really living what we call our Gospel in the world. So it is very very important to me and I belong to some volunteer organizations where we help to do that work.”*

Consequently, although volunteering is among the constructive pathways to successful aging and social health and engagement of older adults (Rowe & Kahn, 2015), there are many nuances involved in older adults' capabilities to participate in such social instances related to their economic and health conditions.

6.6 City life and home spatial design: A look at the spectrum of older adults' home environments and the interaction of space and technology, and their impact on older adults' social life in light of the Covid-19 pandemic

In this section, with a focus on the built environment, I will illustrate a spectrum of older adults' home environments and discuss around physical access to outside that facilitated safe

social interaction during the Covid-19 pandemic (built environment features such as a backyard, enough spaces to physically distance, and visual access to outdoors through a window). I will also go over older adults' discussions of their current home environment and factors, including social ties and place attachment, that may motivate their decisions in staying at their homes. Moving on to the scale of community and cities, I will highlight the importance of public spaces and public infrastructure in communities and cities (such as public libraries) as crucial to the formation of social ties among residents. In addition, I will illustrate how the disruption to city life (closures in cities due to taking physical distancing measures during the Covid-19 pandemic) contributed to lost opportunities for the formation of organic social ties. Overall, the role of the built environment as the context and backdrop to the formation of social connections is highlighted in this section.

6.6.1 Home and physical access to outside that facilitated safe social interaction during the Covid-19 pandemic (features such as a backyard, enough spaces to physically distance, and visual access to outdoors through a window)

The housing arrangement of the participants that I recruited online ranged from single-family homes (home ownership) to rental condos, and rental apartments corresponding to their socioeconomic status. Participants from the village of Woodbridge in Detroit all lived in apartment units as part of the residential community. Single-family homes offered the most opportunities for physical distancing and taking safety measures during the Covid-19 pandemic – opportunities such as access to a backyard, which seemed critical for maintaining social contact with older adults' close social network. The participants described that friends and family members could gather in their backyard while adhering to the recommended physical distancing safety measures: “*We were very grateful that we have this house. We have a nice backyard area,*

so we would sometimes sit outside six feet distance for the children to come and we would eat dinner outside with six feet in between us.” In addition, older adults who mentioned living in single-family homes had access to adequate areas inside the homes for possible isolation and taking precautionary measures to quarantine: *“Our house is 3200 square feet just for the two of us, so during the pandemic, we were able to walk through the house in different areas and we had a lot of space to spread out.”* My interviews demonstrated that access to a backyard and adequate space to quarantine are critical built environment features that can protect older adults’ health during a respiratory pandemic. I should highlight that access to these potentially protective features is not equitably distributed among older adults. Those who mentioned living in a rental condo unit or apartment building did not describe having access to enough outdoor space to safely gather or even enough outdoor space to plant some greenery: *“In my condo, I can do a few balcony boxes and stuff, but I do try to have a lot of indoor plants inside.”*

With regard to remote work using some form of Social ICTs, among the participants who explained to have created a set-up for their equipment, access to the outside through windows was a feature that they described as critical for them. One participant living in a rental condo and working remotely mentioned: *“I have windows on my side. I wanted to make sure that I was looking at something; that I had outside. So that I can feel like I am connected to the rest of the world.”* Another participant also described her remote work set up in her apartment in Chicago facing Lake Michigan: *“I am sitting in my living room, at really my dining room table which really has become my office table. And I have this glorious view [of Lake Michigan]. I love being out here, I have no drapery because I want to see the work shifting. And I like the way the clouds are moving today and the chemtrails from the planes when they go by, I like looking at the water and I love the changes. I have a second bedroom which I turned into an office I just don’t love*

being in there for some reason. Being here is so much better because I get to look away for a moment, and I see the world out there which is great!” Consequently, visual access to the outside world through a window is another important built environment feature that can provide mental restoration for older adults, especially during a respiratory pandemic. I should highlight that access to this built environment feature is not equitably distributed among older adults from varied socio-economic backgrounds.

6.6.2 Home, and the importance of lighting as an ambient environment feature

In discussing ambient environment with the participants and modifications they make to their home settings while connecting virtually through different modes of social ICTs, lighting, and adjustments to it were the most discussed environmental quality. Participants discussed adjustments to the natural lighting through controlling sunlight from windows, adding artificial lighting, and adjusting the direction and warmth of artificial lighting.

In addition, lighting and its critical impact on health, especially in states such as Minnesota, where Seasonal Affective Disorder (SAD) is prevalent due to lack of sunny days was highlighted by one participant: *“I have a light that is helpful if I don’t have any direct sunlight from a window, it has different settings that you can put it on and you can get your daylight. I like having the light, especially in Minnesota because it gets dark early here and Seasonal Affective Disorder is a real thing. I lived in a loft downtown where there was no direct sunlight, so I used the light often.”* Her remarks point to the critical role of lighting design not only for the benefit of our eyes but also for our mental and emotional wellbeing.

As we discussed the wide range of engagement with varied modes of Social ICTs, one participant from the Woodbridge community, drew my attention to the importance of placemaking through the display of pictures and memories and its critical impact for the quality

of life of older adults: *“Sometimes it makes my mind easier with a phone call. I wish I could talk to my children more often. I got two daughters and they’re busy with their jobs. I got their pictures up on the wall, sitting next to the TV. When I look at all my children and grandchildren’s images, I feel like they’re sitting here with me!”*

6.6.3 Moving or staying? A look at older adults’ discussions of their current home environment and factors, including social ties and place attachment, that may motivate their decisions in staying or leaving their homes

6.6.3.1 Economic factors, social ties, and place attachment

As revealed in my research, economic factors are among the most important deciding factors in one’s decision regarding staying in one’s current home or moving to another residence. In addition, the richness of the established social ties and social capital that older adults form during their residence in a community seems to be another determining factor that may prohibit them from moving. One participant discussed these issues: *“Believe it or not, it has been less expensive for me to live in this house (four-bedroom Colonial house where she and her husband raised their children) than it is to go find another kind of dwelling because the mortgage is paid off and I have a dog and I like to have a place for the dog to exercise and many other residences would cost me a lot of money and I couldn’t have a dog! I know all the neighbors in this area, and I belong to a church that I like very much, and I don’t need to move. But I will admit that it’s a waste of space to have one person in a house this big! And that’s something I feel a little morally wrong about!”* Consequently, the existing rich social bonds in one’s community is among the determining factors for aging in place.

6.6.3.2 Non-inclusivity and inaccessible home designs can make life harder for older adults – Social technologies can play a role in alleviating older adults’ social isolation

In my conversation with one of the participants with a broken leg that required long-term use of a wheelchair, she described that the inaccessible design of her home, made her life challenging during her disability. Due to the inaccessibility of the top of the stove as well as the bottom of the sink, her cooking activities were very limited that negatively impacted her nutritious intake. Luckily, due to her long-time career as a renowned chef, her colleagues and friends were able to send her nutritious food and she would be able to enjoy a meal remotely together with her colleague or friend: *“I had a remarkable face-to-face social life when we could do that. But when I broke my leg, many spaces such as the top of the stove and the bottom of the sink were not accessible to me. But I still have the ability to turn on the I-Pad and to be with somebody, and the chefs would sometimes send over lunch, and then they would go back to their restaurants, and we would eat together.”* In addition, she mentioned that a room that she designated as office space was not accessible to her because the space did not allow for the wheelchair maneuver: *“I could not get into the office for a while; I just couldn’t maneuver in there! So I had to depend on figuring out how to do this as best as I could!”* Her comments clearly demonstrate a call for inclusivity and accessibility in spatial design. In addition, utilizing Social ICTs can play a role in lessening one’s social isolation burden in times of solitude.

6.6.4 Public libraries as social technology!

In the previous section, I described that many older adults altered a space in their home – among the frequently mentioned ones were dining room/living room area or a bedroom – to fit their needs of accommodating the Social ICT equipment and gadgets required for remote connection. I wanted to highlight that a participant – a freelancer involved in research, editing,

and writing manuscripts – mentioned public libraries as a crucial social technology for her: “*Besides the technology in my home, my other crucial technology was public libraries and the library of Congress.*” Her comment demonstrates that the technologies for social connection extend well beyond the gadgets and equipment for remote connection, into the fabric of communities and cities. Designers of the built environment play critical roles in the creation and maintenance of these rich public spheres where opportunities for spontaneous social connection form naturally among participants of urban life.

6.6.5 Disruption of city life and lost opportunities for the formation of organic social connections: “I mostly miss the things that are more about the environment and atmosphere of life!”

In my inquiries about the loss of social connections during the Covid-19 pandemic, one participant, involved in the virtual freelancing work on editing, writing, and research of manuscripts, identified the emptying of public urban spaces and loss of participation in the urban life of cities as a significantly missed urban experience at the time of my interview in February 2022: “*I miss things that are more about the environment and the atmosphere of life. Downtown Washington D.C. is kind of dead, I mean people just didn’t go back to their offices still. The food trucks are out but everything is a little bit sparse, you can tell something hit this area! So, you know, I like the trappings of urban life! Things like food trucks. Also things like being on the bus, seeing the people on the bus, seeing the bus drivers, getting on the metro, and seeing what people are reading. I take a lot of cues and information from my environment and there’s just a lot less of it out there!*”

This comment expressed by the participant highlights the theme that the urban public spaces in cities are crucial to the formation of organic social connections. These connections that

happen through participation in city life and spontaneous encounters are critical to our social wellbeing (Peterson, 2017; Barker et al., 2019).

6.6.6 Discussion on the role of the built environment of homes and cities as the context and backdrop to the formation of social connections

The role of the built environment as the context and backdrop to the formation of social connections was highlighted in this section. In the home environment, physical access to outside that facilitated safe social interaction during the Covid-19 pandemic was highlighted – built environment features such as a backyard, enough spaces to physically distance, and visual access to outdoors through a window. The healing impacts of nature, fresh air flow, and natural lighting are emphasized in the literature (Megahed & Ghoneim, 2020); and it should be noted that considering these features in the design of spaces, also enhances occupants' social health.

My research indicated that factors including social ties and place attachment may play a role in motivating older adults' decisions in staying at their current homes and aging in place. In line with this finding, research by Oswald et al., (2011) demonstrated that outdoor place attachment and perceived neighborhood quality were among the important factors for older adults regarding their life satisfaction.

And finally, moving on to the scale of community and cities, I referred to the importance of public spaces and public infrastructure in communities and cities (such as public libraries) as crucial to the formation of social ties among residents. In addition, I demonstrated that the disruption to city life (closures in cities due to taking physical distancing measures during the Covid-19 pandemic) contributed to lost opportunities for the formation of organic social ties.

6.7 Conclusion

The research questions that informed the qualitative research process were answered in this chapter. The first three research questions were structured to capture the critical factors that impact access, engagement, and experience with the Social ICT technologies – starting with the broad societal and economic forces that shape older adults’ perception and ending with looking at a specific example of Social ICT:

1) Engagement with Social ICT technologies – What are the systemic, as well as life course experiences and factors that impact the engagement of older adults with Social ICT technologies?

2) Perception and access to Social ICT technologies – How do older adults describe their access, interaction with, and sentiments towards ICT devices and technologies?

3) An in-depth look at Zoom as an example of a screen-based and voice-activated Social ICT: How do older adults describe their engagement and criticism of this type of Social ICT, as well as speculations about positive potentials of it?

Regarding the first question two themes were highlighted: 1) broad social, economic, and systemic issues, and 2) some determining life course experiences and their influences on older adults’ engagement with social ICTs. Regarding theme 1, initially, economic stressors and income disparities and their important influences on the affordability of participating in social activities were discussed. Second, lack of access to broadband internet and technology infrastructure during the life course, their translation to digital literacy gaps, and digital exclusion at the old age were expanded. Regarding theme 2, Some of the determining life course experiences, especially relative to our education and trainings in the workforce, as well as the

role of ‘heuristics’ were identified as influential on older adults’ engagement with the Social ICTs.

Regarding the second question, initially the experiences of older adults with the most frequently used modes of remote communication were discussed, and second, the potential of utilizing Social ICT infrastructure for providing access to telemedicine and telecare was expanded.

Regarding the third question that focuses on a specific example of Social ICTs – Zoom – initially I discussed the potentially positive and empowering aspects of utilizing social ICTs – namely, bridging for social engagement between generations, a vehicle for maintaining relevancy throughout old age, and a vessel for participation and activism in the community. In addition, I outlined the criticisms and potentially negative aspects of engagement with Zoom as an example of an audio-visual social ICT; aspects such as loss of human-to-human connection and social bonds, perpetuating Lookism and Classism, and contribution to physical inactivity.

4) Body, health, and ability to engage with currently-designed ICT technologies – How do older adults describe health issues that impact their ability to engage with the currently designed ICT technologies?

5) Exploring a spectrum of older adults’ jobs, volunteer activities, and the impact of the Covid-19 pandemic on older adults’ social life.

6) City life and home spatial design: A look at the spectrum of older adults’ home environments and the interaction of space and technology, and their impact on older adults’ social life in light of the Covid-19 pandemic.

The fourth research question was structured to investigate health issues common as we age and whether the current ICT technologies available to older adults are designed while

considering them. The fifth research question was structured to reveal challenges of social life after retirement (volunteering or continuation of involvement in the workforce) in light of the Covid-19 pandemic. And finally, the sixth question was formulated to reveal the urban and the domestic spatial contexts that allow for social interactions to form considering the Covid-19 pandemic – whether through Social ICT technologies or in-person participation in city life. The role of the built environment as the context and backdrop to the formation of social connections was highlighted in the section.

Chapter 7 Synthesis of Findings

As discussed in previous chapters, a two-phased research design – that involves combining a correlational research strategy in stage one and a qualitative research strategy in stage two – was employed to answer the primary research questions in this study. In this chapter, a synthesis of the critical findings of the two research strategies will be presented to link the results of both stages and offer a comprehensive understanding of the connection between environmental design and technologies for social well-being of older adults. I will utilize the qualitative research findings to explain and provide the potential explanatory context for the patterns and results of the quantitative analysis. The results of this chapter will inform the evidence-based recommendations, concluding remarks, and suggested future work that is presented in the following chapter.

Both the quantitative and qualitative research strategies demonstrated that to ensure a socially integrated and healthy aging experience for older adults, attention to the continuity of design, from the scale of technology design to home and neighborhood, becomes essential. Attention to this integrative approach and the continued connection of experiences is critical for social well-being and healthy aging.

While in this research, the role and entanglement of technology with space was evaluated, the decisive role of policies and the overarching changes that accompany broad policy shifts should not be forgotten. For example, many neighborhoods continue to expose residents to environmental pollutants and toxins; and while at the policy level, there is progress to be made

for recognition of rights to housing and rights to health as human rights, built environment designers can actively partner with community activists, grassroots organizations and movements to ensure all residents – including older adults – are living and aging in healthy environments.

In the following chapter segment, I will provide a synthesis and summary of findings from the two research strategies that cover the following three scales of technological and environmental design: 1) technology; 2) home; 3) neighborhood, community life, and access to public resources.

7.1 Technology and social well-being

7.1.1 Barriers to engagement with virtual modes of communication

Responses to my quantitative research inquiry about the built environment features that may act as barriers to older adults' engagement with social ICTs and virtual modes of communication, indicated the minimal role of the built environment; Poor lighting and glare (15.04%) were mentioned. However, it appears that other underlying conditions may play critical roles in preventing one from virtual socialization. I explored this question further during my interviews and the results of my qualitative research revealed the determining role of economic stressors and income disparities on one's ability to afford technological equipment and participating in social activities. One participant discussed the obstacles that limited his engagement with Social ICTs: "*When you can talk to a device and it will happen, that's the best thing in the world! But you got to have the device! That costs, you know! As people get older, the money is not there! Some people have to take care of their medication first, and if they do, they cannot eat! If they eat, they cannot take care of their medication! Affordability is a very big issue!*" Consequently, my research pointed to the concepts aligned with the idea of "cumulative disadvantage over the life course, that translates into the digital divide among the aging

population and creates major obstacles in engaging with varied forms of Social ICTs (Cotton, 2021).

In addition, the qualitative research revealed that lack of access to broadband internet and technology infrastructure during the life course, translates to digital literacy gaps and digital exclusion at the old age. In line with Cotton (2021) on her conceptualization of ‘the life course paradigm’ (Elder, 1995) that illustrates ICT use varies across one’s life course depending on historical timing, proliferation of technologies, different formative experiences, this research also highlighted some of the determining life course factors such as educational backgrounds and trainings in the workforce as critical to one’s access to Social ICTs at the old age.

7.1.2 Positive potentials of engagement with social ICTs

The results of the multiple linear regression revealed a statistically significant association between ‘frequently’ or ‘sometimes’ using video-calling to socialize with family and friends and decreased loneliness levels among the older adults while controlling for: age group, marital status, quality of internet access, having extended family in the same town/city as the respondent. I made a conjecture that access and engagement with a form of Social ICT is among the buffering factors that can mitigate the harmful impacts of loneliness among the older adults – especially during times when our access to in-person social support can be limited or non-existent.

The results of my qualitative research pointed to some of the potentially positive and empowering aspects of utilizing social ICTs – namely, bridging for social engagement between generations, a vehicle for maintaining relevancy throughout old age, and a vessel for participation and activism in the community: *“It [Zoom] has allowed me, because one of my interests is agism and elimination of older adults, so being able to do workshops virtually has*

given me more exposure. I've been able to have more exposure in the community and in my social work community as well."

My findings are in line with Cotton, (2021, p. 382) conceptualization of 'sense of mattering' that points to "an individual's recognition of his or her value and importance to others – e.g., the perception by an individual of being important, acknowledged, and relied upon by social ties (Rosenberg & McCullough, 1981) through social connectedness (Francis et al., 2016; Francis et al., 2019)." Social ICTs can potentially empower and enhance a sense of mattering among the older population.

One policy implication of this finding points to public programs such as Medicare's recognition of the positive impacts of access to Social ICTs for older adults' well-being and provision of funding for access to the technologies for social connection among the older population.

7.2 Home spatial design for social well-being

There is a growing recognition that housing is a social determinant of health, and this perspective encourages us to adopt the 'health equity' lens in providing equitable housing, especially for the older generations (Gonyea, 2021). Access to housing is part of the healthy aging vision, and living in an affordable, accessible home in a livable community is associated with well-being outcomes (i.e., physical health, cognitive well-being, mental health, and improvements in daily living quality) (Gonyea, 2021). The findings in my quantitative research also emphasized attention to inclusive design and accessible features of homes and their centrality for social interaction and social health of older adults. Regarding barriers to in-person social activities, more than one-third of participants identified the lack of inclusive and accessible design of the home as their first choice. Attention to inclusive design and accessibility

are discussed in the literature on planning for an aging population (Carr et al., 2013). Features such as step-free access to the home, barrier free spaces, and ground-level access to bedrooms and bathrooms have been extensively discussed in the literature regarding equitable accessibility for people across the life span (Wellecke et al., 2022). This research shows that inclusive and accessible design features are also critical for the social health of older generations as they age in place.

In addition to inclusive and accessible design features in homes, the results of my qualitative research showed that residential built environment features such as a backyard, adequate spaces to physically distance, and visual access to outdoors through a window facilitated safe social interaction and contributed to older adults' well-being during the pandemic. Having access to public green spaces nearby one's home such as parks and communal gardens is important to protecting older adults' social well-being during public health emergencies such as the Covid-19 respiratory pandemic.

7.3 Neighborhood, community life, and access to public resources and their impacts on social well-being of the older adults

Attention to the physical characteristics of neighborhoods is essential to residents' physical and mental well-being, physical activity, and ability to participate in social activities (Aneshensel, Harig, & Wight, 2016). These physical dimensions of neighborhoods include designs that promote walkability and pedestrian-friendly features, diversity of land use, and density of housing (Aneshensel, Harig, & Wight, 2016). The findings of my qualitative research demonstrated that healthy aging in place and social well-being not only depends on the environmental characteristics of the home environment, but also the community and

neighborhood. Lived experiences of the older residents also include the connection of their homes to the surrounding neighborhood and community.

My qualitative findings showed that public spaces are crucial to the formation of organic social connections and collective efficacy. These connections that happen through participation in city and community life and spontaneous encounters are critical to our social well-being: *“I like the trappings of urban life! I mostly miss the things that are more about the environment and atmosphere of life!”*

As discussed in the previous section on quantitative findings about the ‘home’ environment, access to yards, gardens, and porches was critical for older adults’ social connections. Adopting a health equity lens encourages designers and planners to consider equitable access to communal green spaces for residents’ well-being throughout their life course.

Table 7.1: Summarized synthesis of findings.

<p style="text-align: center;">Quantitative Research Strategy (Correlational research – survey questionnaire)</p>	<p style="text-align: center;">Qualitative Research Strategy (Conducting in-person and virtual interviews with older adults)</p>
<p style="text-align: center;">1) Technology a. Barriers to engagement with virtual modes of communication</p>	
<p>In the survey questionnaire, responses to the inquiry about the built environment features that may act as barriers to older adults’ engagement with social ICTs and virtual modes of communication, indicated minimal role of the built environment; Poor lighting and glare (15.04%) was mentioned. However, it appears that other underlying conditions may play critical roles in preventing one from virtual socialization.</p>	<p>My interviews revealed the determining role of broad social, economic, and systemic disparities and stressors, and their interaction with older adults’ social life. These systemic and life course factors can act as critical obstacles to older adults’ access and engagement with Social ICT technologies:</p> <p><i>“None of that [pieces of technology used for virtual communication] is available to me because fixed income puts those way out of reach! I would love to have something like that you know, but affordability is a very big issue. Tablets and computers cost! And when you are on a fixed income, money is not there!”</i></p>
<p style="text-align: center;">1) Technology: b. positive potentials of engagement with social ICTs</p>	

<p>The results of the multiple linear regression revealed a statistically significant association between ‘frequently’ or ‘sometimes’ using video-calling to socialize with family and friends and decreased loneliness levels among the older adults while controlling for: age group, marital status, quality of internet access, having extended family in the same town/city as the respondent.</p> <p>I made a conjecture that access and engagement with a form of Social ICT is among the buffering factors that can mitigate the harmful impacts of loneliness among the older adults – especially during times that our access to in-person social support can be limited or non-existing.</p>	<p>Social ICTs potential for empowering older adults:</p> <ul style="list-style-type: none"> - vehicle for maintaining relevancy and participation in society, community activism, etc. - opportunities for mentorship, bridge between generations, transfer of knowledge - Virtual platforms can expand access to community engagement and activism for the older adults: <p><i>“It [Zoom] has allowed me, because one of my interests is agism and elimination of older adults, so being able to do workshops virtually has given me more exposure. I’ve been able to have more exposure in the community and in my social work community as well.”</i></p>
<p>2) Home</p>	
<p>Kitchen, living room, and dining area, were identified as the most frequently utilized indoor spaces for in-person socializing by the participants prior to the pandemic. Attention to inclusive design, accessible features, natural ventilation of these spaces, and provision of access to outdoors are among the environmental design strategies to allow for safe social interactions during a highly contagious respiratory pandemic.</p>	<p>Residential built environment features such as a backyard, enough spaces to physically distance, and visual access to outdoors through a window facilitated safe social interaction and contributed to older adults’ well-being during the pandemic.</p> <p><i>“I have windows on my side. I wanted to make sure that I was looking at something; that I had outside. So that I can feel like I am connected to the rest of the world.”</i></p>
<p>3) Neighborhood, community life, and access to public resources</p>	
<p>Yards or gardens, and porches were among the exterior spaces that were reported as most frequently utilized for in-person socializing prior to the pandemic. It should be highlighted that access to outdoor open space is a valuable resource for older adults’ social and physical well-being, particularly during the public health crisis times, and we learned that access to this resource is not equitable among the older generations. Designers and planners need to adopt a human rights lens while planning cities and consider <u>equitable access to communal green spaces</u> for residents’ well-bring throughout their life course.</p>	<p>Urban public spaces in cities are crucial to the formation of organic social connections. These connections that happen through participation in city life and spontaneous encounters are critical to our social well-being:</p> <p><i>“I like the trappings of urban life! Things like food trucks. Also, things like being on the bus, seeing the people on the bus, seeing the bus drivers, getting on the metro, and seeing what people are reading. I take a lot of cues and information from my environment and there’s just a lot less of it out there [during the pandemic]!”</i></p>

7.4 Technology, Home, Community: An integrative approach to design for aging in place and designing a continuum for healthy aging

Adopting a health equity lens has been emphasized among policymakers to designate rights to healthy housing as a critical piece of a healthy aging solution (Gonyea, 2021). Many low-income older adults struggle daily with housing that is affordable and resources that they need to be healthy, such as nutrition and access to healthcare. Advocating for health equity in housing in later life, would ensure access to affordable and secure housing that allows for active participation in community life for the older people regardless of race, sexual orientation, ethnicity, socioeconomic status, and zip code (Gonyea, 2021).

The two research strategies incorporated in this research demonstrate an intimate entanglement between inclusive and accessible design of Social ICTs, design of spaces of older adults' residences, and connection to the neighborhood and community life and resources. Attention to this integrative approach and continued connection of experiences is critical for social well-being and healthy aging.

To demonstrate this continuity of design, in my quantitative research and the inquiry about features of the built environment that may encourage the participants to engage in virtual socializations about half of the participants (49.55%) identified 'ability to engage in creative virtual activities and/or games with others (creating music, cooking food, or any other DIY activities', as their top choice. 'Ability to share live views of my window or flowers in my garden' were the second most chosen option (48.21%). Consequently, 'experiential sharing' is highlighted throughout this research and the interior and architectural design features are identified as central to the creation of virtual social experiences for the older adults. In addition, my interviews also captured this continuity of design: among the participants who explained to

have created a set-up for their remote work and ICT equipment, access to the outside through windows was a feature that they described as critical for them. One participant living in a rental condo and working remotely mentioned: *“I have windows on my side. I wanted to make sure that I was looking at something; that I had outside. So that I can feel like I am connected to the rest of the world.”* In another instance, in my inquiries about the loss of social connections during the Covid-19 pandemic, one participant involved in virtual freelancing work on the editing, writing, and research of manuscripts, identified the emptying of public urban spaces and loss of participation in the urban life of cities as a significantly missed urban experience_at the time of my interview: *“I miss things that are more about the environment and the atmosphere of life. Downtown Washington D.C. is kind of dead, I mean people just didn’t go back to their offices still. I like the trappings of urban life! Things like food trucks. Also things like being on the bus, seeing the people on the bus, seeing the bus drivers, getting on the metro, and seeing what people are reading. I take a lot of cues and information from my environment and there’s just a lot less of it out there!”*

Aligned with the health equity lens, architects and built environment designers are encouraged to actively adopt a health lens while designing spaces – from the scale of interior design to the design of communities and cities. Designing experiences for healthy aging requires a shift of perspective; this shift requires moving away from designing spaces or technologies in social and cultural vacuums, and actively considering the design of the continuum of experience of healthy aging – from access to Social ICTs within interior spaces of a home, to access to public transportation, healthcare and healthy food within one’s community.

Chapter 8 Conclusions: Design and Research for the Future of Healthy Aging-in-Place

8.1 Recommendations – design of policies, spaces, and technologies

Older adults are a heterogeneous population and experience a spectrum of cumulative advantages and disadvantages throughout their lives. The impacts of the compound advantage or disadvantage throughout life result in people reaching old age in distinct health states and trajectories (Gonyea, 2021). Understanding this perspective is valuable for environmental and technological designers as it encourages to adopt a ‘health equity’ lens while designing technologies, intergenerational residential environments, and communities for healthy aging. Flexibility and multiplicity in designing for a range of abilities, social, cultural, and economic backgrounds are encouraged to provide healthy aging opportunities for older people regardless of zip code, socioeconomic status, race, ethnicity, and income.

At the health policy level, the implications of recognizing ‘housing’ as a social determinant of health must encourage stronger ties between health care and housing policies. Adopting this perspective would entail expanding funding for housing initiatives through Medicare and Medicaid and providing access to supportive services as well as social ICTs in homes. In addition, policies designed to reduce the costs of homeownership for older people such as property tax cuts and utility subsidies should be considered (Aneshensel, Harig, & Wight, 2016).

In line with the literature, the results of this research illustrated the benefits of access to Social ICTs for older adults as a resource for battling isolation and loneliness. While access to

this resource is not equitable among the older people (economic constraints being one of the major obstacles in access to Social ICT devices), the implications of the research findings points to advocating for government health policies that incentivize and/or subsidize access to social ICTs, especially among the marginalized older populations.

In a closer look at the FY 2022's NOFO Toolkit (Notice of Funding Opportunity) published by HUD's (Department of Housing and Urban Development) Section 202: Supportive Housing for the Elderly Program, HUD prioritizes sponsorship for the construction of supportive housing that promotes long-term wellness, aging in place, and supporting social health for very-low-income older adults (FY 2022 section 202 Supportive Housing for the Elderly Program, 2023). However, in the 'Physical Design' section of the toolkit, 'Technology' is defined broadly and through general features without any prioritization for social well-being – i.e., providing access to internet infrastructure is listed as an optional point that is bundled with features such as 'wireless door locks with fob', or 'in-unit control of unit temperature'.

In light of this research and other studies completed after the Covid-19 pandemic, it is highly recommended that provision of internet infrastructure as well as necessary Social ICT devices, supportive spaces, as well as training and educational infrastructure, be recognized and prioritized as influential to older adults' social health and quality of life in this toolkit. HUD's funding criteria and toolkits are important apparatuses that enhance the baseline for the design and construction of housing that is supportive of older adults' social health and quality of life. Through innovative policies and funding opportunities, HUD, Medicare, and Medicaid can potentially collaborate in creating stronger ties between housing and health care for the provision of healthy housing for the older adults.

Recognition of housing as a social determinant of health among health systems is essential in elevating population's health and well-being. Kaiser Permanente, as the largest integrated health system in the US, has allocated investments to address housing stability and is actively involved in strategic community partnerships and coalitions that provide affordable housing (Choucair & Watts, 2018). Housing is key to improving health and is urgently requiring health care sector to recognize housing as a form of health care. Prioritizing health equity requires policy interventions to recognize housing and health care as human rights.

At the urban design, community, and neighborhood planning level, prior research demonstrates the relationship between neighborhood socioeconomic disadvantage and a range of poor health outcomes among the older population such as: mortality, number of chronic conditions, self-rated health, depressive symptoms, and cognitive functioning (Aneshensel, Harig, & Wight, 2016). For example, living in impoverished and disadvantaged neighborhoods has been associated with low levels of cognitive functioning, especially among the poor older adults; while the neighbors from higher socioeconomic groups appeared to be protected from the negative impacts of the impoverished neighborhood (Aneshensel, Harig, & Wight, 2016).

These findings align with the Neighborhood Stress Process Model that posits the idea of 'compound disadvantage.' The Compound disadvantage model predicts that personally disadvantaged residents suffer the most from living in disadvantaged neighborhoods (Aneshensel, Harig, & Wight, 2016). Consequently, adopting a 'health equity' lens is critical for investments in the urban design and planning of our cities, communities and neighborhoods. Attention to the inclusive and accessible design of physical infrastructure (roads, sidewalks, healthcare infrastructure, access to clean water and nutrition, etc.), accessible public

transportation systems and walkability, green spaces, and density of housing, and diversity of land use are critical to realizing the vision of equitable healthy aging.

At the architectural and interior design level of residential spaces and integrated Social ICTs – Design for ‘Experiential Sharing’: Although attention to inclusivity and accessibility has been repeatedly advocated in the architecture and design literature, only 3.5% of the US housing stock are designed with accessibility in mind (Gonyea, 2021). As previously discussed regarding the environmental design of homes, built environment features such as access to a backyard, enough spaces to physically distance, and visual access to outdoors through a window facilitated safe social interaction and contributed to older adults’ well-being during the pandemic. And as people reach old age in different health states and economic capabilities, provision of diversity of housing sizes, and typologies is necessary to their healthy aging. However, inclusive and accessible design, as well as access to green spaces and outdoors (ranging from a public and communal format to window and visual access to green spaces for each individual home) are features that are necessary for healthy aging regardless of housing size.

In addition, this research finds that the frequency of Social ICT use and the experience of less loneliness is aligned with the ‘social causation perspective (Cotton, 2021).’ And more specifically, the positive potential of using ICTs among the older adults to maintain connection with social ties that can assist them in enhancing their social contact and well-being (Cotton, 2021). Consequently, equipping the residential environment with internet infrastructure, and providing spatial features and qualities such as attention to lighting and interior elements that can cater to group activities and virtual creative activities is encouraged.

Finally, the idea of utilizing Social ICTs for ‘experiential sharing’ was highlighted throughout this research, underpinning the importance of designing at the intersection of physical space and the digital interface. To create an interactive and co-creative experience (i.e., transferring culinary knowledge, participation in communal events and social activism, etc.) while engaging Social ICTs, the supportive role of the built environment and spatial features, such as adequate lighting, becomes essential.

Experiential sharing via Social ICTs is associated with the creation and reinforcement of social bonds, as well as sense of belonging and community in the virtual space (Munzel & Kunz, 2016). In addition, Social ICTs have been identified as having a potentially beneficial impact on family dynamics through the creation of a collective experience via pathways such as assisting in maintenance of family relations and improving their communication and connectedness (Trilar et al., 2018). Consequently, with the increasing infiltration of technology in our daily spaces, it is becoming more important than ever for the environmental designers to recognize this positive potential of the built environmental design (via avenues such as spatial design that accommodates virtual indoor and outdoor group activities, lighting design, ergonomics, acoustics, etc.) for creation of a healthy experience for people across the age spectrum.

8.2 Study limitations

As discussed in chapter 4, the online distribution of my survey questionnaire through the Twitter social media platform was primarily due to the need for social distancing measures recommended during the time of my data collection and the logistical limitations faced during the Covid-19 pandemic. Consequently, it limited my survey to the older adult respondents who are adopters and users of social media. To overcome sampling bias and improve generalizability

of the findings, the characteristics of the sample frame should match the diversity of the target population as much as possible.

Another limitation points to the representation of a diverse range of older adults in this research. As previously discussed, older adults across the United States experience a spectrum of cumulative advantages and disadvantages throughout their lives, thus, reaching old age at distinct health states. Consequently, conducting cross-sectional research and relying on a relatively limited number of participants does not represent the full diversity of the experiences of aging across the country.

And finally, participants from the Woodbridge independent housing community in Detroit were gracious to allow me to conduct in-person interviews to overcome some of the issues related to sampling bias earlier. However, due to time and budget constraints, I was not able to administer the survey questionnaire to the Woodbridge residents and enrich the results of my quantitative research with their insights.

8.3 Future directions for research

One important future direction for conducting impactful environmental design research points to identification of **exemplary** architectural design of intergenerational living for the older adults and study the contribution of socio-spatial design to residents' social well-being and enhanced quality of life. It is essential to describe the contribution of environmental design features, from the scale of interior to urban design, to the projects' success while also delineating the contribution of health and economic policies that contributed to the projects' successes.

In addition, in this research participants were rarely located in or near a green outdoor environment while video-calling. As previously discussed, the benefits of in-person immersion in green spaces for psychological and physical well-being of older adults is well documented

(Pleson et al., 2014; Hooper et al., 2020). A potentially promising association to explore in future studies could be based on investigating the relationship between video-calling while having access to views from the outside, or sitting at/near a yard, garden, balcony, or porch, and the participants mental wellbeing and quality of life measures. Understanding this relationship can have important implications for the design of virtual experiences that happen within physical settings.

8.4 Thesis contributions

“Aging-in-place” and healthy aging perspectives advocate for environments, programs, services and technologies that allow non-institutionalized and community-dwelling older adults to enhance their quality of life. Aligned with these goals, opportunities for maximizing their social engagement and connection to their social network, communities and neighborhoods should also be highlighted. The research in this dissertation research was an exploratory study to understand the role of Social ICTs in residential spatial arrangements that may facilitate older adults’ social engagement. The research questions, research design, and data collection were conceived and conducted as the Covid-19 pandemic and the pre-cautionary physical distancing measures were exacerbating social isolation and loneliness for all the people around the world – particularly older people. It explored and clarified the close entanglement of broader societal health policies in relation to spatial and technological outcomes and innovations: form follows policies.

The thesis stemmed from the following research objectives: 1) to understand the connections between environmental design and the design of Social ICTs for battling social isolation among the older people; 2) to formulate research questions that explore the relationships between access to Social ICTs and residential spatial features of older adults’

homes that impact their social connectedness; and 3) to inform design and environmental design research through contextualizing the findings of the research within the related fields of design and public health.

Situated at the intersection of environmental design research and public health, this research contributes to informing equitable environmental, technological, and policy design interventions that encourage healthy aging; an integrative approach to design for healthy aging in place is encouraged.

APPENDICES

Appendix A: Tables Related to the Systematic Review of the Literature Chapter

Appendix Table A-1: Summarized characteristics of the included studies.

	Author (s) (year)	Level	Methods	Participants	Intervention	Setting	Results
1	Yngve Dahl & Erica Löfström (2019)	3b	Methods: Interviews; Qualitative, participatory, and explorative approach through conducting workshops; multi-stakeholder participatory approach	Participants: Care center residents, activity coordinator, department manager, nursing assistant, Kindergarten employee, Culture Coordinator, Car technology coordinator, Municipal manager	Intervention: Interactive technologies for social inclusion: large interactive displays that would facilitate co-design work	Setting: Residential care centers in Norwegian municipalities	“Places” and already established “Hubs” of social activities as suitable locations for implementation of socially inclusive technology and intergenerational interactions.
2	Peek et al., (2015)	3b	Methods: The researchers employed qualitative explorative field study that involved home visits to community-dwelling older adults. Purposive sampling was utilized to represent a broad spectrum of older adults with variations in the level of	Participants: 53 community-dwelling older adults, between the age of 68–95	Intervention: N/A	Setting: Home of each participant in the Netherlands	Thematic Analysis was utilized for analysis of the gathered data . 6 major themes that was found to be influential on the level of technology use by the older adults in the context of aging in place: <ol style="list-style-type: none"> 1) Challenges in the domain of independent living 2) Behavioral options 3) Personal thoughts on technology use 4) Impact of the social network

			<p>technology experience, health conditions, and living arrangements. Semi-structured interviews were conducted to understand reasons that the older adults used technology.</p>				<p>5) Impact of organizations 6) And the role of physical environment</p> <p>In a deeper look at the interaction of technology with the participants' home environment, the researchers reported environment (inside the home as well as the outside and community environment) affected older adults' technology use and their technology-related beliefs and attitudes. The authors concluded that in line with the literature on environmental gerontology and health geography, in developing technologies for aging, attention to the physical environment is critical.</p> <p>Page 235: "Older adults 'perception and use of technology are embedded in their personal, social, and physical context'"</p>
3	Cahill et al., (2019)	3b	<p>Methods: Page 485: "Action Research study: The researchers employed methods from human factors research and combined "qualitative human-machine interaction (HMI) design frameworks/methods, including realist ethnography, process mapping,</p>	<p>Participants: Two key stakeholders in the study were (1) older adults/residents and (2) care givers.</p>	<p>Intervention: N/A</p>	<p>Setting: Oneview Healthcare residential care environment – Dublin</p>	<p>Results: As a conclusion to a 3-phased study, the researchers argued that technology that promotes interdependence, relationship-centered care, and advocates social communication among key roles including: family members, residents, and caregivers, is linked to high quality of life for older adults.</p> <p>Throughout their studies, the researchers conceptualized a sensing framework that would</p>

			<p>persona-based design, and participatory design.”</p> <p>In addition, “stakeholder evaluation” that required active participation of stakeholders throughout the project was also used as an overall approach in this study that is comprised of three phases.</p>				<p>govern the technology development; the framework includes three dimensions of 1) the resident wellness 2) the resident’s environment 3) care delivery.</p> <p>Environment is described as an important component that impacts both resident’s social and physical health and can be modified according to the changes to the care delivery and the presence of caregiver in the environment.</p> <p>Overall, the researchers encouraged premising technology development on biopsychosocial models of wellness, the state of the home/environment, and social relationships between older adults, family members and the members of professional caregiving community.</p>
4	Petersson, Lilja, & Borell, (2012)	3b	<p>Methods: Page 793: “explorative qualitative design influenced by grounded theory (Glaser and Strauss 1967) and a hermeneutic interpretative approach as described by Ödman (2007).”</p>	<p>Participants: Over 65 (n= 8) with variations in age, gender, housing and social condition, rural or urban areas, and the home modification received. The participants were recruited from the previous longitudinal research undertaken by the authors and had to have</p>	<p>Intervention: Receiving home modification & related technologies and services & their impacts on experiences of safety in daily lives of older adults</p>	<p>Setting: This qualitative research was conducted as part of a longitudinal research program that studied impacts of home modifications</p>	<p>Data was analyzed using a comparative approach (Glaser and Strauss 1967)</p> <p>Results: The researchers highlighted three prerequisites for feeling safe in everyday life: 1) feeling healthy 2) having someone to rely on 3) feeling at home.</p> <p>These prerequisites are foundational and if unfulfilled, technology alone cannot improve experiences of safety. In that regard, social environment</p>

				reported lack of safety in Part I of the Client-Clinician Assessment Protocol (C-CAP)		for older adults during 2002-08 in Sweden	is mentioned as a prerequisite for feeling safe and benefiting from technology. The findings draw our attention to the importance of social and physical context of older adults' lives while developing any impactful technology that is intended to improve their safety and autonomy.
5	Juul, Wilding, & Baldassar, (2019)	3b	<p>Methods: Qualitative ethnographic fieldwork that utilized Case Study and included a mix of qualitative ethnographic fieldwork tools:</p> <p>participant observation and taking field notes (n=18), face-to-face conversations,</p> <p>video ethnography,</p> <p>in-depth semi-structured interviews with residents (n=15), family members (n=10), and staff (n=5).</p>	<p>Participants: Page 4: "The participants were residents from high care wards between 67–100 years old. Between 4–12 residents participated in the"</p>	<p>Intervention: incorporation of technologies (Touch Screen Technology) that can transcend cultural and language barriers towards promoting meaningful social and physical activities</p>	<p>Setting: residential aged care facility in Perth, Western Australia, that hosted Culturally and Linguistically Diverse (CaLD) residents from non-English speaking backgrounds</p>	<p>Results: interdependent factors, including environmental, organizational, caregiver, patient, and management- & government-related influence residents' engagement with the technology.</p> <p>For the technologies to enhance quality of life, and increase meaningful social and physical engagement among residents, they need to be successfully integrated into the daily life and the established social ties between staff and residents.</p> <p>In their discussion about environmental factors, the authors mentioned that an amalgam of organizational, management- & government-related factors, as well patient- and caregiver-related ones can limit environment's potential to allow for opportunities for physical activity and social interaction among residents and staff – the finding is in line with the Socio-ecological model of health.</p>

							<p>The researchers advocated for “social relational dimensions of technology interventions” in supporting their successful application.</p> <p>They also highlighted the crucial role of government and policy makers in prioritizing increased physical and social activities in residential aged care facilities.</p>
6	Roberts, De Schutter, Franks, & Radina, (2018)	3a & 3b	<p>Methods: Participants filled out a “short survey on demographic characteristics and comfort with using technology” after engaging in the VR experiment. Page 28.</p> <p>Focus groups were also conducted with participants.</p>	<p>Participants: Residents of a Midwestern CCRC (n= 41)</p>	<p>Intervention: VR simulation using VR headset</p>	<p>Setting: A Midwestern continuing care retirement community (CCRC) in the US</p>	<p>Results: The researchers intended to explore the older adults’ responses to the audiovisual virtual reality (VR) experience. After performing analysis of the gathered data, researchers summarized recommendations for improving VR technology:</p> <ol style="list-style-type: none"> 1) Promoting social connectivity with family or friends 2) Increasing interactivity 3) Attention to factors that facilitate older adults’ ease of use; and education of developers of technology about cognitive and physical changes of any aging adult in terms of changes to body movement, sight, hearing, etc. that affect their use of technology. <p>The researchers highlight incorporation of older adults’ needs and preferences while</p>

							<p>developing the VR technology.</p> <p>I concluded that any environment (virtual or physical) shapes our social interaction. This research highlights the critical role of interactivity and social connectivity within a virtual setting.</p>
7	Willard, Cremers, Man, van Rossum, Spreeuwenberg, & de Witte, (2018)	5	<p>Methods: The study followed principles of User-Centered Design including: assessing user requirements through observations and interviews. The platform was tested with participants.</p>	<p>Participants: community-dwelling older adults</p>	<p>Intervention: an online community care platform (OCC-platform) comprising of care, health, and communication functions</p>	<p>Setting: Netherlands</p>	<p>Results: The online community platform was found as useful for social participation and self-management of frail older adults.</p>
8	Bruggen cate, Luijkx, & Sturm, (2019)	3b	<p>Methods: Semi-structured interviews were conducted with community-dwelling older adults. Topics covered:</p> <ol style="list-style-type: none"> 1) Social networks 2) Social support 3) Connectedness 4) Neighborhood 5) Activities and hobbies <p>Use and experience with social technology</p>	<p>Participants: community-dwelling older adults (minimum age 75) (n=12) who were identified by professional caregivers to be at risk for loneliness or social isolation.</p>	<p>Intervention: N/A</p>	<p>Setting: Southern region of the Netherlands</p>	<p>Results: The researchers aimed to investigate the social needs of older adults and the role of social technology in achieving them,</p> <p>The results emphasized the heterogeneity and diversity of social needs among older adults. The authors emphasized two suggestions with regard to social networks of older adults and the role of social technology:</p> <ol style="list-style-type: none"> 1) “Supporting and improving the world close by (their neighborhood)

							<p>2) Bringing the outside world a bit closer” page 1827.</p> <p>I also concluded that the results supports the idea that technology needs to be shaped by the social and physical world as experienced by us.</p>
9	Kim, Cho, & Jun, (2020)	5	<p>Methods: The study followed principles of User-Centered Design</p>	<p>Participants: 12 experts from different fields such as IT service industry, medical industry, architectural design, business enterprise, analyzed and commented on various scenarios that were developed based on ethnographic accounts.</p>	<p>Intervention: N/A</p>	<p>Setting: South Korea</p>	<p>Results: This interdisciplinary research revealed that Smart Homes need to be connected to expanded to encompass communities that residents live in. Similar to the concepts of telemedicine that included a network of hospitals and health care spaces, Smart Homes need to be connected to the infrastructure in the community such as libraries, sports facilities, etc.</p>
10	Castro Rojas, Bygholm, & Hansen, (2018)	5	<p>Methods: Design-based research project that utilizes a focus group with older adults, and interviews with professionals that teach older adults about using ICTs.</p>	<p>Participants: Focus group was conducted with 7 older adult users of ICTs. 2 interviews were conducted with professionals working on teaching older adults about using ICTs.</p>	<p>Intervention: N/A</p>	<p>Setting: Costa Rica</p>	<p>Inductive process of content analysis</p> <p>Results: The study demonstrated that age-related changes and interaction needs and preferences of older adults are among critical aspects that if appropriately considered in the design of learning environments, can encourage engaging with ICTs among the older generations and closing the digital divide.</p>

Appendix Table A-2: Clarifying the limitations for each included study.

	Study	Limitations
1	Dahl & L�fstr�m, 2019	<p>The authors recognized several limitations involved in their study:</p> <ul style="list-style-type: none"> • Participation of limited number of representatives per each stakeholder group could undermine generalizability of the generated knowledge outcomes from participants perspectives and experiences • Due to the minor representation of some stakeholders in the study that affected the composition of participants in the study, some of the residents’ voices were absent in the reported results of the research • The primary value in the design solutions generated during the research were in their representation of the collective experiences and knowledge that were co-constructed during the research. More than blueprints for design solutions, the prototypes were intended to provide “concrete points for reflection” during the research (page 62).
2	Peek et al., (2015)	<ul style="list-style-type: none"> • In highlighting the shortcomings of cross-sectional research, the authors encouraged further longitudinal research explorations that can unravel how the changes in the personal, social, and physical context affect community-dwelling older adults’ visions and attitudes regarding utilizing technology • The authors also identified the inherent biases in the research team’s values and beliefs as a potential limitation to this qualitative research and called for studies that may involve other tactics of data collection such as surveys to further uncover nuances with regard to older adults beliefs and visions.
3	Cahill et al., (2019)	<ul style="list-style-type: none"> • While emphasizing that the research was an Action Research study, the authors mentioned the spectrum of diversity in age-related functional, cognitive, and sensory needs of older adults as an important factor that should be considered while designing the technological interventions. Under-representation of older adult residents of the residential care setting or the feedback of family members or caregivers, could lead to solutions that are not beneficial for all the stakeholders that were involved in the Action Research study. • Seamless merging of any designed technology within the established culture of care at a residential care facility could be challenging at times and the authors identified staff training as a key focus in the implementation phase of the Action Research study.
4	Petersson, Lilja, & Borell, (2012)	<ul style="list-style-type: none"> • Limitation: Small sample size (n=8). “variation in the participants’ demographic aspects of gender, housing, and type of home modification as these might have impacted on the participants’ experiences of safety” page 809.

5	5) Juul, Wilding, & Baldassar, (2019)	<ul style="list-style-type: none"> • The authors also point to the issue of integration of any novel technology (in this case Touchscreen Technology) to support social and physical needs of residents of the aged care facility, and identifies management support and restructuring staff duties as critical factors for success. At a higher level, the authors encouraged government funding models and policy makers to prioritize physical and social activity while designing interventions and directing investments. • Future research is needed to evaluate the effectiveness of Touchscreen Technology while other changes such as staff training would be underway.
6	Roberts, De Schutter, Franks, & Radina, (2018)	<ul style="list-style-type: none"> • In recommendation for conducting future research, the authors point to the heterogeneity of older adults and their diversity of functional, physical, and cognitive needs and investigation of the varied impacts of VR technologies on the wellbeing of each community of older adults. The authors call for quasi-experimental studies that can evaluate the effectiveness of VR technologies as an intervention.
7	Willard, Cremers, Man, van Rossum, Spreeuwenberg, & de Witte, (2018)	<ul style="list-style-type: none"> • Limited sample size can negatively impact generalizability of findings.
8	Bruggencate, Luijckx, & Sturm, (2019).	<ul style="list-style-type: none"> • The authors call for research that can supplement their study with other modes of data collection such as observational tactics or quasi-experimental designs with an intervention embedded in the research design. The purpose would be to include larger sample of older adults and capture varied nuances in their use of social technology. Moreover, different types of platforms for social technology needs to be investigated.
9	Kim, Cho, & Jun, (2020)	<ul style="list-style-type: none"> • Smart Home research needs to be expanded to include people of all ages and not be limited to the aging population.
10	Castro Rojas, Bygholm, & Hansen, (2018)	<ul style="list-style-type: none"> • The study was conducted with older adults who were interested in engaging with ICTs; to improve generalizability, perspectives of other groups need to be considered as well.

Appendix Table A-3: Clarifying the research questions for each included study.

	Study	Research Question
1	Dahl & Löfström, 2019	explored stakeholders' views on the role of interactive technology in shaping an inclusive, socially active, and supportive care environment in residential settings.
2	Peek et al., (2015)	The authors intended to investigate the factors that were influential in the level of engagement with various types of technology among community-dwelling older adults who were aging in place.
3	Cahill et al., (2019)	explore and validate stakeholders' (older adult residents of residential care environment and care givers) perspectives on the development of new technology that promotes older adults' wellbeing and person-centered care delivery.
4	Petersson, Lilja, & Borell, (2012)	explored aspects that contributed to the experiences of safety and autonomy in daily lives of older adults who had received some form of home improvement and technological interventions to augment safety at home
5	5) Juul, Wilding, & Baldassar, (2019)	investigated the potential in novel technologies (Touchscreen Technology in this case) for enhancing quality of life and promotion of meaningful participation in social and physical activities among culturally diverse older adult residents and staff of care facilities.
6	Roberts, De Schutter, Franks, & Radina, (2018)	The researchers intended to explore the older adults' responses to the audiovisual virtual reality (VR) experience and investigate its usefulness towards promotion of health and quality of life and facilitation of meaningful activities among older adult residents of a CCRC (continuing care retirement community).
7	Willard, Cremers, Man, van Rossum, Spreeuwenberg, & de Witte, (2018)	The researchers wanted to understand the wishes and needs of the frail older adults regarding their daily lives and social engagements that would have implications for design of social ICT platforms.
8	Bruggencate, Luijkx, & Sturm, (2019).	The researchers aimed to investigate the social needs of older adults and the role of social technology in achieving them.
9	Kim, Cho, & Jun, (2020)	The researchers asked 12 experts across multiple fields to discuss the following questions based on each scenario that they presented to the experts: "(1) What is important and what are the problems for the residents in each situation presented in the scenario? (2) How can space or technology improve their lives? (3) What are the smart home services that should be provided for residents in each situation? Page 5."
10	Castro Rojas, Byholm, & Hansen, (2018)	How can we utilize the results of context-sensitive design principles to impact design of learning environments for using ICTs among the older adults.

**Appendix B: IHPI’s Complete Survey Questions About the Built Environment, 2020
NPHA**

POLL QUESTIONS

**At Home and in the Neighborhood
During the COVID-19 Pandemic**



NATIONAL POLL ON
HEALTHY AGING
UNIVERSITY OF MICHIGAN

January/February 2021 www.healthyagingpoll.org



Questions were answered by respondents age 50–80.

Q1. Which of the following do you have access to where you live? Select all that apply

1. A view of nature from inside your home
2. A place to safely isolate if you had COVID-19
3. An outdoor space (balcony, patio, porch or yard) to safely engage with your neighbors/ community
4. A greenspace (garden, a park, or woods) within walking distance

Q2. Since March 2020, how often have you done the following?

	Every day or almost every day	A few times a week	A few times a month or less	Never
Spent time outdoors/interacted with nature				
Interacted with people in your neighborhood				
Walked or biked around your neighborhood				

Q3. Since March 2020, how often have you felt a lack of companionship?

1. Hardly ever
2. Some of the time
3. Often

Q4. Since March 2020, how often have you felt isolated from others?

1. Hardly ever
2. Some of the time
3. Often

Data Source and Methods

This National Poll on Healthy Aging report presents findings from a nationally representative household survey conducted exclusively by Ipsos Public Affairs, LLC (“Ipsos”) for the University of Michigan’s Institute for Healthcare Policy and Innovation. National Poll on Healthy Aging surveys are conducted by recruiting from Ipsos KnowledgePanel®, the largest national, probability-based panel in the U.S.

This survey module was administered online in June 2020 to a randomly selected, stratified group of older adults age 50–80 (n=2,074). The sample was subsequently weighted to reflect population figures from the U.S. Census Bureau.

The completion rate was 78% among panel members contacted to participate. The margin of error is ±1 to 2 percentage points for questions asked of the full sample and higher among subgroups.

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Appendix C: Survey Questionnaire

Dissertation Survey on Aging and Technology

Start of Block: Block 1

Title of Project: Age, Place, and Health: Understanding the role of environmental and technological innovations in enhancing older adults' Quality of Life

Your Consent to Participate in a Research Study

General information:

You are invited to participate in a voluntary research study about the potential implication of using technology in the home setting for social connection and quality of life of older adults. This is a study conducted by Kimia Erfani at the Taubman College of Architecture and Urban Planning at the University of Michigan in order to complete her Ph.D. dissertation.

The purpose of this study is to look at the impact of the spaces and the design of your home environment as well as your engagement of technology on your quality of social connectedness with family and friends. Participating in this study will involve taking an online survey which will last about 20 minutes. There are no risks in participating in this survey.

Situated at the intersection of environmental design research and public health, my project informs equitable environmental design interventions that encourage healthy aging. The survey contains 5 sections about your daily life: 1) your home setting and social activities before the pandemic; 2) your home setting and virtual social activities during the pandemic; 3) the quality of your social connectedness before the pandemic; 4) the quality of your social connection during the pandemic; 5) your personal background.

Principal Investigator: Kimia Erfani, PhD student at Taubman College of Architecture and Urban Planning – University of Michigan
2000 Bonisteel Blvd. Ann Arbor, MI 48109
Email: erfani@umich.edu

What procedures are involved?

The survey will last about 20 minutes. Participating in this research is completely voluntary. By completing and submitting this survey, you are agreeing to be part of the study. You may skip or refuse to

answer any survey question and move to the next one or withdraw for any reason at any time.

At the end of the survey, you will be asked if you wish to further participate in the next phase of this study which includes an online follow-up interview via Zoom. If you indicate your willingness, the researcher will use your provided email to reach out to you and set up an online interview at a future date.

Will I be compensated for my participation in this research?

As an appreciation for your participation, at the end of this survey, you will have an option to receive payment of \$10 Amazon Gift Card by providing your email address. The email that you provide at the end of the questionnaire will be used to send the gift card as a thank you for your participation.

Will my study-related information be kept confidential?

To protect confidentiality, you will not be identified in any reports on this study. The data will be kept on a password-protected computer. Researcher will code the responses to protect the information. Records will be kept confidential. Responses will only be used for the purpose of this study and will not be available to any person or institution including other researchers for related studies.

Who should I contact if I have questions?

To find out more about the study (HUM00196141) to ask any questions about this study, or to talk about any problems you may have as a study participant, please contact the principal investigator Kimia Erfani at erfani@umich.edu.

Please print this consent form if you would like to retain a copy for your records.

Consent:

I have read and understood the above consent form. By clicking the “Start the Survey” button below to enter the survey, I indicate my willingness to voluntarily take part in this study.

End of Block: Block 1

Start of Block: Default Question Block

Page Break

Q2 Which of the following best describes the housing type that you are living in:

- Free-standing single-family home with a garden (1)
 - Free-standing single-family home without a garden (2)
 - Residential community with multiple houses (3)
 - Apartment building or condominium with balcony (4)
 - Apartment building or condominium without balcony (5)
 - Others (Please describe): (6) _____
-

Q3

Section A: For the questions in the following section, please think of your experiences BEFORE the COVID-19 pandemic:



Q5 A-1) Please think of your own residence. BEFORE the COVID-19 pandemic, how often did you use the following residential spaces to engage in IN-PERSON socializing with the members of your social network?

Interior spaces of the house:

	Daily (6)	4-6 times a week (5)	2-3 times a week (4)	Once a week (3)	Once a month (2)	Rarely/Never (1)
Kitchen (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Living room (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bedroom (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Office room (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dining area (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Basement (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q6 Exterior spaces of the house:

	Daily (6)	4-6 times a week (5)	2-3 times a week (4)	Once a week (3)	Once a month (2)	Rarely/Never (1)
Yard or garden (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Balcony (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Porch (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Common space in your apartment or condominium (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Q7 A-2) Please think of your experiences BEFORE the COVID-19 pandemic, and indicate to what extent the following interior features of your home prevented you from having your friend or family over?

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
Indoor air quality (malodors, allergens, etc.) (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Noise (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of adequate lighting in my house (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Layout of home furniture (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Layout of the unit (lack of adequate space inside home, such as: small kitchen, small living room, small guest bedroom, etc.) (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of privacy (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My home can't be visited by people who have trouble with steps or who use wheelchairs or walkers (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q8 A-3) Please think of your experiences BEFORE the COVID-19 pandemic, and indicate to what extent the following interior features of your home encouraged you to have your friend or family over?

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
Views to nature (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Daylight (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Having a porch of balcony (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adequate space for a group activity (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spaces to display my memorable and noteworthy things (family photos, trophies, etc.) (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Q9

Section B: For the questions in the following section, please think of your experiences DURING the COVID-19 pandemic:

Q10 B-1) During the pandemic, do you connect with your family or friends using video-calling (via Zoom, Skype, Microsoft Teams, WhatsApp, FaceTime, Viber, Imo, Facebook, or any other application that allows for video-based communication)?

Yes (1)

No (2)



Q11 B-2) During the pandemic, approximately how often do you use video-calling to socialize with your family and friends?

Few times a day (7)

Once a day (6)

Few times a week (5)

Once a week (4)

Once a month (3)

Few times a year (2)

Rarely/Never (1)

Q12 B-3) What are the benefits of using video-based communication? (choose all that apply)

- I can see people I don't get to see in person very often. (1)
 - I maintain close relationships with my family. (2)
 - I maintain close relationships with my friends. (3)
 - For me, there are no benefits to using video calling. (4)
 - Other benefits you see of video calling (please describe): (5)
-

Q13 B-4) When you make video-calls are you alone or others (e.g. family members, friends, partner, etc.) are present in the same room with you?

- Always alone (1)
- Sometimes include others (e.g. family members, friends, partner, etc.). (2)
- Always include others (e.g. family members, friends, partner, etc.). (3)

Page Break



Q14

B-5) Where are you usually physically located when you use video-calling to virtually connect with a member of your social network?

Interior spaces of your home:

	Daily (6)	4-6 times a week (5)	2-3 times a week (4)	Once a week (3)	Once a month (2)	Rarely/Never (1)
Kitchen (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Living room (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bedroom (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Office room (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dining area (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Basement (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q15

Exterior spaces of your home:

	Daily (6)	4-6 times a week (5)	2-3 times a week (4)	Once a week (3)	Once a month (2)	Rarely/Never (1)
Yard or Garden (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Balcony (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Porch (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Office room (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Common space in your apartment or condominium (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In my car (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
While shopping (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Q16 B-6) Please indicate to what extent the following interior features of your home prevent you from video calling your friend or family?

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
Poor Acoustics and noise (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor Lighting and glare (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Privacy (I don't want others in my household see me while video calling) (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of access to Wi-Fi or internet connection (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of access to appropriate devices for video calling in my home environment (such as small screen or other limits) (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't have any usable surface to set up my device on (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I move around a lot in my home and engaging in video calling restricts my mobility (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q17 B-7) Please indicate to what extent the following proposed features can potentially encourage you to have video calls with your friends and extended family?

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
Integration of video calling applications and devices with my appliances such as TV, screen on refrigerator, etc. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Integration of sound communication system in spaces of my choice to be able to continue talking while video calling. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to share live beautiful views of my window or flowers in my garden (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to engage in creative virtual activity and/or games with others (creating music, cooking food, or any other DIY activity) (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others (Please describe): (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q18

Section C: For the questions in the following section, please think of your experiences DURING the COVID-19 pandemic:

Q19 C-1) Since the start of the pandemic, currently I live with:

- Only spouse or significant other (1)
 - Family including children or grandchildren (2)
 - Alone (3)
 - Caregiver (4)
 - One or more friends or roommates (5)
 - Others (Please describe): (6) _____
-

Q20 C-2) Please indicate the number of close friends & family members that you interact with during the pandemic:

- None (1)
 - 1 (2)
 - 2-3 (3)
 - 4-5 (4)
 - 6-7 (5)
 - 8 or more (6)
-

Page Break



Q21 C-3) Since the start of the pandemic, how often do you...?

	Daily (6)	4-6 times a week (5)	2-3 times a week (4)	Once a week (3)	Once a month (2)	Rarely/Never (1)
Socialize with friends and family (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in neighborhood and community activities (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in activities of organized groups (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Volunteer (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in physical activities or sports involving people (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in other activities involving people (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q22 C-4) Since the start of the pandemic, how often have you...?

	Always (5)	Most of the time (4)	About half the time (3)	Sometimes (2)	Never (1)
Felt left out (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Felt that you lack companionship (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Felt isolated (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break



Q23 C-5) The following section asks about your sense of community during the pandemic:

	Very much (4)	Often (3)	Sometimes (2)	Not at all (1)
Do you have many in-person visitors every day? (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you socialize a lot within your building community or neighborhood? (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Is there a strong feeling of belonging at your place of residence? (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you have many virtual calls/visits every day? (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you socialize a lot with your friends on social media? (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Are your online community of friends concerned with helping and supporting one another? (12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you have a strong feeling of belonging to your virtual community? (13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q49 C-6) Please indicate to what extent you agree with the following statements:

	Strongly agree (4)	Somewhat agree (3)	Somewhat disagree (2)	Strongly disagree (1)
I know the people next door very well. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know the people in my neighborhood very well. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My neighbors are always concerned with helping and supporting one another. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My neighbors always acknowledge one another when passing in the hallway/street. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know people that I socialize with virtually very well. (14)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know the people in my friends list on social media platforms very well. (15)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q24 C-7) Since the start of the pandemic, how often is someone available to...?

	Always (5)	Most of the time (4)	About half the time (3)	Sometimes (2)	Never (1)
Have a good time with (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Get together with for relaxation (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do enjoyable activities with (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Q25

Section D: For the questions in the following section, please think of your experiences BEFORE the COVID-19 pandemic:

Q26 D-1) Before the pandemic, I lived with:

- Only spouse or significant other (1)
 - Family including children or grandchildren (2)
 - Alone (3)
 - Caregiver (4)
 - One or more friends or roommates (5)
 - Others (Please describe): (6) _____
-

Q27 D-1) Please indicate the number of close friends & family members that you used to interact with before the pandemic:

- None (1)
 - 1 (2)
 - 2-3 (3)
 - 4-5 (4)
 - 6-7 (5)
 - 8 or more (6)
-



Q28 D-3) Before the pandemic, how often did you...?

	Daily (6)	4-6 times a week (5)	2-3 times a week (4)	Once a week (3)	Once a month (2)	Rarely/Never (1)
Socialize with friends and family (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in neighborhood and community activities (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in activities of organized groups (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Volunteer (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in physical activities or sports involving people (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participate in other activities involving people (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break



Q29 D-4) Before the pandemic, how often did you...?

	Always (5)	Most of the time (4)	About half the time (3)	Sometimes (2)	Never (1)
Feel left out (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feel that you lack companionship (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feel isolated (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q30 D-5) The following section asks about your sense of community before the pandemic:

	Very much (4)	Often (3)	Sometimes (2)	Not at all (1)
Did you have many in-person visitors every day? (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Did you socialize a lot within your building community or neighborhood? (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Was there a strong feeling of belonging at your place of residence? (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Did you have many virtual calls/visits every day? (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Did you socialize a lot with your friends on social media? (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Were your online community of friends concerned with helping and supporting one another? (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Did you have a strong feeling of belonging to your virtual community? (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q31 D-6) Before the start of the pandemic, how often was someone available to...?

	Always (5)	Most of the time (4)	About half the time (3)	Sometimes (2)	Never (1)
Have a good time with (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Get together with for relaxation (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do enjoyable activities with (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Q32

Vaccination Status:

Q33 Have you received a shot of Covid 19 Vaccination?

Yes (1)

No (2)

Q34 If yes SELECTED: Please briefly explain how vaccination has impacted your social life?

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Q48

About you and your household:

Q35 What is your age group?

50-54 (1)

55-59 (2)

60-64 (3)

65-69 (4)

70-74 (5)

75-79 (6)

80+ (7)

Q36 What is your gender identity?

Male (1)

Female (2)

Non-binary (3)

Prefer not to say (4)

Others (Please specify): (5) _____

Q37 What is your race/ethnicity?

- African American/ Black (1)
- American Indian or Alaskan Native (2)
- Asian American / Asian (3)
- Hispanic / Latin(x) (4)
- Native Hawaiian or Pacific Islander (5)
- Middle Eastern, Arab, or Arab American (6)
- White/ Caucasian (7)
- Others (Please specify): (8) _____

Page Break

Q38 What is your marital status?

- Single (1)
 - Married (2)
 - Divorced (3)
 - Widow/Widower (4)
 - With partner (5)
 - Others (please specify): (6) _____
-

Q39 Do you have extended family living in the same city or town where you currently live?

- Yes (1)
 - No (2)
-

Q40 What is your household's annual income?

- Below 30,000 (1)
 - 30,000 to 70,000 (2)
 - 70,001 to 120,000 (3)
 - 120,001 to 185,000 (4)
 - More than 185,000 (5)
-

Q41 What is the highest degree or level of education you have completed?

- Less than High School (1)
 - Some High School (2)
 - High School or equivalent (for example: GED) (3)
 - Some college, but no degree (4)
 - Associate degree (for example: AA, AS) (5)
 - Bachelor's degree (for example: BA, BS) (6)
 - Master's degree (for example: MA, MS, MEng, MEd, MBA) (7)
 - Professional degree (for example: MD, DDS, DVM, LLN, JD) (8)
 - Doctorate degree (for example: PhD, EdD) (9)
 - Others (please specify) (10) _____
-

Q42 From scale of 1 to 10 (10 representing excellent quality), How would you rate the quality of your internet access at home?

0: No access - 10: Excellent

0 1 2 3 4 5 6 7 8 9 10



Q43 How would you rate your physical health?

- Excellent (5)
 - Very good (4)
 - Good (3)
 - Fair (2)
 - Poor (1)
-



Q48 How would you rate your mental health?

- Excellent (5)
 - Very good (4)
 - Good (3)
 - Fair (2)
 - Poor (1)
-

Page Break

Q44 In what state and city do you currently live?

State (1) _____

City (2) _____

Zip code (3) _____

Q45 Approximately how many years have you lived in your current residential setting?

0-4 (1)

5-9 (2)

10-14 (3)

15-19 (4)

More than 20 (5)

Page Break _____



Q47 Thank you very much for your participation. **If you want to receive a \$10 Amazon Gift card, please provide your email address here:**

Q46 Please indicate your willingness to participate in a follow-up interview with me via Zoom and sharing your experiences and insights about spaces and technologies for aging in place. **Your participation in the interview will be greatly appreciated and you will have an option to receive an additional \$20 Amazon gift card.**

- I am willing to participate in a virtual interview via Zoom (1)
- I am not available for an interview (2)

Display This Question:

If Please indicate your willingness to participate in a follow-up interview with me via Zoom and sha... = I am willing to participate in a virtual interview via Zoom

And And Thank you very much for your participation. If you want to receive a \$10 Amazon Gift card, please provide your email address here: Text Response Is Empty

Q50 **Please provide your email here. I will use the email that you provided to reach out to you to set up a time for our Zoom interview.**

End of Block: Default Question Block

Appendix D: R Code for Performing Classical MDS and K-means Cluster Analysis

```
# Load required packages
library(magrittr)
library(dplyr)
library(ggpubr)
# Compute MDS
mds <- twitterx %>%
  dist() %>%
  cmdscale() %>%
  as_tibble()
colnames(mds) <- c("Dim.1", "Dim.2")
# Plot MDS
ggscatter(mds, x = "Dim.1", y = "Dim.2",
  label = rownames(twitterx),
  size = 1,
  repel = TRUE)

# K-means clustering
clust <- kmeans(mds, 4)$cluster %>%
  as.factor()
mds <- mds %>%
  mutate(groups = clust)
# Plot and color by groups
ggscatter(mds, x = "Dim.1", y = "Dim.2",
  label = rownames(twitterx),
  color = "groups",
  palette = "jco",
  size = 1,
  ellipse = TRUE,
  ellipse.type = "convex",
  repel = TRUE)
```

Appendix E: Interview Protocol

Basic questions about the participant's social connection network:

Tell me about yourself; your social life; and the story of the impact of pandemic on your social life.

More prompts:

1. Do you live with anyone else?
2. Do you have family close by?
3. Are you currently employed? Part-time? Full-time?
4. Do you have other daily or part-time commitments (volunteer work, care obligations, etc?)
5. Before the pandemic, how often did you have in-person visits from family/friends? Can you tell me about your experiences of in-person meeting and getting together with family and friends before the pandemic? How did it change during the pandemic? How about now?
6. Where would you gather in your home when you had family/friends over during the pandemic? (Prompt outdoor spaces, if needed)
7. Can you tell me about a memorable, positive experience of safely getting together with your family/friends during the pandemic?
8. Can you tell me about any memorable, negative experiences of getting together with your family/friends during the pandemic?

Motivation to use and utilization of technology for social connection & the role of built environment in facilitating remote social connection:

What kind of technology did you use during the pandemic? Social media, Zoom etc.?

What made it easier or more difficult for you to use these technologies?

Who are you connecting with? How are you connecting with them? How is the environment impacting your experience?

Definition of Social Information Communication Technologies (Social ICT): *I will explain the definition for the participant: “A type of technology (such as social media, video-conferencers, voice-activated virtual assistants) that facilitates information exchange and communication between two or more individuals. They are typically screen-based and voice-activated.”*

1. Do you have access to and/or use any Social ICT technologies? What type of SICT technologies do you use? Is it provided by an employer or other entity?
2. When did you start using these technologies? Did you use them before the pandemic? Did your use change during the pandemic?
3. What prompted you to start using these technologies?
4. What continues to motivate you to use these technologies?
5. Do you wish you could have access to any particular social ICT that you don't have access to right now?

Social connection using Social ICT inside the home environment:

1. Can you tell me about a time when you had a positive experience while using these technologies to connect with your family/friends.
 - a. What activities did you engage in?
 - b. Where were you located while using the technology? Can you describe the environment that you were in?
2. Can you tell me about a time when you had a negative experience while using these technologies to connect with your family/friends.
 - c. What activities did you engage in?
 - d. Where were you located while using the technology? Can you describe the environment that you were in?

3. Where are you usually located while you connect with your family/friends using these technologies?
 - e. Can you tell me if you've ever **experienced any issues** with the following while you were using these technologies?

Problem with spatial design:

- i. Lighting & glare
- ii. Acoustics and noise
- iii. Privacy
- iv. Suitable furniture
- v. Layout of your home

Problem with health and ergonomic design of the device:

- vi. Issue with vision
- vii. Issues with hearing
- viii. Issues with muscles and joints
- ix. Other health issues?

4. Any Problem with knowledge about using the device?
5. Any financial deterrents to buying and using devices for social?
6. Did you change your home space in any way to allow for you to comfortably connect with your family/friends through these technologies?

Assessing changes in experiences of in-person & virtual social connection:

1. With availability of vaccines at this moment that offer protection from the COVID virus, can you tell me how did your usage of these technologies has changed?
2. How do you describe the changes that you can feel regarding your socializing with friends and family these days?

3. To what extent has the quality of relationships changed through this transition in the pandemic?

- a. Have you got closer to your family/friends?
- b. Any friends or family with whom the relationships have developed in a better quality?
- c. Any relationships that have become less enjoyable to you?
- d. What aspects of interaction through technology or in-person do you think may have impacted the quality of your relationships (to improve or become less enjoyable)?

Social ICT, work (if applicable), home:

1. What was/is your occupation? What type of Social ICT is available to you from your job (if any).

- a. Tell me about your experience of using these technologies during the pandemic. Did you work from home? How did your home environment change because of working from home?

General attitudes towards Social ICT for connecting people:

2) Do you think social ICT is beneficial for connecting people together?

- a. In what aspects it might be beneficial?
- b. In what aspects it might be detrimental?
- c. Would you change anything about having access to social ICT at your home for the better? If yes, what?

Final Thoughts:

Anything else that comes to your mind that I did not ask?

BIBLIOGRAPHY

- Rackham, Horace. " The Dissertation Handbook: A Guide to Submitting Your Doctoral Dissertation and Completing Your Doctoral Degree Requirements." Diss. U of Michigan, 2023
- Aneshensel, C. S., Harig, F., & Wight, R. G. (2016). Aging, neighborhoods, and the built environment. In *Handbook of aging and the social sciences* (pp. 315-335). Academic Press.
- Barker, A., Crawford, A., Booth, N., & Churchill, D. (2019). Everyday encounters with difference in urban parks: Forging 'openness to otherness' in segmenting cities. *International Journal of Law in Context*, 15(4), 495-514.
- Barnes, L. L., De Leon, C. M., Wilson, R. S., Bienias, J. L., & Evans, D. A. (2004). Social resources and cognitive decline in a population of older African Americans and whites. *Neurology*, 63(12), 2322-2326.
- Barnett, K., Mercer, S. W., Norbury, M., Watt, G., Wyke, S., & Guthrie, B. (2012). Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *The Lancet*, 380(9836), 37-43.
- Beard, J. R., & Bloom, D. E. (2015). Towards a comprehensive public health response to population aging. *The Lancet*, 385(9968), 658–661. [https://doi.org/10.1016/S0140-6736\(14\)61461-6](https://doi.org/10.1016/S0140-6736(14)61461-6)
- Bengtson, V. L. (2009). *Handbook of theories of aging*. New York: Springer.
- Bennett, B. (2019). Technology, aging and human rights: Challenges for an aging world. *International journal of law and psychiatry*, 66, 101449.
- Bentley, J. P., Brown, C. J., McGwin, G., Sawyer, P., Allman, R. M., & Roth, D. L. (2013). Functional status, life-space mobility, and quality of life: a longitudinal mediation analysis. *Quality of Life Research*, 22(7), 1621-1632.
- Brandt, E., Binder, T., Malmborg, L., & Sokoler, T. (2010, November). Communities of everyday practice and situated elderliness as an approach to co-design for senior interaction. In *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction* (pp. 400-403).
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
- Breakwell, G. M., Hammond, S., Fife-Schaw, C., & Smith, J. A. (Eds.). (2006). (3rd ed.). *Research methods in psychology*. Sage Publications, Inc.
- Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American psychologist*, 32(7), 513.
- Bronfenbrenner, U., & Morris, P. A. (2007). The bioecological model of human development. *Handbook of child psychology*, 1.

- Cahill, J., Portales, R., McLoughlin, S., Nagan, N., Henrichs, B., & Wetherall, S. (2019). IoT/Sensor-Based Infrastructures Promoting a Sense of Home, Independent Living, Comfort and Wellness. *Sensors*, 19(3), 485.
- Canter, D. (1977). *The psychology of place*. London: Architectural Press.
- Canter, D. (1997). The facets of place. In *Toward the Integration of Theory, Methods, Research, and Utilization* (pp. 109-147). Springer, Boston, MA
- Canter, D. (1983). The Purposive Evaluation of Places: A Facet Approach. *Environment and Behavior*, 15(6), 659–698.
- Carr, K., Weir, P. L., Azar, D., & Azar, N. R. (2013). Universal design: A step toward successful aging. *Journal of aging research*, 2013.
- Castro Rojas, M. D., Bygholm, A., & Hansen, T. G. (2018). Exercising older people’s brains in Costa Rica: Design principles for using information and communication technologies for cognitive activity and social interaction. *Educational Gerontology*, 44(2-3), 171-185.
- Chan, M. S., van den Hout, A., Pujades-Rodriguez, M., Jones, M. M., Matthews, F. E., Jagger, C., ... & Bajekal, M. (2019). Socio-economic inequalities in life expectancy of older adults with and without multimorbidity: a record linkage study of 1.1 million people in England. *International journal of epidemiology*, 48(4), 1340-1351.
- Chen, R., Weuve, J., Misra, S., Cuevas, A., Kubzansky, L. D., & Williams, D. R. (2022). Racial disparities in cognitive function among middle-aged and older adults: The roles of cumulative stress exposures across the life course. *The Journals of Gerontology: Series A*, 77(2), 357-364.
- Chodzko-Zajko, W. J., Proctor, D. N., Singh, M. A. F., Minson, C. T., Nigg, C. R., Salem, G. J., & Skinner, J. S. (2009). Exercise and physical activity for older adults. *Medicine & science in sports & exercise*, 41(7), 1510-1530.
- Choucair, B., Watts B. (2018). Rx for Health: A Place to Call Home. *Health Affairs Blog*. Retrieved 9 February 2023, from DOI: 10.1377/hblog20180821.6119.
- Cornwell, B., Laumann, E. O., & Schumm, L. P. (2008). The social connectedness of older adults: A national profile. *American sociological review*, 73(2), 185-203.
- Cornwell, E. Y., & Waite, L. J. (2009). Social disconnectedness, perceived isolation, and health among older adults. *Journal of health and social behavior*, 50(1), 31-48.
- Cotten, S. R. (2021). Technologies and aging: Understanding use, impacts, and future needs. In *Handbook of aging and the social sciences* (pp. 373-392). Academic Press.
- Dahl, Y., & Löfström, E. (2019). Supporting social interaction in care environments: Exploring stakeholder perspectives on the potential of interactive technology. *International Journal of Human–Computer Interaction*, 35(1), 53-64.
- D’cruz, M., & Banerjee, D. (2020). ‘An invisible human rights crisis’: The marginalization of older adults during the COVID-19 pandemic—An advocacy review. *Psychiatry research*, 292, 113369.
- De Leon, C. F. M., Gold, D. T., Glass, T. A., Kaplan, L., & George, L. K. (2001). Disability as a function of social networks and support in elderly African Americans and Whites: The Duke EPSE 1986–1992. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 56(3), S179-S190.

- Donini, L. M., Savina, C., & Cannella, C. (2003). Eating habits and appetite control in the elderly: the anorexia of aging. *International psychogeriatrics*, 15(1), 73-87.
- Durick, J., & Leung, L. (2018). Designing Augmented, Domestic Environments to Support Aging in Place. In *Assistive Augmentation* (pp. 117-129). Springer, Singapore.
- Eghtesadi, M. (2020). Breaking social isolation amidst COVID-19: A viewpoint on improving access to technology in long-term care facilities. *Journal of the American Geriatrics Society*, 68(5), 949.
- Elder, G. (1995). The life course paradigm: Social change and individual development. In P. Moen, G. Elder, & K. Luscher (Eds.), *Examining lives in context: Perspectives on the ecology of human development* (pp. 101-139). Washington, DC: American Psychological Association.
- Eruchalu, C. N., Pichardo, M. S., Bharadwaj, M., Rodriguez, C. B., Rodriguez, J. A., Bergmark, R. W., ... & Ortega, G. (2021). The expanding digital divide: digital health access inequities during the COVID-19 pandemic in New York City. *Journal of Urban Health*, 98(2), 183-186.
- Everitt, B. S., Landau, S., Leese, M., & Stahl, D. (2011). Cluster analysis: Wiley series in probability and statistics. *Southern Gate, Chichester, West Sussex United Kingdom: John Wiley & Sons*.
- Fernandes, C. S., Magalhães, B., Lima, A., Nóbrega, P., Silva, M., & Santos, C. (2022). Impact of Exergames on the Mental Health of Older Adults: A Systematic Review and GRADE Evidence Synthesis. *Games for Health Journal*.
- Francis, J., Kadylak, T., Cotten, S. R., & Rikard, R. V. (2016). When it comes to depression, ICT use matters: A longitudinal analysis of the effect of ICT use and mattering on depression among older adults. In C. Stephanidis (Ed.), *HCI International 2016 – Posters' extended abstracts: 18th International Conference, HCI International 2016 Toronto, Canada, July 17- 22, 2016, Proceedings Part II* (pp. 301_306). Cham, Switzerland: Springer.
- Francis, J., Rikard, R. V., Cotten, S. R., & Kadylak, T. (2019). Does ICT use matter? How information and communication technology use affects perceived mattering among a predominantly female sample of older adults residing in retirement communities. *Information, Communication & Society*, 22(9), 1281-1294. Available from <https://doi.org/10.1080/1369118X.2017.1417459>
- Frumence, G., Nyamhanga, T., Mwangu, M., & Hurtig, A. K. (2014). The dependency on central government funding of decentralised health systems: experiences of the challenges and coping strategies in the Kongwa District, Tanzania. *BMC Health Services Research*, 14(1), 1-9.
- FY 2022 section 202 supportive housing for the elderly program. (n.d.). Retrieved from https://www.hud.gov/program_offices/spm/gmomgmt/grantsinfo/fundingopps/fy22_section202
- Goldy, S. P., & Piff, P. K. (2020). Toward a social ecology of prosociality: why, when, and where nature enhances social connection. *Current opinion in psychology*, 32, 27-31.
- Gonyea, J. G. (2021). Housing older Americans: the challenges of accessibility, affordability, and quality. In *Handbook of Aging and the Social Sciences* (pp. 321-336). Academic Press.

- Greaves, C. J., & Farbus, L. (2006). Effects of creative and social activity on the health and well-being of socially isolated older people: outcomes from a multi-method observational study. *The journal of the Royal Society for the Promotion of Health*, 126(3), 134-142.
- Groat, L. N., & Wang, D. (2013). *Architectural research methods*. John Wiley & Sons.
- Gugliermetti, L., & Garcia, D. A. (2018). A cheap and third-age-friendly home device for monitoring indoor air quality. *International journal of environmental science and technology*, 15(1), 185-198.
- Hahn, E. A., DeWalt, D. A., Bode, R. K., Garcia, S. F., DeVellis, R. F., Correia, H., & Cella, D. (2014). New English and Spanish social health measures will facilitate evaluating health determinants. *Health Psychology*, 33(5), 490.
- Hooper, P., Foster, S., Edwards, N., Turrell, G., Burton, N., Giles-Corti, B., & Brown, W. J. (2020). Positive HABITATS for physical activity: Examining use of parks and its contribution to physical activity levels in mid-to older-aged adults. *Health & Place*, 63, 102308.
- Hughes, M. E., Waite, L. J., Hawkey, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on aging*, 26(6), 655-672.
- Iciaszczyk, N. (2016). Social connectedness, social support and the health of older adults: A comparison of immigrant and native-born Canadians.
- Juul, A., Wilding, R., & Baldassar, L. (2019). The best day of the week: New technology enhancing quality of life in a care home. *International journal of environmental research and public health*, 16(6), 1000.
- Kaplan, R. (2001) The nature of the view from home: psychological benefits. *Environment and Behavior*, 33, 507-542.
- Kaplan, R. & Kaplan, S. (1989) *The Experience of Nature: A Psychological Perspective*. Cambridge: Cambridge University Press.
- Kaplan, S. (1995) The restorative benefits of nature: toward an integrative framework. *Journal of Environmental Psychology*, 15, 169-182.
- Kim, M. J., Cho, M. E., & Jun, H. J. (2020). Developing Design Solutions for Smart Homes Through User-Centered Scenarios. *Frontiers in Psychology*, 11, 335.
- Kweon, B. S., Sullivan, W. C., & Wiley, A. R. (1998). Green common spaces and the social integration of inner-city older adults. *Environment and behavior*, 30(6), 832-858.
- Le, T., Reeder, B., Chung, J., Thompson, H., & Demiris, G. (2014). Design of smart home sensor visualizations for older adults. *Technology and Health Care*, 22(4), 657-666.
- Lee, K., Jarrott, S. E., & Juckett, L. A. (2020). Documented outcomes for older adults in intergenerational programming: a scoping review. *Journal of Intergenerational Relationships*, 18(2), 113-138.
- Lee, L. N., & Kim, M. J. (2020). A critical review of smart residential environments for older adults with a focus on pleasurable experience. *Frontiers in psychology*, 10, 3080.
- Liu, L., Stroulia, E., Nikolaidis, I., Miguel-cruz, A., Rios, A., & Rios Rincon, A. (2016). International Journal of Medical Informatics Smart homes and home health monitoring technologies for older adults : A systematic review. *International Journal of Medical Informatics*, 91, 44-59.

- Lockton, D. (2012). Cognitive biases, heuristics and decision-making in design for behaviour change. *Heuristics and Decision-Making in Design for Behaviour Change (August 5, 2012)*.
- Lorusso, L. N., & Bosch, S. J. (2018). Impact of multisensory environments on behavior for people with dementia: a systematic literature review. *The Gerontologist, 58*(3), e168-e179.
- Maher, B. A., O'Sullivan, V., Feeney, J., Gonet, T., & Kenny, R. A. (2021). Indoor particulate air pollution from open fires and the cognitive function of older people. *Environmental Research, 192*, 110298.
- Mandzuk, L. L., & McMillan, D. E. (2005). A concept analysis of quality of life. *Journal of orthopaedic nursing, 9*(1), 12-18.
- Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A.M., De Vries, S., Triguero-Mas, M., Brauer, M., Nieuwenhuijsen, M.J., Lupp, G., Richardson, E. A., Astell-Burt, T., Dimitrova, D., Feng, X., Sadeh, M., Standl, M., Heinrich, J., & Fuertes, E., (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental research, 158*, 301-317.
- Mcewan, T., Tam-Seto, L., & Dogra, S. (2017). Perceptions of sedentary behavior among socially engaged older adults. *The Gerontologist, 57*(4), 735-744.
- Megahed, N. A., & Ghoneim, E. M. (2020). Antivirus-built environment: Lessons learned from Covid-19 pandemic. *Sustainable cities and society, 61*, 102350.
- Mollenkopf, H., Walker 1949-, A., International Society for Quality of Life Studies. Conference (5th : 2003 : Frankfurt, G., & service)., S. (Online. (2007). *Quality of life in old age international and multi-disciplinary perspectives. Quality of life in old age international and multi-disciplinary perspectives*. Dordrecht : Springer. Retrieved from <https://link.springer.com/openurl?genre=book&isbn=978-1-4020-5681-9>
- Munzel, A., & Kunz, W. H. (2013). Sharing experiences via social media as integral part of the service experience. Available at SSRN 2307120.
- Nelson, A. (2002). Unequal treatment: confronting racial and ethnic disparities in health care. *Journal of the national medical association, 94*(8), 666. <https://www.spectrumhuman.org/OperationAble>
- Okabe-Miyamoto, K., Folk, D., Lyubomirsky, S., & Dunn, E. W. (2021). Changes in social connection during COVID-19 social distancing: It's not (household) size that matters, it's who you're with. *Plos one, 16*(1), e0245009.
- Olmsted, F. L. (1870). *Public parks and the enlargement of towns* (pp. 52-99). Cambridge, MA: American Social Science Association.
- Oswald, F., Jopp, D., Rott, C., & Wahl, H. W. (2011). Is aging in place a resource for or risk to life satisfaction? *The Gerontologist, 51*(2), 238-250.
- Otoni, C. A., Sims-Gould, J., & Winters, M. (2021). Safety perceptions of older adults on an urban greenway: Interplay of the social and built environment. *Health & Place, 70*, 102605.
- Peek, S. T., Luijckx, K. G., Rijnaard, M. D., Nieboer, M. E., van der Voort, C. S., Aarts, S., ... & Wouters, E. J. (2016). Older adults' reasons for using technology while aging in place. *Gerontology, 62*(2), 226-237.

- Peine, A. (2019). Technology and aging—theoretical propositions from Science and technology studies (STS). In *Aging and Digital Technology* (pp. 51-64). Springer, Singapore.
- Peng, L., Man, S. S., Chan, A. H., & Ng, J. Y. (2022). Personal, Social and Regulatory Factors Associated With Telecare Acceptance by Hong Kong Older Adults: An Indication of Governmental Role in Facilitating Telecare Adoption. *International Journal of Human-Computer Interaction*, 1-13.
- Petersson, I., Lilja, M., & Borell, L. (2012). To feel safe in everyday life at home—a study of older adults after home modifications. *Aging and Society*, 32(5), 791.
- Peterson, M. (2017). Living with difference in hyper-diverse areas: how important are encounters in semi-public spaces? *Social & Cultural Geography*, 18(8), 1067-1085.
- Piette J, Solway E, Singer D, Kirch M, Kullgren J, Malani P. Loneliness Among Older Adults Before and During the COVID-19 Pandemic. University of Michigan National Poll on Healthy Aging. September 2020. Available at: <http://hdl.handle.net/2027.42/162549>
- Pillemer, K., Wells, N. M., Wagenet, L. P., Meador, R. H., & Parise, J. T. (2011). Environmental sustainability in an aging society: a research agenda. *Journal of Aging and Health*, 23(3), 433-453.
- Pilotto, A., Boi, R., & Petermans, J. (2018). Technology in geriatrics. *Age and Aging*, 47(6), 771-774.
- Pinto, S., Fumincelli, L., Mazzo, A., Caldeira, S., & Martins, J. C. (2017). Comfort, well-being and quality of life: Discussion of the differences and similarities among the concepts. *Porto Biomedical Journal*, 2(1), 6-12.
- Pleson, E., Nieuwendyk, L. M., Lee, K. K., Chaddah, A., Nykiforuk, C. I., & Schopflocher, D. (2014). Understanding older adults' usage of community green spaces in Taipei, Taiwan. *International journal of environmental research and public health*, 11(2), 1444-1464.
- Powell, T., Bellin, E., & Ehrlich, A. R. (2020). Older adults and Covid-19: the Most vulnerable, the hardest hit. *Hastings Center Report*, 50(3), 61-63.
- Relph, E. (2016). The paradox of place and the evolution of placelessness. In *Place and Placelessness Revisited* (pp. 20-34). Routledge.
- Renaud, K., & Van Biljon, J. (2008, October). Predicting technology acceptance and adoption by the elderly: a qualitative study. In *Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries: riding the wave of technology* (pp. 210-219).
- Roberts, A. R., De Schutter, B., Franks, K., & Radina, M. E. (2019). Older adults' experiences with audiovisual virtual reality: perceived usefulness and other factors influencing technology acceptance. *Clinical gerontologist*, 42(1), 27-33.
- Rosenberg, M., & McCullough, B. C. (1981). Mattering: Inferred significance and mental health among adolescents. *Research in Community and Mental Health*, 2, 163-182.
- Rowe, J. W., & Kahn, R. L. (2015). Successful aging 2.0: Conceptual expansions for the 21st century. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, 70(4), 593–596. <https://doi.org/10.1093/geronb/gbv025>
- Rowles, G. D., & Bernard, M. (2013). *Environmental Gerontology : Making Meaningful Places in Old Age*. New York: Springer Pub. Co. Retrieved from

- Rueggeberg, R., Wrosch, C., & Miller, G. E. (2012). The different roles of perceived stress in the association between older adults' physical activity and physical health. *Health psychology, 31*(2), 164.
- Scharlach, A. E. (2017). Aging in context: Individual and environmental pathways to aging-friendly communities—The 2015 Matthew A. Pollack Award Lecture. *The Gerontologist, 57*(4), 606-618.
- Schieber, F. (2003). Human factors and aging: Identifying and compensating for age-related deficits in sensory and cognitive function. *Impact of technology on successful aging, 42-84*.
- Schneider, B. A., Daneman, M., & Pichora-Fuller, M. K. (2002). Listening in aging adults: from discourse comprehension to psychoacoustics. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 56*(3), 139.
- Seino, S., Kitamura, A., Nishi, M., Tomine, Y., Tanaka, I., Taniguchi, Y., ... & Fujiwara, Y. (2018). Individual-and community-level neighbor relationships and physical activity among older Japanese adults living in a metropolitan area: a cross-sectional multilevel analysis. *International Journal of Behavioral Nutrition and Physical Activity, 15*(1), 46.
- Simpson, D. (2015). *Young-old : urban utopias of an aging society*. Zürich: L. Müller.
- Sugihara, S., & Evans, G. W. (2000). Place attachment and social support at continuing care retirement communities. *Environment and Behavior, 32*(3), 400-409.
- Sutin, A. R., Stephan, Y., Luchetti, M., & Terracciano, A. (2020). Loneliness and risk of dementia. *The Journals of Gerontology: Series B, 75*(7), 1414-1422.
- Talen, E. (2002). Help for urban planning: the transect strategy. *Journal of Urban Design, 7*(3), 293-312.
- Tan, K. S., & Chan, C. M. (2018). Unequal access: Applying Bourdieu's practice theory to illuminate the challenges of ICT use among senior citizens in Singapore. *Journal of aging studies, 47*, 123-131.
- Ten Bruggencate, T., Luijkx, K. G., & Sturm, J. (2019). When your world gets smaller: How older people try to meet their social needs, including the role of social technology. *Aging & Society, 39*(8), 1826-1852.
- Traynor, V., Fernandez, R., & Caldwell, K. (2013). The effects of spending time outdoors in daylight on the psychosocial wellbeing of older people and family carers: a comprehensive systematic review protocol. *JBIC Evidence Synthesis, 11*(9), 36-55.
- Trilar, J., Kos, A., Jazbinšek, S., Jensterle, L., & Stojmenova Duh, E. (2018). ICT to promote well-being within families. *Sensors, 18*(9), 2760.
- Tummers, L. (2016). The re-emergence of self-managed co-housing in Europe: A critical review of co-housing research. *Urban Studies, 53*(10), 2023–2040.
<https://doi.org/10.1177/0042098015586696>
- Unger, J. B., Johnson, C. A., & Marks, G. (1997). Functional decline in the elderly: evidence for direct and stress-buffering protective effects of social interactions and physical activity. *Annals of Behavioral Medicine, 19*(2), 152-160.

- Urban League of Detroit & Southeastern Michigan. (2022). Retrieved 30 September 2022, from <https://www.deturbanleague.org/>
- Van Leeuwen, K. M., Van Loon, M. S., Van Nes, F. A., Bosmans, J. E., De Vet, H. C., Ket, J. C., ... & Ostelo, R. W. (2019). What does quality of life mean to older adults? A thematic synthesis. *PloS one*, *14*(3), e0213263.
- Vaportzis, E., Giatsi Clausen, M., & Gow, A. J. (2017). Older adults perceptions of technology and barriers to interacting with tablet computers: a focus group study. *Frontiers in psychology*, *8*, 1687.
- Vercelli, A., Rainero, I., Ciferri, L., Boido, M., & Pirri, F. (2018). Robots in Elderly Care. *DigitCult - Scientific Journal on Digital Cultures*, *2*(2), 37–50.
- Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication research*, *19*(1), 52-90.
- Wang, J. (2012). Classical multidimensional scaling. In *Geometric structure of high-dimensional data and dimensionality reduction* (pp. 115-129). Springer, Berlin, Heidelberg.
- Wellecke, C., D'Cruz, K., Winkler, D., Douglas, J., Goodwin, I., Davis, E., & Mulherin, P. (2022). Accessible design features and home modifications to improve physical housing accessibility: a mixed-methods survey of occupational therapists. *Disability and Health Journal*, 101281.
- Wendel, M. L., Garney, W. R., & McLeroy, K. R. (2015). Ecological approaches. *American Journal of Public Health*, *86*, 674-677.
- Willard, S., Cremers, G., Man, Y. P., van Rossum, E., Spreeuwenberg, M., & de Witte, L. (2018). Development and testing of an online community care platform for frail older adults in the Netherlands: a user-centred design. *BMC geriatrics*, *18*(1), 1-9.
- Williamson, J. B., & Béland, D. (2015). The Future of Retirement Security in Comparative Perspective. *Handbook of Aging and the Social Sciences: Eighth Edition*, 461–181. <https://doi.org/10.1016/B978-0-12-417235-7.00022-6>
- Woessner, M. N., Tacey, A., Levinger-Limor, A., Parker, A. G., Levinger, P., & Levinger, I. (2021). The evolution of technology and physical inactivity: the good, the bad, and the way forward. *Frontiers in public health*, 672.
- Yang, H. Y., & Stark, S. L. (2010). The role of environmental features in social engagement among residents living in assisted living facilities. *Journal of Housing for the Elderly*, *24*(1), 28-43.
- Yen, I. H., Fandel Flood, J., Thompson, H., Anderson, L. A., & Wong, G. (2014). How design of places promotes or inhibits mobility of older adults: realist synthesis of 20 years of research. *Journal of aging and health*, *26*(8), 1340-1372.
- Zisberg, A., Shadmi, E., Sinoff, G., Gur-Yaish, N., Srulovici, E., & Admi, H. (2011). Low mobility during hospitalization and functional decline in older adults. *Journal of the American Geriatrics Society*, *59*(2), 266-273.