AGING-IN-PLACE:

THE INFLUENCE OF COVID-19

ON SMART DEVICE ACCEPTANCE

By

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Abstract: Covid-19 and the increasing population of older adults in developed countries have increased the need for alternative solutions for preventative health and long-term care. Smart homes and other assistive technology have been proposed as a solution to detect health problems early and prevent major issues later, provide better care access through telemedicine solutions, and support the autonomy of older adults with cognitive or physical issues who wish to continue to live in their homes. Rural older adults' acceptance of assistive technology is understudied compared to other groups, but the few studies available indicated that many tend to reject it. However, Covid-19 may increase interest in the technology, and the goal of this project was to determine if rural Oklahoman older adults' acceptance of the technology has increased enough for it to be implemented. This is a qualitative study that used Grounded Theory coding to determine common themes of participants to determine the level of acceptance. Interviews indicated that acceptance is still low for some devices but that rural older Oklahomans may consider other remote health instruments for specific conditions, fall detection, and home security devices if recommended by a doctor and if their issues with the technology, such as self-image, independence, and financial concerns, were resolved. If the acceptance of these devices is increased in the future, it may be possible to provide better preventative care for rural Oklahomans, detecting problems early and treating the main issues to delay major health complications. This could narrow healthcare disparities between urban and rural older adults, especially during special situations like pandemics.

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CHAPTER I

INTRODUCTION

As a higher percentage of the population grows older, more people are at risk of nursing home placement due to chronic diseases such as dementia, cardiac disease, and diabetes. Around 671.1 million people worldwide were 65 or older in 2015, with an expected rise to one billion, or 12%, by 2030 and 1.6 billion, or 17%, by 2050 (Roberts et al., 2018). In North America alone, there were 49.2 million older adults in 2016, and they are expected to comprise 21.4% of the population by 2050 (Roberts et al., 2018).

Long-term care annually costs the U.S. around $275 billion, not including the estimated $450 billion in unpaid care provided by family and friends (Pennsylvania Health Care Association, 2019; Feinberg et al., 2011). Families pay around 23% of care costs out-of-pocket, and individually, care costs vary wildly depending on what services and types of care are needed, which can range from the cheaper adult daycare at $19,500 on average to private nursing home rooms with full care costing around $102,000 (Pennsylvania Health Care Association, 2019; Genworth, 2019).

Assistive technology ranging from robotics to smart homes has been proposed to help relieve caregiver burden, reduce cognitive and physical health problems among older adults, and keep older adults in their homes longer (Majumder et al., 2017). Rural older adults are more likely to live far away from good long-term and healthcare services, which has led to smart

homes and telemedicine being used in conjunction and proposed as a potential method to reduce care disparities by bridging gaps in care, with telemedicine already showing some early success. with this group (Bossen et al., 2015). Problems the technology has been proposed to address include fall detection, and health and activity monitoring, including vital health marker monitoring for issues such as tachycardia, e-health services, home monitoring to detect potential dangers such as gas leaks, task and cognitive assistance and reminders, and cognitive assessments (Majumder et al., 2017; Amiribesheli & Bouchachia, 2018).

The literature review showed there are gaps in studies concerning how the technology would affect privacy and autonomy, a lack of focus on other stakeholders such as caregivers, and little focus on the downsides to the technology and on the human problems in general, such as acceptance issues, usability issues, and fears of stigmatization (Fritz et al., 2015; Marikyan et al, 2018; Demiris et al., 2004; Damodaran & Olphert, 2010). The current research primarily consisted of pilot studies instead of long-term studies in the home and focused on urban users, with little research on rural users and their specific needs (Marikyan et al, 2018; Berridge, 2018; Mathew, 2005). The lack of literature on key humanistic issues also meant there was no theory addressing the key problems smart homes will face when integrated into the home, let alone a theory that can help address culturally divergent populations like rural users, who are more likely to distrust the technology and have usability issues (Mathew, 2005).

All of the issues related to care and using technology to assist are further complicated by Covid-19. The mortality for Covid-19 among older adults in one study's hospitals was an average of 26.2% (OR = 1.09), with this rising depending on the comorbidities to an average 62.2% mortality rate for dementia, which had the highest rates and increasing rates based on the severity of dementia (Bianchetti, 2020). The World Health Organization and CDC estimated 95% of all Covid-19 deaths occurred in those 60 and older, with over half of these deaths occurring in those 80 and older (Centers for Disease Control and Prevention, 2020; Sandoiu,

2020). In the United States, 35% of those deaths occurred in long-term care facilities (Sandoiu, 2020). There are also concerns about the long-term effects of the virus due to older adults isolating themselves to protect themselves from the virus and those who do live with others possibly being at increased risk of abuse due to having limited escape options (Sandoiu, 2020). In terms of how this affects patients who may not have Covid-19 but other chronic conditions such as heart disease and diabetes, many have not seen a care provider regularly since the pandemic hit their country either due to hospitals nearby being overtaxed by Covid-19 or fear of contracting the disease, which can lead to their condition becoming worse due to lack of management (Mauro et al., 2020; Chen, 2020).

Covid-19caused a surge in telemedicine use for medical and counseling appointments and which can also assist with other tasks, such as vital sign monitoring (Perrin et al., 2020; Figueroa & Aguilera, 2020). This allowed high-risk patients who needed care but may be endangered in nearby hospitals to be monitored through the pandemic (Perrin et al., 2020). Videoconferencing technology also allows patients to visit relatives and reduce their overall feelings of isolation (Padala et al., 2020). This thesis focused on healthier older adults who are unlikely to need long-term care devices but can use more general health, fall, and security monitoring. Unfortunately, many assistive and long-term care devices are not as publicly available, so there has been no examination of how the devices examined in this study might provide assistance for patients who have a care deficit due to Covid-19. However, the results of this thesis and evidence for the rising demand for home care and virtual caregiver assistance in some areas suggested that some of these devices would be more acceptable now, just as telemedicine has become (Ansberry, 2020; Comas-Herrera et al., 2020; Cox, 2020).

Thus, a Grounded Theory approach was used to develop a framework for a theory of smart home implementation among rural users. This was done by first assessing the phenomena by looking at relationships by key themes, then entering into deeper analysis to develop the

beginnings of a theory for assistive technology acceptance and implementation. The thesis focused on three specific types of technology common in smart homes and healthcare, remote health monitoring, fall detection, and personal security systems. Past studies have shown these features were of interest to older adults and more acceptable than other features because they are viewed as useful (Demiris, 2004; Townsend et al., 2011; Chen & Chan, 2014). However, studies have also shown older adults are generally not willing to pay for health-related features without insurance coverage, remote health monitoring had acceptance issues among some groups due to privacy concerns, fall protection was less acceptable than the other two types of technology, and that overall they were most interested in security technology, possibly because it was more familiar to them and had less privacy-related concerns (Kirchbuchner et al., 2015; Gövercin et al., 2016; Townsend et al., 2011; Fritz et al., 2015; Demiris et al., 2008). Thus, this study proposed interviewing rural older adults who monitor one or more vital signs daily, such as blood pressure, about adopting these three types of technology and asking if their perspective, particularly on remote health monitoring, had changed due to Covid-19 making it difficult to access their doctor in-person.

Section 1: Statement of the Problem

Of the 49.2 million older American adults, around 10.6 million are rural, with the portion of the rural older adults expected to skyrocket to 25% due to Baby Boomers retiring and working adults migrating to urban areas (Roberts et al., 2018; Smith & Trevelyan, 2019; Pendall et al., 2016). Key health issues that can lead to long-term cognitive and physical disabilities for older adults in the U.S. include dementia, cardiovascular disease and stroke, chronic bronchitis, cancer, and diabetes (Office of Disease Prevention and Health Promotion, 2020). Nursing homes were associated with great losses in privacy and autonomy, as well as higher rates of respiratory, urinary tract, diarrhea, skin, and staphylococcus infections that led to rehospitalizations and

longer stays, increased healthcare expenditure, increased complications with other health issues, and increased morbidity (Fritz et al., 2018; Montoya & Mody, 2011).

In studies, older adults preferred smart homes and other assistive technology if they can result in the ability to live at home longer because the technology can be potentially less invasive and reduce autonomy less when designed with their needs in mind (Fritz et al., 2018). Assistive technology like remote health monitoring can also prevent problems and prevent placement in a nursing home, which potentially reduces the older adults' risk of infections common in residents, which is all the more important in the time of the Covid-19 pandemic.

Section 2: Purpose of the Study

The purpose of this study was, using Grounded Theory, to explore the perceptions of rural Oklahomans in Payne County on three types of common smart home technology, remote health monitoring, fall detection, and home security systems, that were connected to a smart home hub and could help the older adult better monitor their health, prevent health problems and injuries, and provide an additional feeling of safety during Covid-19 and other pandemics.

Section 3: Hypotheses

This was an early-stage inductive study meant to explore perceptions, and as such, no hypotheses were tested.

Section 4: Significance

As noted, nursing home placement is common among older adults and multiple problems from infections acquired at homes were common (Montoya & Mody, 2011). Rural older adults were particularly at risk of this due to their lack of easy access to healthcare providers, which can lead them to potentially delay treatment, and good nursing homes. Also, as noted, long-term care was expensive with a cost of $275 billion, not including the $450 billion in unpaid care, and this

was primarily due to nursing home placement, which was the most expensive type of care on average despite the issues (Pennsylvania Health Care Association, 2019; Genworth, 2019; Feinberg et al., 2011).

Smart homes and other assistive technology have great potential when combined to form a system that can target specific user needs and preferences to reduce nursing home placement and make home care easier, particularly if system components are customizable to include only needed functions. They are also likely to be much more affordable in the long run with most systems and devices currently on the market costing hundreds to thousands for technology that potentially last several years compared to annual nursing home care that can cost several tens of thousands of dollars each year. The primary challenge to their implementation was the lack of insurance coverage among many states and the lack of stringent research, particularly on priority groups such as rural users, that helps address acceptance issues (Berridge, 2018). This study may help bridge the gap in the lack of rural studies with its development of an initial theory on acceptance issues among rural older adults for three key types of devices and how to address those issues.

Section 5: Operational Definitions

Subsection 1: Older Adults

The category of older adults was often defined as adults age 65 and up in censuses and studies (Roberts et al., 2018; Smith & Trevelyan, 2019; Pendall et al., 2016). For the purpose of this study, the term matched the traditional definition of older adults being age 65 and up, as it was expected those who are retired or are considering retirement are more likely to be considering long-term care, have health issues that need monitoring, and to have more issues with technology.

Subsection 2: Smart Homes

Smart home technology was generally defined as smart technology used within the home and monitors home systems and services to adjust for user needs, though the definition can vary wildly because this is a relatively new area (Gross, 1998; Home Technology Association, 2020). In this study, smart homes were defined as any technology that was primarily used in the home that can assist older adults, including a smart home hub or tablet that can control remote health monitoring devices and be used for telehealth, a fall detection device, and home security system devices.

Subsection 3: Rurality

Rurality, or rural areas, was typically defined as areas with less than 2,500 people, while urban clusters were generally defined as areas of 2,500-50,000 people (United States Census Bureau, n.d.). However, when taking into account how Oklahoma's healthcare resources were distributed, this was a poor definition. Healthcare resources tended to be primarily located in larger metropolitan areas of over 100,000 people like Oklahoma City and Tulsa, with smaller areas often having fewer healthcare and nursing care resources. Stillwater, the largest town within the target area of Payne County, had very limited or no access to some specialty and testing resources despite having a population of almost 50,000 and several smaller surrounding towns. Thus, Payne County itself, for the purpose of this study, was considered rural because it lacks adequate healthcare resources for its population, like most areas in Oklahoma, and accessing those resources in a larger city will require around an hour of travel just to reach the city.

Subsection 4: Aging-In-Place

Aging-in-place usually refers to older adults who had an increasing need for care but were not required to move out of their homes and into some type of assisted living facility. Instead, they were typically provided with strategies and resources that allowed them to

continue to live at home as long as possible. This study used this basic definition with the added idea that assistive technology is one of the key resources that may help older adults stay in their homes longer.

Section 6: Delimitations

The geographic and recruitment location, rural group, health, age group, and technology were the delimitations for this study. This study only included Payne County older adults who responded to who showed interest from advertising at organization meetings and churches, local bulletin boards, and local Facebook page outreach. Furthermore, it only included older adults who seemed to be cognitively healthy, and any older adults suspected of having mental health issues, such as dementia, were excluded due to consent issues. Older adults were also required to be using some sort of self-monitoring technology, such as a blood pressure machine, regularly to qualify for the study. The self-monitoring technology could have been for any condition and could have been a regular device or remote monitoring device. The user must also have had access to email and high-speed Internet to receive and stream videos about the technology that were discussed in the study. Perceptions of the technology and demographic data were obtained with a survey created by the researcher, with no other surveys or scales being used. The results may not generalize to the international population, the urban U.S. older adults, or even the other rural older adult populations in other states.

Section 7: Limitations

The primary limitations for the study were a low number of participants, phone interviews rather than in-person sessions, and self-reporting accuracy. The low number of participants restricting the range of data collected limits the statistical power and strength of the coding, as the general population is not well-represented, no racial or ethnic minorities participated, people in the lowest income bracket did not participate, there were few adults in the

older 75-84 and 85+ age groups, and the population consisted primarily of women instead of an even distribution of males and females. Thus, the sample population was only relevant for rural white older adults average to high income and was more relevant specifically for women between 65-74. Self-reporting of demographics and technology use, as well questions about concerns about the ease of use of the devices in the interviews could have also been an issue, particularly technology use, as there was some evidence before or during the interviews when some participants struggled with their phones, seemed confused about basic technology, or asked a relative for help with their devices that they may have been overestimating their technological capabilities when they answered the questions on how easy they found devices to use.

CHAPTER II

LITERATURE REVIEW

Section 1: Need for Smart Homes and Primary Barriers

Subsection 1: Population Overview

In 2015, 671.1 million people out of around 7.3 billion, or 9%, were 65 and older, and by 2030, it is estimated there will be one billion (12%) elderly adults, which will increase further to 1.6 billion (17%) by 2050 (Roberts et al., 2018). Meanwhile, the population under 20 will have an almost flat growth rate, and the population of 20-64 years will have a more moderate increase. Europe will have older adults comprise over 25% of the population by 2050, while they will comprise around 21.4% of the population in North America by then. Other continents such as Asia will also experience rapid growth in this demographic except Africa. Within the United States, 49.2 million adults were 65 and older in 2016. Around 28.7 million or 58% were 65-74, while 14.2 million or 29% were 75-85 and 6.3 million or 13% were 85 and up (Roberts et al., 2018).

Females outnumber males in all of these groups, and the number of males per 100 females decreases as age increased, with 88 males to 100 females for the 65-74 group, 76 males to 100 females for the 75-84 group, and 53 males to 100 females in the 85 and up group (Roberts et al., 2018). Over 75% of the older adult population was white, with the majority of the white population being non-Hispanic white (82.2). Around 8% were Hispanic, 9% were black,

less than 5% were Asian, 1% were multiracial, and Native American or Alaska Native, Native Hawaiian, Pacific Islander, or another race groups were each less than 1% of older adults (Roberts et al., 2018). Of the 49.2 million elderly, 10.6 million live in rural areas, and although estimates vary, the portion of the population in rural areas that falls within the 65 and older age group is expected to skyrocket to 25% as more Baby Boomers retire and younger adults migrate to urban areas (Roberts et al., 2018; Smith & Trevelyan, 2019; Pendall et al., 2016).

Subsection 2: Need for Aging-in-Place Technology among Rural Elderly

Among the elderly in the U.S., key health issues include heart disease and stroke, cancer, emphysema or chronic bronchitis, diabetes, and dementia, which can lead to cognitive and/or physical disabilities (Office of Disease Prevention and Health Promotion, 2020). Around 18 million older adults, or a little under half, required assistance within a month for activities of daily living, or ADL, and 25% required regular care (Freedman & Spillman, 2014). Thus, overall annual long-term care in the United States costs $275 billion, 23% of which is out-of-pocket (Pennsylvania Health Care Association, 2019). Meanwhile, the estimated value of uncompensated care provided by family and friends is around $450 billion annually (Feinberg et al., 2011). Individually, the annual cost of paid home caregivers is between $51,480-$52,624 on average, adult day care is around $19,500, assisted living is around $48,612, semi-private nursing home rooms are around $90,155, and private nursing home rooms are around $102,200 (Genworth, 2019).

Assistive technology, which can include robotics, smart homes, telemedicine, wearables, and mobile phones, has been proposed to help prevent or address certain cognitive and physical health issues (Majumder et al., 2017). Smart devices, in particular, have been proposed for various problems, including home health and activity monitoring, e-health

services in conjunction with telemedicine, vital health marker monitoring such as tachycardia and abnormal sleep indicative of sleep disorders, home environment monitoring for dangers such as gas leaks, automated emergency calls, fall detection, reminder systems, task assistance ranging from automatic lighting and cognitive assistance to guiding users through daily tasks, and cognitive health assessment (Majumder et al., 2017; Amiribesheli & Bouchachia, 2018). Because of the well-known issue of rural elderly living farther away from healthcare providers and good nursing homes, smart devices and telemedicine have been proposed as solutions to bridge the gaps in their healthcare access and long-term care, with telemedicine solutions already becoming acceptable in rural communities (Bossen et al, 2015). This thesis will focus on more general aging-in-place devices in these categories, including remote health monitoring, fall detection, and smart security cameras, as the interviews will be with older adults who do not need a caregiver.

Subsection 3: Major Privacy Issues for Older Adults

Older adults from various countries tend to have similar issues and preferences with smart devices and monitoring systems. Although this thesis will focus on interviewing older adults, the research on opinions of their relatives and caregivers will be included, as there is a possibility some participants interviewed will discuss relatives' attempting to get them to adopt telemedicine due to Covid-19. The extant literature demonstrates that older adults are generally accepting of cameras; however, but they tended to be more accepting of cameras recording only silhouettes (Demiris et al., 2004; Demiris et al., 2008; Townsend et al., 2011; Chernbumroong et al., 2010; Portet et al., 2013; Kirchbuchner et al., 2015; Fritz et al., 2015; Himmel & Ziefle, 2016). A primary concern for older adults and caregivers was privacy violations and, while reasons differed for their feelings of concerns, older adults tended to feel uncomfortable about constant home monitoring to the point that they reject cameras even for issues such as fall detection (Demiris et al., 2004; Coughlin et al., 2007; Satpathy &

Mathew 2007; Peek et al., 205; Kirchbuchner et al., 2015; Gövercin et al., 2016; Demiris et al., 2008; Fritz et al., 2015).

Generally, monitoring technology like cameras was most acceptable outside the home, more acceptable in public rooms like the kitchen and living room, and less acceptable for bathrooms and other private areas, though acceptance levels varied for bedrooms (Fritz et al., 2015; Himmel & Ziefle, 2016). Privacy and confidentiality concerns are evident among this population, particularly related to common concern about monitoring was data security and who would access to data collected by monitors (Coughlin et al., 2007; Kirchbuchner et al., 2015; Himmel & Ziefle, 2016). Given this, previous findings have demonstrated older adults found monitoring more acceptable if the person monitoring was a trusted relative (Fritz et al., 2015; Himmel & Ziefle, 2016; Pal et al., 2018). Finally, Berridge and Wetle (2019) found older adults and their children tended to disagree on what devices would be acceptable for monitoring, with older adults disliking the technology, particularly the more invasive types such as cameras, while their children tended to prefer monitoring technology in general and feel their parent(s) would accept it. Some children were already considering using cameras to monitor their parent(s) and did not feel it would impact the parent's privacy since it was their child observing (Berridge & Wetle, 2019). One felt her mother would feel safer, despite the mother vehemently opposing cameras in her interview (Berridge & Wetle, 2019). It should also be noted that the children tended to underestimate their low-income parents' capabilities in terms of understanding the technology and privacy risks, which may also be a factor in their feeling that full consent to implement the technology with their parents is not needed (Berridge & Wetle, 2019).

Subsection 4: Major Financial and Technical Issues for Older Adults

Older adults would generally only purchase a smart home system if the price were low (Demiris et al., 2004; Callejas & Lopez-Cozar, 2009; Chen & Chan, 2014; Peek et al., 2015; Fritz, et al., 2015; Kirchbuchner et al., 2015; Gövercin et al., 2016; Yusif et al., 2016; Pal et al., 2018). In addition, reliability is a concern, as the system will need to continue to be able to carry out basic functions as expected for several years even if certain functions no longer work, and older adults in one study were concerned about a reduction in quality of life if the system fails (Satpathy & Mathew, 2007; Coughlin et al., 2007; Chen & Chan, 2014; Kirchbuchner et al., 2015; Himmel & Ziefle, 2016; Fritz et al., 2015). A major barrier to acceptance is complexity, as older adults need a system that is easy to use and often express anxiety about new technology (Demiris et al. 2004; Satpathy & Mathew, 2007; Chen & Chan, 2014; Kirchbuchner et al., 2015; Peek et al., 2015; Yusif et al., 2016; Pal et al., 2018). A related barrier is training, as older adults prefer extensive training using methods that take into account their health, limitations, and culture and tend to express a preference for simple devices with only a few features (Demiris et al., 2004; Mordini et al., 2008; Oppenauer et al., 2007; Wallace et al., 2010; Chen & Chan, 2014).

Research has demonstrated a strong preference for voice controls over touch screens while others found no preference for one method over the other (Portet et al., 2013; Wallace et al., 2010). Novitzky et al. (2015) note that screen size, mobility of devices, interface problems, hardware problems, and intolerance of devices that do not meet the specific needs of older adults all contribute to the problem of implementing a uniform, widespread smart home system. For example, Novitzky et al. (2015) note that despite being one of the most advertised features for older adults, fall detection systems rarely provide more security or protection than a simple, wearable one-button alarm, and may only be so popular commercially due to the preferences of designers and caregivers for flashy technology and the ability to monitor older adults and ease the caregiver's anxiety.

Subsection 5: Major Social and Psychological Issues for Older Adults

Older adults tend to view isolation, controlling caregivers and relatives, autonomy, and stigma as major concerns. Although controlling caregivers and relatives are likely less concerning for the group of older adults in this study, as most will still be autonomous, the literature on this area will still be covered briefly, as some participants are likely to mention their opinions on relatives who want them to adopt the technology. Older adults concerned about isolation tend to mention issues such as smart homes and devices replacing human caregivers or relatives monitoring them without contacting or visiting them (Demiris et al., 2004; Zwijsen et al., 2011; Fritz et al., 2015; Peek et al., 2015; Marikyan et al., 2018). Smart homes and devices are also sometimes viewed as a threat to their feelings of control and autonomy, as some have expressed concerns that the systems could control their home or that the people controlling the technology could force them to modify their daily habits (Mathew, 2005; Portet et al., 2013; Peek et al., 2015; Himmel & Ziefle, 2016; Fritz et al., 2015; Kirchbuchner et al., 2015; Yusif et al., 2016; Pal et al., 2018). Older adults in the United States also tend to prefer relationships where they give more than they take, are in control, and are not burdening their family, and they view smart homes as threatening because they feel the system confirms they are dependent (Peek et al., 2015; Fritz et al., 2015). Older adults in the United States and Europe tend to think they are healthier than they are, strive for complete autonomy, and think they do not need preventative and assistive technology until they have considerable disabilities, in contrast to older adults in Asia (Demiris et al., 2008; Zwijsen et al., 2011; Peek et al., 2014; Portet et al., 2013; Chernbumroong et al., 2010; Townsend et al., 2011; Kirchbuchner et al., 2015; Chen & Chan, 2014). Furthermore, many Western elderly and caregivers are afraid that older adults who use the technology will experience stigma (Peek et al., 2015; Yusif et al., 2016; Zwijsen et al., 2011). One survey found that older adults who are most likely to adopt smart homes were women 60-70 years

old with a physical disability who lived in a two-story house, had a fall history, and had some experience with information and communication devices such as cellphones (Arthanat, Wilcox, & Macuch, 2019).

Subsection 6: Cognitive Impairment, Technology, and Older Adults

This study will not focus on older adults with severe cognitive impairment, such as those with dementia. However, it would be remiss to exclude the literature on this group entirely, as it provides valuable reinforcement of the general literature on what older adults want from assistive devices. With regards to older adults with issues such as dementia, Novitzky et al. (2015) studied the literature on gerontechnology dating back to 1990 from several countries. They found older adults want to be included in the development of the technology and, if they are not included, are more likely to stop using the technology (Wallace et al., 2010; Francis, Balbo, & Firth, 2009). They also found the needs of older adults are poorly understood by the often much younger developers to the point needs are often still not met even during testing and implementation (Panek & Zagler, 2008; Lauriks et al., 2007). Older adults with dementia, in particular, need specialized training to use even simple systems (Mordini et al., 2008; Oppenauer et al., 2007; Wallace et al., 2010).

Section 2: Key Theoretical Concepts Regarding Ethics and Acceptance

Subsection 1: Bioethical Theory

The key theoretical concepts used in this review are bioethics, the biopsychosocial model, and Maslow's Hierarchy of Needs. Beauchamp & Childress (2008) list the four most commonly accepted bioethical principles, which are beneficence, non-maleficence, justice, and respect for autonomy. Beneficence means removing harms and providing benefits to the patient. Similarly, non-maleficence involves not intentionally harming or injuring the patient. Justice typically is defined as fairness, or that each person should receive equal treatment and

have an equal chance of receiving the limited resources available in the amount needed. It involves not exacerbating health and social inequalities or stigmatizing disadvantaged groups. Respect for autonomy involves informed consent and allowing patients to make decisions voluntarily (Beauchamp & Childress, 2008). Schröder-Bäck et al. (2014) also added three principles, health maximization, efficiency, and proportionality. Health maximization involves improving the overall health of the population, not just individuals, like beneficence. Efficiency involves taking into account scarce public resources and determining if the proposed use is the best and most cost-effective one for a problem. Proportionality asks if the cost and benefit of the proposed solution are proportional and if it is the least infringing of the possible alternatives.

With regards to assistive devices, the general goal is to meet all of these principles, with many articles analyzed seeming to focus on Schröder-Bäck et al.'s (2014) additional principles of efficiency and proportionality, followed by the original principles of justice and health maximization. Few discuss bioethics directly. Efficiency and proportionality are general goals to reduce the cost of care through assistance and prevention, as it expected most devices will cost far less than long-term care and emergency care services that might be needed otherwise, but to be affordable for many older adults on lower incomes, the devices will need to be covered by insurance (Demiris et al., 2004; Coughlin et al., 2007; Zwijsen et al., 2011). Zwisjen et al. (2011) and Demiris et al. (2008) both propose widespread implementation of the devices in places like apartments for seniors to reduce costs and make the technology accessible for everyone, regardless of income. This also ties into the principles of justice and health maximization, as one of the primary goals of Zwisjen et al. (2011) and Demiris et al. (2008) is to equalize care regardless of income level and to have it available to all older adults.

Beneficence and non-maleficence are more questionable goals. Generally, the goal of assistive and healthcare technology is to provide benefits and avoid harming users. However, due to privacy and stigma issues, possible loss of autonomy, reduced human contact, and the simple fact that devices may not provide the expected benefits, these goals may not be met (Bharucha et al., 2009; Demiris et al., 2004; Coughlin et al., 2007; Demiris et al., 2008; Bjørneby et al., 1999; Bjørneby et al., 2004; Cash, 2003; Melander-Wikman et al., 2007; Gatward, 2004; Zwisjen et al., 2011). Obviously, violation of respect for autonomy is also a concern due to possible autonomy and privacy losses just mentioned.

Thus, this brief ethical overview implies the technology can meet efficiency, justice, proportionality, and health maximization goals if it is tested thoroughly and made widely available to reduce cost and increase accessibility. Beneficence and non-maleficence may also be met provided the technology has been thoroughly tested and the individual's need for the technology outweighs any downfalls, such as increased monitoring of major health conditions and better preventative care in exchange for minor privacy losses due to the information being sent to their doctor's office. Because almost all of the technology involves some form of data sharing with relatives, caregivers, or hospital staff, respect for autonomy will be violated to some degree. The goal for this principle should be to minimize these violations by limiting data sharing only to those contacts the user approves of, such as their cardiologist and nurses or close relatives, and to limit the amount of information shared, such as only sharing vital health statistics or warnings if the user has fallen.

Subsection 2: Acceptance Theories

With regards to the other two theories mentioned, the biopsychosocial model and Maslow's Hierarchy of Needs, these are less related to ethics and more to acceptance. Older adults are likely to only accept assistive and healthcare technology if it meets their needs.

The biopsychosocial theory combines the biomedical theory, which focuses primarily on biological needs, with the psychosocial theory, which focuses on psychological and social needs (Weise-Bjornstal, 2010; Suls & Rothman, 2004; Suls et al., 2013). The biomedical model includes physical health, disabilities, genetics, neurochemistry, comorbidity, and other biological factors that influence disease or injury at the biological level. The psychological level includes attitudes, beliefs, self-esteem, coping skills, temperament, and other factors relating to the mind. The social and environmental level includes social groups, such as family and peers, the workplace, culture, socioeconomic variables, and other relationship and background factors that can influence health. Thus, the biopsychosocial theory is recommended because it views health holistically (Weise-Bjornstal, 2010; Suls & Rothman, 2004; Suls et al., 2013).

Maslow's Hierarchy of Needs, on the other hand, allows for the classification of these needs based on how likely a person is to prioritize them. Thielke et al. (2011) discuss key factors related to the theory that are likely to influence acceptance of healthcare and assistive technology. The theory has five levels of needs, with the most important to least important in terms of priority being physiological, safety, love/belonging, self-esteem, and self-actualization. Typically, a person would try to meet the lower level, survival needs, first before the higher-level needs. However, Thielke et al. (2011) argue that many older adults try to use the technology to meet their higher-level needs as well, and since developers tend to prioritize meeting lower-level needs, this may be a primary factor related to low acceptance rates. Many older adults prioritize the needs of self-esteem and self-actualization (Thielke et al., 2011).

Self-esteem needs include autonomy, self-confidence, self-control, and respect from others (Thielke et al., 2011). Older adults who feel threatened by the idea they may need to live in a facility may strongly reject any technology that they feel could reduce autonomy or

make them look weak or sickly, even if their actual health status is problematic, as most older adults in this culture regard themselves as healthy compared to other older adults. To meet self-esteem needs, autogenous intent or active participation by the older adult in acquiring and using the technology is likely required. Technology obtained by exogenous intent, which involves others prescribing the technology for the user or the technology pushing for certain behavioral changes, is likely to be rejected, as it is threatening to self-control and autonomy. Technology focused on boosting self-esteem through rewards, such as praise for meeting health goals or for helping users become more autonomous without outside help, is more likely to be accepted (Thielke et al., 2011).

Self-actualization involves the sense of being alive and participating in meaningful activities, such as hobbies, exercise, and volunteer work (Thielke et al., 2011). These activities tend to be ends within themselves, such as exercising for enjoyment rather than simply increasing fitness. Technology that can help older adults meet these goals is also more likely to be accepted. Finally, although not discussed as much, social/belonging needs are also a priority for older adults, who are often concerned about isolation. Technology that may reduce human contact is a threat to this need and likely to be rejected (Thielke et al., 2011).

One problem with current healthcare and assistive technology is that it tends to be aimed at lower-level needs, such as safety, prevention and aid with physical problems, and prevention and aid with cognitive problems. Many older adults may already feel that their safety and health needs are being met, which reduces the likelihood of acceptance in these areas. Furthermore, they may view the technology as a threat to their self-esteem, autonomy, and self-control because of the implications that they are not meeting their lower-level needs. In addition, they may view it as a threat to their social lives and reject it (Thielke et al., 2011). Thus, it is recommended where possible to include features that can boost social, self-esteem,

and self-actualization needs. For example, face-to-face videoconferencing technology may be desirable to older adults to see their doctors and relatives, which is why the remote health monitoring technology discussed includes it. The ability to control who enters their living space may also be desirable, which is why home security systems are included in this study.

Section 3: Current Literature on Patient-Centered Design

Subsection 1: Patient-Centered Design and Privacy for Older Adults

The primary concerns in the literature involve making sure technology targeting older adults is patient-centered, respects their need for privacy and autonomy, and is affordable. Fritz et al. (2015) discussed using patient-centered care with a focus on self-identified culture rather than general cultural values associated with stereotypical traits, such as religion, gender, and race, to reduce cost and improve care quality. Fritz et al. (2015) found participants varied greatly in terms of the type of privacy that was most important to them, with some concerned with modesty or privacy when in various states of undress, others concerned about home privacy, or natural privacy, and some concerned with Big Brother and government surveillance. Many were concerned about norm privacy, or expectations for activities one could do or not do in one's private home (Fritz et al., 2015).

Subjects indicated that independence gained must be balanced with privacy needs, as severe intrusions from the smart home system can outweigh the gains in autonomy and make it not worth it for them, with a few stating that cameras and sensor monitors of any kind were not acceptable (Fritz et al., 2015). However, participants generally preferred a small loss of privacy to smart home surveillance to the greater loss in nursing homes (Fritz et al., 2015).

Subsection 2: Patient-Centered Design and Safety for Older Adults

Safety was a key issue and theme for some older adults, and features that were perceived to be related to safety, such as comfort, convenience, and quality of life aids, were desirable to them (Fritz et al., 2015). Note that this is consistent with why some express interest in the devices, but it contradicts Thielke et al.'s (2011) research on why older adults actually use assistive technology (for example, for self-esteem and self-actualization needs). Most expressed the desire to have a system implemented as soon as possible so they could learn how to use it but also contradicted this desire by stating that adoption would only be considered if it was absolutely necessary, implying they would prefer to delay adopting a system as long as possible (Fritz et al., 2015). Most subjects thought women would be more accepting of help, as would the upper-middle class due to their income (Fritz et al., 2015). Finally, educating potential users was found to be critical in order to address trust issues concerning technology and provide information about real versus unreal concerns (Fritz et al., 2015).

Most users also stated they would not trust a system if it was not recommended by relatives and would not seek out a system without persuasion by relatives (Fritz et al., 2015). They also felt that smart homes should not replace human caregivers among those who need more help but rather aid them, and that robot systems helping physically with tasks, such as dressing and feeding, would be unacceptable due to them finding the idea alienating (Fritz et al., 2015). On the other hand, monitoring for safety and health using sensors instead of cameras was generally viewed positively due to the possible quality of life increases (Fritz et al., 2015).

Section 4: Current Literature on Remote Health Monitoring, Fall Detection, and Security Monitoring Devices

Subsection 1: Remote Health Monitoring

This section will briefly cover the acceptance of smart remote health monitoring devices. It will exclude the more common internal monitoring devices, as these have major differences from telemedicine devices. Currently, Liu et al. (2016) say there is medium-to-high-quality evidence that smart and remote health devices can monitor physical function, pulmonary disease, cognitive decline, mental health, heart health, fall detection, and ADLs and are beneficial for older adults, while fall prevention, disability prediction, and quality of life technology have less or no evidence of being beneficial. Giger et al. (2015) found that home health monitoring was generally tolerated and care access and delivery, treatment adherence, and patient engagement and retention could be improved with the technology. Reduced long-term care and healthcare costs are also likely with preventative and home health technology implementation (Giger et al., 2015). Beer and Takayama (2011) found that older adults are willing to adopt a home health and assistive technology system if the benefits of using it are clear, they can control when it activates in social situations, it has tutorials/manuals available, and it takes into account physical needs, as some had trouble using the mouse due to deteriorating motor skills. Tseng et al. (2013) found that ease of use, accurate system performance, and user's perception of their ability to use the health monitoring system were significantly correlated with acceptance.

In a comprehensive acceptance study, Li et al. (2019) found that education, income levels, and frequent use of new technology were the factors most significantly correlated with acceptance. Most considered the systems easy to use, so this did not influence perspectives as much. Facilitating factors such as positive social influence and attitudes toward assistive technology could increase perceptions that the technology is easy to use and useful, as well as the intention to use it. Poor health also had a significant influence on perceptions of usefulness and intention to use. In terms of risk factors that could decrease intention to use, the social risk was considered low, but privacy concerns, low accuracy of measuring tools,

and general quality issues could significantly decrease intention to use. In terms of desired features, older adults wanted the wearable device to aesthetically fit in and be customizable to fit individual preferences. Specific requests included that the device be lightweight, waterproof, easy to take on and off, and aesthetically pleasing. Also, they wanted technical support, financial aid, and training to be readily available. For privacy reasons, they would prefer the data be transmitted only to their physicians or family members (Li et al., 2019).

Subsection 2: Fall Detection

Smart homes and devices often include fall detection, which has raised privacy concerns among older adults, as many systems use cameras to constantly monitor for falls (Demiris et al., 2004; Coughlin et al., 2007; Satpathy & Mathew 2007; Peek et al., 205; Kirchbuchner et al., 2015; Gövercin et al., 2016; Demiris et al., 2008; Fritz et al., 2015; Iio et al., 2016). Silhouette cameras are generally more acceptable than regular cameras (Demiris et al., 2004; Coughlin et al., 2007; Satpathy & Mathew 2007; Peek et al., 205; Kirchbuchner et al., 2015; Gövercin et al., 2016; Demiris et al., 2008; Fritz et al., 2015). Londei et al. (2009) found the perception of safety was most related to acceptance for fall detection cameras, especially if they could be used for home security as well. However, only 48% were willing to use such a device and many would only use it if they lived alone or their health deteriorated (Londei et al., 2009).

Iio et al. (2016) found that some older adults willingly used wearable sensors for fall detection despite their wariness of cameras, while Sitar-Taut (2018) found that fall sensors were accepted by almost 70% of participants, with some primary concerns revolving around potentially losing the device, privacy, and feeling the device was unnecessary. Pirnejad et al. (2014) found a lower rate of 61.7% acceptance for wearable sensors and found that users generally reported feelings of satisfaction and security with the device. The attrition rate of

57% attrition was most commonly attributed to health deterioration followed by device or network issues (Pirnejad et al., 2014). Another study by Williams et al. (2013) found that participants expressed contradictory feelings regarding a wearable fall detection device, on the one hand stating it was reassuring to them, made them feel safe, and was more useful because it could be worn outside the home, but at the same time stating that it made them feel more vulnerable, possibly due to fears of being stigmatized in public. Other barriers to acceptance included privacy concerns due to constant monitoring, ageism, and discrimination, discomfort while wearing the device, false alarms, fears of bothering relatives and being institutionalized, and concerns about the device not working correctly outside the home (Williams et al., 2013; Brownsell & Hawley, 2004; Doughty et al., 1996; Gatward, 2004; Miskelly, 2001; Horton, 2008; Williams et al., 2000; Parker et al., 2008; Gövercin, et al., 2010).

Bianchi et al. (2010) and Dovgan et al. (2011) used different combinations of wearable and ambient home fall technology for detection in their laboratory and found acceptance ranging from 70% to over 99%. Gövercin et al. (2010) found feelings of safety were the main factor affecting acceptance of both types of sensors, with healthier individuals also expressing more privacy concerns and sicker ones having fewer concerns. Ironically, ambient sensors in Gövercin et al.'s (2010) were most wanted for the bathroom, which contradicts previous studies, and least for the bedroom. Financially, Gövercin et al. (2010) found that participants were more willing to spend money to buy or rent a wearable system (38%) compared to an ambient sensor system (13%), though the amounts they were willing to pay varied and most expected their insurance provider to cover all costs. Demiris et al. (2008) found that mats that could detect gait changes and falls were acceptable and generally did not cause privacy concerns, but users would prefer those that could detect intruders. In short, these studies seem to indicate that fall and gait mats are the least threatening, followed by

sensors, then silhouette cameras. Regular cameras are generally not acceptable for many due to privacy concerns (Demiris et al., 2004; Coughlin et al., 2007; Satpathy & Mathew 2007; Peek et al., 205; Kirchbuchner et al., 2015; Gövercin et al., 2016; Demiris et al., 2008; Fritz et al., 2015; Iio et al., 2016). Lapierre et al. (2018) note, in general, that fall detection studies focus on technical issues and not on acceptability. The acceptability issues found are likely contributing factors to the underuse of fall detection technology (Lapierre et al., 2018).

Subsection 3: Smart Security Monitoring

Home security monitoring studies that take into account the acceptance issues of older adults are generally rare. Demiris et al. (2004) found that home security cameras and related devices were among the primary types of smart technology wanted by older adults. However, they were concerned about emergency alerts being ignored by responders (Demiris et al., 2004). In another study, Demiris et al. (2008) found that older adults would prefer the gait change mats instead be used to detect intruders. Yusif et al. (2016) also found that older adults preferred technology which could increase their security and awareness of their surroundings. These studies indicate that older adults have a need to secure their home environment, but as mentioned, there is a lack of research in this area.

Section 5: Current Literature on Covid-19

Subsection 1: General Issues with Covid-19

The average mortality rate for older adults with Covid-19 is 26.2% (OR = 1.09), and this can rise with comorbidities up to an estimated 62.2% for people with dementia, which was associated with the highest rates and rates with the biggest increases based on the severity of the condition (Bianchetti, 2020). The World Health Organization and CDC estimated that those 60 and older comprised 95% of all Covid-19 deaths, and those 80 and up comprised over 50% of older adult deaths (Centers for Disease Control and Prevention, 2020; Sandoiu,

2020). Long-term care facilities in the United States have 35% of the older adult deaths (Sandoiu, 2020). Older adults with other conditions, such as heart disease and diabetes, which can be comorbid with Covid-19, often are not seeing their healthcare provider regularly due to overtaxed hospitals or fear of the disease, which can lead to their condition progressing more quickly due to not being managed (Mauro et al., 2020; Chen, 2020). Giacomo et al. (2020) found that those with Covid-19 and one comorbidity had a hazard ratio of 1.79 for poor prognosis, and those with two or more comorbidities had a hazard ratio of 2.59.

Other concerns include social isolation and abuse risk, as older adults may protect themselves from the virus by staying within the home (Sandoiu, 2020). Even before the pandemic, Lambrini (2016) stated that social isolation was epidemic in the older adult population in several countries around the world. D'cruz and Banerjee (2020) note that older adults are the most likely to be isolated in their home with no physical contact or social engagements during the pandemic. Although technology can provide some substitute methods of social interaction, many older adults have no access to videoconferencing or do not know how to use it and are not being taught (D'cruz and Banerjee, 2020). With regards to abuse, worldwide around 15.7% of older adults experienced abuse in 2019 (World Health Organization, 2020). D'cruz and Banerjee (2020) and Han and Mosqueda (2020) note that prolonged contact with caregivers can increase the likelihood and frequency of neglect and abuse, and preliminary reports in developed countries indicate an increase of up to ten times the normal rates.

Stigma against older adults, or ageism, is noted by the WHO to be the most normalized form of discrimination (World Health Organization, 2015). D'cruz and Banerjee (2020), Lintern (2020), and Baker and Fink (2020) note that Covid-19 and previous pandemics have generally further normalized ageism, resulting in the contradiction of older adults having a

greater need for healthcare resources and public health programs but less likely to receive them compared to younger and middle-aged people due to perceived abilities to contribute productively to society being lower. This has resulted in some leaders asking older adults to sacrifice their needs for others or suggesting that older adult deaths were acceptable, with the latter trending on social media, implying broad social acceptance of this (D'cruz & Banerjee, 2020; Aronson, 2020; Fernandez & Montogomery, 2020; Sparks, 2020). Hate crimes against older adults also have occurred, possibly due to others perceiving them as violating government guidelines (Al Jazeera News, 2020). Normalizations related to ageism, such as systemic exclusion, hate crimes, and microaggressions, may continue well after the pandemic ends (Morrow-Howell et al., 2020; D'cruz & Banerjee, 2020).

Note that these issues are not present in all societies. In Southeast Asia and the Middle East, older adults have more independence and self-control, as they are more respected, which may lessen issues of increased stigma and abuse in these societies (Zubair & Norris, 2015; D'cruz & Banerjee, 2020). Thus, D'cruz & Banerjee (2020) argue for social and digital integration of older adults into society by prioritizing their care during the pandemic, ensuring they receive help with essentials and social benefits, making helplines available for those who need advice, providing simple instructions and staff to help with their digital education, encouraging family and friends to engage in virtual visits, increasing health campaigns targeting older adults, increasing the knowledge of people regarding the diversity of older adults, including them as stakeholders during planning, and addressing issues for those in facilities or with cognitive and/or physical impairments. Technology cannot solve all of these issues, but as seen in this section, it can provide alternative ways of obtaining information and communicating with the outside community, family, relatives, and healthcare providers to reduce isolation and ask for help during emergencies.

Subsection 2: Technology for Covid-19

The technology proposed for Covid-19 most commonly involves remote healthcare devices (Javaid et al., 2020; Zhou et al., 2020). As mentioned in the introduction, telehealth for physical and mental health appointments as well as vital sign monitoring has surged due to Covid-19 (Perrin et al., 2020; Figueroa & Aguilera, 2020). High-risk patients can thus be monitored despite the pandemic by hospitals without being endangered (Perrin et al., 2020). Videoconferencing technology is also useful for reducing feelings of isolation by allowing visitation with relatives and friends (Padala et al., 2020). Telehealth has become more acceptable due to Covid-19 (Ansberry, 2020; Comas-Herrera et al., 2020; Cox, 2020). Other assistive devices for prevention and long-term care have not been examined, but it is possible that acceptance has increased, which is what this thesis is trying to determine.

HIPAA regulations are the primary telehealth implementation barriers in hospitals (Cuffaro et al., 2020). For patients, connectivity issues, lack of needed devices, physical issues such as hearing and/or vision problems, cognitive issues, inexperience with technology, and electricity and Internet access are possible barriers (Sorinmade et al., 2020; Seifert et al., 2020; Jordan, 2020). D'cruz and Banerjee (2020) note that little effort has been made to help older adults learn to use social interaction technology such as videoconferencing, despite evidence that older adults are capable of learning to use it (Martínez-Alcalá et al., 2018). Seifert et al. (2020) state that essentially older adults may now be excluded socially due to digital exclusion. Smith et al. (2020) note a primary issue is that less than 1% of rural people use telehealth, and this is partially due to problems with insurance reimbursement and medical providers' lack of training, as well as fears about privacy and effectiveness. Implementation is often dependent upon individual providers rather than the hospital system or patients, which means a single healthcare organization's providers may vary widely in their policies regarding remote healthcare and telehealth visits (Smith et al., 2020). Developed countries are using telehealth and remote healthcare

technology but lack guidelines on effectively and affordably implementing the technology, as well as making it accessible to all (Ohannessian et al., 2020). Other types of assistive technology outside of telehealth appointments and remote healthcare have generally not been covered in the literature, though presumably, any type of technology that could reduce the likelihood of a person needing to go to the hospital or care facility would be beneficial during pandemics such as Covid-19.

Section 6: Gaps in the Literature

Subsection 1: Privacy Issues

Mortenson et al. (2015) expressed concern that holistic research on the effects of surveillance technology was lacking and that privacy concerns in some studies seemed to mainly focus on data protection and not concerns that older adults expressed, such as home privacy and observation during private situations. Furthermore, Sixsmith (2013) notes that studies on how monitoring could change a person's behavior, daily routine, and social relationships have not been conducted. Mortenson, et al. (2016) note that in Bentham's 1995 work on the panopticon from 1791, he discussed a prison with a central location for observing individuals who would not know when they were being watched. Foucault (1977) used this metaphor when discussing how potential surveillance may change how people who think they are being observed think and behave. As home privacy is invaded by monitoring, technology users may feel judged based on cultural norms, express concern, and alter their behavior to match social expectations and avoid potential consequences (Fritz, 2015; Foucault, 1977).

Subsection 2: Financial Issues

In terms of how states differ in potentially funding assistive technology purchases, Berridge (2018) states that Medicaid in some states is beginning to reimburse purchases, but

some of these states do not track purchases of cameras, tracking devices, and monitors (Berridge, 2018). Furthermore, to implement a program, research must be discussed with policy makers before implementing programs on how to keep systems cost-effective, choice in how much information is shared and with whom it is shared, and how to ethically implement the technology among users with cognitive impairment (Berridge, 2018). Finally, she emphasizes a lack of recent studies that address gaps in current research, including long-term implementation studies, which must be done to understand the practical issues of implementing systems (Berridge, 2018).

Subsection 3: Rural Older Adult Issues

Another area in which studies are lacking is the target group of rural older adults. Mathew (2005) notes that rural older adults need smart homes more than urban older adults, as they live in areas with few healthcare providers, and they end up institutionalized more often since they cannot get transportation to medical facilities as easily. Rural older adults present many special challenges, including having little experience with technology and distrust of it, low-income, and a need for features that may have not even been studied yet due to the focus of most research on urban older adults, who can have different needs (Mathew, 2005). Despite these issues, in the few studies conducted, rural older adults have shown interest in assistive technology and their primary barrier to adoption is likely to be a lack of funds to buy the technology, followed by the complexity of systems (Mathew, 2005).

Because of the aforementioned issues with financing a smart home system among rural users, Mathew (2005) proposed government subsidies or insurance coverage for smart home and assistive technology purchases for older adults, as well as creating simpler systems with interfaces similar to televisions. Mathew (2005) believes that these are essential components to successful acceptance among rural older adults. Furthermore, the technology needs to be

adaptable to the user's lifestyle in terms of features and usability, as well as the ability to be set up in older homes that are not ideal for smart home systems and flexibility in placing the components, as rural adults often have an area in which they spend most of their time, such as the couch (Mathew, 2005). Other things that can increase adoption include the ability to fix small technical issues without technical support and to easily purchase the systems in rural areas, and one way to do this would be to install a basic system and allow older adults to get used to small tasks being covered, such as automatic lighting, in hopes they will accept a more complicated, targeted system later (Mathew, 2005).

Satpathy and Mathew (2007), within rural Mississippi, found that many older adults knew about healthcare applications and the Internet, such as one person who mentioned a lady who used health monitoring technology and telemedicine. Although many felt incapable of using the technology, and their relatives felt they would not use the technology, many also felt that the Baby Boomer generation would be more receptive to the technology and could learn how to use it (Satpathy & Mathew, 2007). Rural older adults also wanted the technology to be similar to technology they already had, such as their television remote, and possibly due to their more traditional nature, they were far more concerned about monitoring, even by close relatives, in contrast to urban older adults, who tended to accept monitoring by relatives (Satpathy & Mathew, 2007). Finally, although rural older adults expressed interest in housing with a smart home system already integrated, they still preferred human caregivers (Satpathy & Mathew, 2007). This is somewhat problematic in terms of helping rural older adults, as these studies indicate they may resist smart homes and other assistive technology until they are on the verge of being forced into an assisted living facility. Thus, designers must concede to their desires and make the system as flexible and affordable as possible.

A more recent study on general assistive technology found that rural older adults with obesity were interested in the technology but felt the main barriers were the complexity of the

devices, connection signals despite recent gains in increasing access in rural areas, and lack of resources to purchase the technology (Batsis et al., 2019a). Another study on rural Dutch users found they were relatively accepting of smart home technology in order to stay at home (Van der Kloet, 2019). Furthermore, it should be noted that telemedicine, which has often been recommended as a component of smart home systems, has become more acceptable and was found to benefit patients with dementia and their caregivers for at-home appointments and in a study with a rural elderly group for a 16-week obesity program (Moo et al., 2019; Batsis et al., 2019b). It is possible that acceptance of telemedicine will eventually lead to the acceptance of other smart home components as users become more comfortable with the technology.

In a dissertation, Kwan (2019) found that when a rural user purchased a monitoring system for fall detection this encouraged other residents nearby to consider purchasing one, though notably most felt they would only purchase one after their first fall or felt they could be more careful to avoid falls instead of relying on a system. The same older adult who used the fall detection system also used Amazon's Alexa for reminders, news, and entertainment, as did a few others (Kwan, 2019). Most lived in large lots and had a significant distance between themselves and their nearest neighbor, leading some to consider emergency wearable and smart home devices, but they did not purchase the devices because of unreliable cellphone and Internet signals in their area. Like previous studies, many were wary of technology due to concerns about privacy violations, restrictions on their independence, potential cost, and fear of not being able to learn the commands, though it should be noted that their children were not concerned about their parent's privacy. Those who felt pressured to live with their children or in a facility but did not want to were most receptive to the technology (Kwan, 2019).

Subsection 4: Other Technology Issues

Marikyan et al. (2018) note that studies often display three key weaknesses, including focusing only on older adults and not other stakeholders such as caregivers and healthcare providers, focusing only on the device structure and function, or focusing only on the benefits of systems rather than analyzing potential issues. Older adults stated various reasons for accepting a system, ranging from health, convenience, and energy and cost savings, with the latter reason most influential among rural and international users (Marikyan et al., 2018). Many argue that smart homes increase social interaction and reduce isolation, but some studies show that older adults concerned about stigmatization or in-person communication being replaced are less accepting of them and refuse to use the technology (Damodaran & Olphert, 2010; Demiris et al., 2004). Thus, Marikyan et al. (2018) argue that future studies must test a whole system instead of a few features, that data should be collected on caregivers and healthcare providers, and that currently there is no guarantee that smart homes will be accepted because of the lack of studies on key acceptance issues, such as individual and financial circumstances, psychological resistance, and legal policies.

Subsection 5: Covid-19 Issues

For this thesis, the biggest gap in Covid-19 research and news articles is how it has affected the acceptance of remote health monitoring and assistive technology. Fall detection and home security monitoring have not been analyzed. Telehealth technology has been analyzed primarily by news outlets and short analyses by researchers in regards to videoconferencing appointments, and its acceptance is included as part of this survey's theoretical system. However, remote healthcare technology that fulfills functions such as vital signs monitoring for cardiovascular patients and sending data automatically to the provider has not been analyzed. Basically, outside of videoconferencing, there is a lack of research, and even the possibility of long-term videoconferencing acceptance increases have not been studied by researchers in-depth.

Subsection 6: Main Gap in the Literature Concerning Aging-in-Place Technology and Rural Older Adults

Based on the literature on smart homes for older adults, and specifically the limited studies on rural older adults, there is an evident need to assess rural adults' needs and preferences regarding the technology, including the need for Medicaid funding and accommodation of their physical and psychological limitations due to lack of knowledge of technology and their health issues. In particular, using qualitative approaches such as Grounded Theory are needed to obtain and explain in-depth the perspectives of rural older adults in the United States. Addressing the needs of this group and allowing them to stay in their homes longer could potentially reduce hospitalizations and nursing home placements, which is all the more critical during pandemics that can overwhelm rural facilities, many of which are being forced to close because of budget cuts.

This thesis will focus on older adults who are still in relatively good health cognitively and need minimal or no help from relatives and caregivers. Participants need to use monitoring technology for one condition, such as high blood pressure. The study will focus on the smart device and telemedicine technology discussed in their own subsections, remote health monitoring devices, fall detection, and smart outdoor security monitoring cameras. Questions will attempt to determine if Covid-19 has affected their perceptions of the technology.

CHAPTER III

METHODOLOGY

Section 1: Study Design

The goal of this thesis was to conduct qualitative research by recruiting rural older adults in Oklahoma for in-depth interviews on three smart home devices. The coding method of Grounded Theory was used to inductively generate concepts related to smart home acceptance in rural older adults and a theoretical model from the interview data. Approval from Oklahoma State University's Institutional Review Board (IRB) was sought before initiating the study.

Section 2: Participants and Recruitment

Recruitment used purposive, voluntary sampling and was done locally by having the primary researcher post flyers at community centers and churches, local bulletin boards, and local organization Facebook pages. The potential participants contacted the researcher by phone or email. The goal was to obtain between 15 and 30 older adults who met these criteria: 1) live in a rural area; 2) are 65 or older; 3) are using some type of self-monitoring device; 4) have email to receive and watch videos of the technology before the interview; and 5) have high-speed Internet to stream the videos. Ideally, the interviewees would have been stratified among gender, and recruitment would have focused on one gender if representation for that gender falls below the other. However, due to difficulties obtaining participants due to social distancing measures, changing the study to phone interviews, and who had the technology needed and knowledge to stream the videos, participation was lower than expected with only seven participants and this

was not implemented. The initial screening did not ask about income levels or familiarity with technology. It was hypothesized that those who choose to participate will have higher than average incomes for rural Oklahoman older adults and some experience with technology such as desktop computers and cellphones, as those on a lower income scale and with little technology experience may be less interested due to distrust of technology and/or not having a primary care physician to review remote health monitoring technology results.

Section 3: Screening and Interview Procedures

Participants were asked to provide information over the phone or by email on their rural status, vital sign self-monitoring, and age in the initial screener. They needed an email address so they could watch the videos on the related technology before the interview. If they met the criteria, the researcher sent them the videos, consent form, and scheduled them for a phone interview. The primary researcher developed and used a semi-structured interview guide to account for the fact that little is known about the target population's opinions on devices, such as remote health monitoring, and potentially unknown or off-topic factors could be brought up, particularly as Covid-19 changes perceptions on healthcare technology. Interviews were planned to be 30-45 minutes, but the researcher did not attempt to hold participants to that time length if they wish to continue talking. Most interviews lasted 20-30 minutes. All audio was recorded using Audacity, transcribed by hand, and transcriptions were then double-checked manually by the researcher. During the interview, notes were taken by the interviewer on key parts of the discussion and observations about the participant's behaviors. These were typed and included in the analysis of the results.

Before the interview, participants were given a demographics questionnaire (Appendix 2) covering basic questions on race and ethnicity, age, gender, income, education, and marital status. It also included questions on devices with which the user is familiar, such as desktop and laptop

computers, smartphones, and digital assistants, ease of use, and how often they used the devices. The incentive for the subjects was the opportunity to learn more about remote health monitoring for vital signs, fall detection devices, and security systems and a $10 gift card. During debriefing, they were given an opportunity to ask any questions they had about the devices, such as in what conditions they can be used and how to obtain one. They were also given a choice of a $10 Amazon or Walmart digital gift card, which was emailed to them after completion of the interview and debriefing.

Section 4: Measuring Data

Subsection 1: Interview Guide

The semi-structured interview guide (Appendix 1) was developed to encourage participants to talk about their concerns and interest in the technology. There were 15 questions covering the main topics, including 1) perception of remote health monitoring technology; 2) perception of fall detection technology; 3) perception of home security technology; 4) concerns about acceptance issues, including privacy, ease of use, stigma, and autonomy; 5) how their perceptions have changed, particularly on remote health monitoring since Covid-19 arrived; and 4) what features or changes they would require to accept a system with these three devices. Subtopics explored 1) primary reason interviewees express discomfort with technology; and 2) why they may prefer certain devices and dislike others. There were also 31 probes to 1) encourage participants to discuss their issues with and fears regarding the technology; 2) how these perceptions have changed during Covid-19 and 3) how these problems could be addressed.

Subsection 2: Demographics Questionnaire

Demographic questions encompassed race and ethnicity, age, gender, annual income, educational level, marital status, and technology experiences. The latter attempted to

determine what types of devices participants used, how often, and how easy they found the devices to use. This helped determine how much positive or negative experience with technology may skew acceptance of smart home technology.

Section 5: Analyzing Data

Subsection 1: Interview Guide Analysis

As noted, Grounded Theory was used to inductively analyze the interview transcripts to find abstract and theoretical concepts (a basic unit for theory development) and then present them as a set of interrelated concepts (Tie et al., 2019). In the initial coding stage of Grounded Theory, the initial data analysis began categorizing the data for population representation into common themes of the participants from descriptive and reflective notes written by the researcher about the interviews (Tie et al., 2019). This occurs with open coding analysis, which was used to find raw data by assigning theoretical codes through analyzing the content of the interviews and notes for sections of similar, specific language found in sentences and words that could form the basis of theme labels, or in vivo codes (Corbin & Strauss, 2008). The initial data coding was done manually.

In the intermediate phase of coding, techniques such as constant comparative analysis were used to find core themes and abstract concepts and relate them to each other through axial coding (Tie et al., 2019; Corbin & Strauss, 2008). In this stage, concepts were placed in categories depending on their properties, or the concepts in a category's shared characteristics, and dimensions, or variations of properties (Tie et al., 2019). Data collection was planned to end upon reaching the maximum number of participants or once theoretical saturation is reached, but due to limitations and difficulties with obtaining participants due to Covid-19, data collection was ended once there was enough data to code for themes and relationships and there was notable consensus between multiple participants about key topics.

Once data collection was ended, the final stage, advanced coding, considered concepts to have become abstract and used selective coding and storyline techniques to form the set of interrelated concepts and to explain the core category and other category relationships (Tie et al., 2019; Corbin & Strauss, 2008). Selective coding pertained to stopping regular coding to selectively code for the core category, which represented the main problem faced by participants (Corbin & Strauss, 2008). Once the core category was found, an examination of concepts and issues related to the main category occurred. The storyline technique was used to provide explanations, while theoretical coding used substantive theory to analyze the data, create a theoretical framework, and add more explanatory power (Tie et al., 2019).

Subsection 2: Demographic Questionnaire Analysis

Since demographic questions were kept relatively simple, the variables were put into SPSS and analyzed using its descriptive statistics. Age and income were divided into categories, and percentages and frequency were calculated. Age was specifically divided into 65-74, 75-84, and 85-and-up for this study. Income was divided into levels representing very low, low, average, above-average, and high income in Oklahoma. Variables with nominal and ordinal measurements, including race and ethnicity, educational status, gender, marital status, types of devices used, how often devices are used, and how easy the participants feel technology is to use had frequency and percentage calculated. In addition, the frequencies and percentages for ease of use and the types of devices were separately calculated based on age, gender, educational level, and income to determine how the demographic factors affected technology use and how this may have influenced responses to interview questions. The influence of these demographic variables was not calculated for how often participants used devices because they all used devices daily. Race and ethnicity were also not used in this way, as planned, because all participants were white.

CHAPTER IV

RESULTS

Section 1: Frequencies and Percentages of the Sample

Subsection 1: Demographics and Technology Use

Seven interviews were conducted, and no participants were excluded. The participant demographics table shows the frequencies and percentages of the demographics. The participants were 100% white and non-Hispanic. In terms of age, 57.1% were aged 65-74, 14.3% were aged 75-83, and 28.6% were aged 85 and up. Of the participants, 71.4% were female, and 28.6% were male. None of the participants were below $21,000 or less yearly income, and none had an income between $60,001-$100,000. Thus, 28.6% were in an income range of $21,001-$40,000, 42.9% were between $40,001-$60,000, and 28.6% were above $100,000. In terms of education level, no participants had not completed high school, 14.3% had a high school diploma or GED, 28.6% had some college, 42.9% had a bachelor's degree, and 14.3% had a graduate degree. None of the participants lived with an unmarried partner, 28.6% were single, 14.3% were married, 14.3% were divorced, and 42.9% were widowed. In the technology use table, 100.0% of participants reported using devices daily. In terms of ease of use, 42.9% reported their devices were easy to use, while 57.1% reported some difficulties using the devices, but none of them reported high levels of difficulty. In terms of the types of technology used, 14.3% used a flip phone, 85.7% used a smartphone, 71.4% used a tablet, 71.4% used a laptop or desktop, 14.3%

Table 1. Participant Demographics (N = 7)		
Race	Frequency	Percentage
American Indian or Alaskan Native	0	0.0%
Asian	0	0.0%
Black	0	0.0%
Native Hawaiian or Pacific Islander	0	0.0%
White	7	100.0%
Other	0	0.0%
Ethnicity		
Hispanic	0	0.0%
Non-Hispanic	7	100.0%
Age Range		
65-74	4	57.1%
75-84	1	14.3%
85 and up	2	28.6%
Gender		
Female	5	71.4%
Male	2	28.6%
Other	0	0.0%
Annual Household Income Range		
Up to $21,000	0	0.0%
Between $21,001-$40,000	2	28.6%
Between $40,001-$60,000	3	42.9%
Between $60,001-$100,00	0	0.0%
Above $100,000	2	28.6%
Education Level		
Less Than High School Completion	0	0.0%
High School or GED Completion	1	14.3%
Some College	2	28.6%
Bachelor's Degree	3	42.9%
Graduate Degree	1	14.3%
Marital Status		
Single	2	28.6%
Married	1	14.3%
Partnered	0	0.0%
Divorced	1	14.3%
Windowed	3	42.9%

Table 2. General Technology Use (N = 7)		
How Often Devices Are Used	Frequency	Percentage
Daily	7	100.0%
At Least Once a Week	0	0.0%
Ease of Use		
Easy to Use	3	42.9%
Somewhat Difficult	4	57.1%
Difficult to Use	0	0.0%
Need Assistance Often	0	0.0%
Types of Technology Used		
Flip Phone	1	14.3%
Smartphone	6	85.7%
Tablet	5	71.4%
Computer (Laptop or Desktop)	5	71.4%
Smartwatch	1	14.3%
Home Security Monitoring System	1	14.3%
Streaming Device or Smart Television	2	28.6%
Videoconferencing Software	3	42.9%
Robots or Drones, Including Hobby Types	0	0.0%

used a smartwatch, 14.3% used a home security monitoring system, 28.6% used a streaming device or smart television, 42.9% used video conferencing software, and none used robots or drones, including the hobby or toy types.

Subsection 2: Technology Use by Age

The technology use by age group, gender, educational level, and annual household income tables summarize how these factors are related to ease of use, the number of devices used, and types of devices. The majority of those in the 65-74 age group (75.0%) found their devices easy to use, while the older age groups found it somewhat difficult. The participants 65-74 used a minimum of three devices, while the older age groups used one to two devices. All but one participant in the 65-74 age group used a smartphone. All participants 65-74 (100.0%) used a tablet or a computer and one participant 85 and up used a tablet (50.0%) while the other used a computer (50.0%). One participant in the 65-74 range used a

smartwatch (25.0%), while another used a home security monitoring system (25.0%). Finally, 50.0% of the 65-74 age range used a streaming device or smart television, and 75.0% used videoconferencing software.

Table 3. Technology Use by Age Group (N = 7)			
Ease of Use	Age Group	Frequency	Percentage
Easy to Use	65-74	3	75.0%
Somewhat Difficult	65-74	1	25.0%
Somewhat Difficult	75-84	1	100.0%
Somewhat Difficult	85 and up	2	100.0%
Number of Different Devices Used	Age Group		
1	75-84	1	100.0%
2	85 and up	2	100.0%
3	65-74	1	25.0%
5	65-74	2	50.0%
6	65-74	1	25.0%
Types of Devices Used	Age Group		
Flip Phone	65-74	1	25.0%
Smartphone	65-74	3	75.0%
	75-84	1	100.0%
	85 and up	2	100.0%
Tablet	65-74	4	100.0%
	85 and up	1	50.0%
Computer (Laptop or Desktop)	65-74	4	100.0%
	85 and up	1	50.0%
Smartwatch	65-74	1	25.0%
Home Security Monitoring System	65-74	1	25.0%
Streaming Device or Smart Television	65-74	2	50.0%
Videoconferencing Software	65-74	3	75.0%
Robots or Drones, Including Hobby Types	-	0	0.0%

Subsection 3: Technology Use by Gender

In terms of technology used by gender, 60.0% of females found it easy to use, while all males (100.0%) found it difficult to use. The two male participants only used one to two devices, while the females used two or more. One female used a flip phone, while all of the

other participants used a smartphone. All female participants used computers, while 80.0% of females also used a tablet. Only one of the two male participants used a tablet. The smartwatch, home security, streaming devices or smart televisions, and videoconferencing software were only used by female participants. However, it should be noted that both male participants fell into the 75-84 and 85 and up age brackets, who generally had more issues using technology.

Table 4. Technology Use by Gender (N = 7)			
Ease of Use	Gender	Frequency	Percentage
Easy to Use	Female	3	60.0%
Somewhat Difficult	Female	2	40.0%
Somewhat Difficult	Male	2	100.0%
Number of Different Devices Used	Gender		
1	Male	1	50.0%
2	Female	2	20.0%
2	Male	2	50.0%
3	Female	1	20.0%
5	Female	2	40.0%
6	Female	1	20.0%
Types of Devices Used	Age Group		
Flip Phone	Female	1	20.0%
Smartphone	Female	4	80.0%
	Male	2	100.0%
Tablet	Female	4	80.0%
	Male	1	50.0%
Computer (Laptop or Desktop)	Female	5	100.0%
Smartwatch	Female	1	20.0%
Home Security Monitoring System	Female	1	20.0%
Streaming Device or Smart Television	Female	2	40.0%
Videoconferencing Software	Female	3	60.0%
Robots or Drones, Including Hobby Types	-	0	0.0%

Subsection 4: Technology Use by Educational Level

In terms of educational level, all of those who found the technology easy to use had attended college or graduated with a bachelor's degree, though there were participants at all educational levels who found technology somewhat difficult. It should be noted that the graduate degree holder was also the oldest participant in the study, which may account for her lower familiarity with technology, and admitted her skills with technology had declined significantly since her retirement and reduced exposure to computers. The participants who used only one to two devices tended to have some college or less education outside of the graduate degree-holder, while the users of three or more devices were primarily people with bachelor's degrees. All (100.0%) of the holders of bachelor's degrees used a tablet and a traditional computer. All of the users of the other, less commonly used devices had some college or a bachelor's degree.

Subsection 5: Technology Use by Income Bracket

Both participants (100.0%) in the $21,001-$40,000 income bracket found technology somewhat difficult to use, while the other groups had some participants in both the somewhat difficult and easy to use groups. All of the participants in the $21,001-$40,000 income group had only one to two devices, while all but one of the participants in the higher income groups had three or more devices. The participant who is an outlier in terms of income was the second oldest participant who overall seemed to have the least experience with technology. Smartphone use did not differ much across groups, with only the flip phone user in the $40,001-$60,000 income bracket not using one. Tablets were only used by those with incomes of $40,001 or more, while computer use was present across all income ranges. Participants who used smartwatches, home security monitoring systems, streaming devices or smart televisions, and videoconferencing software all had $40,001 or more income annually.

Table 5. Technology Use by Educational Level (N = 7)			
Ease of Use	Educational Level	Frequency	Percentage
Somewhat Difficult	High School or GED	1	100.0%
Easy to Use	Some College	1	50.0%
Somewhat Difficult	Some College	1	50.0%
Easy to Use	Bachelor's Degree	2	66.7%
Somewhat Difficult	Bachelor's Degree	1	33.3%
Somewhat Difficult	Graduate Degree	1	100.0%
Number of Different Devices Used	Educational Level		
1	Some College	1	50.0%
2	High School or GED	1	100.0%
2	Graduate Degree	1	100.0%
3	Bachelor's Degree	1	33.3%
5	Bachelor's Degree	2	66.7%
6	Some College	1	50.0%
Types of Devices Used	Educational Level		
Flip Phone	Bachelor's Degree	1	33.3%
Smartphone	High School or GED	1	100.0%
	Some College	2	100.0%
	Bachelor's Degree	2	66.7%
	Graduate Degree	1	100.0%
Tablet	High School or GED	1	100.0%
	Some College	1	50.0%
	Bachelor's Degree	3	100.0%
Computer (Laptop or Desktop)	Some College	1	50.0%
	Bachelor's Degree	3	100.0%
	Graduate Degree	1	100.0%
Smartwatch	Some College	1	50.0%
Home Security Monitoring System	Bachelor's Degree	1	33.3%
Streaming Device or Smart Television	Some College	1	50.0%
	Bachelor's Degree	1	33.0%
Videoconferencing Software	Some College	1	50.0%
	Bachelor's Degree	2	66.7%
Robots or Drones, Including Hobby Types	-	0	0.0%

Table 6. Technology Use by Income Group (N = 7)			
Ease of Use	Income Group	Frequency	Percentage
Somewhat Difficult	$21,001-$40,000	2	100.0%
Easy to Use	$40,001-$60,000	2	66.7%
Somewhat Difficult	$40,001-$60,000	1	33.3%
Easy to Use	Above $100,000	1	50.0%
Somewhat Difficult	Above $100,000	1	50.0%
Number of Different Devices Used	Income Group		
1	$21,001-$40,000	1	50.0%
2	$21,001-$40,000	1	50.0%
2	Above $100,000	1	50.0%
3	$40,001-$60,000	1	33.3%
5	$40,001-$60,000	2	33.3%
5	Above $100,000	1	50.0%
6	$40,001-$60,000	1	33.3%
Types of Devices Used	Income Group		
Flip Phone	$40,001-$60,000	1	33.3%
Smartphone	$21,001-$40,000	2	100.0%
	$40,001-$60,000	2	66.7%
	Above $100,000	2	100.0%
Tablet	$40,001-$60,000	3	100.0%
	Above $100,000	2	100.0%
Computer (Laptop or Desktop)	$21,001-$40,000	1	50.0%
	$40,001-$60,000	3	100.0%
	Above $100,000	1	50.0%
Smartwatch	$40,001-$60,000	1	33.3%
Home Security Monitoring System	Above $100,000	1	50.0%
Streaming Device or Smart Television	$40,001-$60,000	2	66.7%
Videoconferencing Software	$40,001-$60,000	2	66.7%
	Above $100,000	1	50.0%
Robots or Drones, Including Hobby Types	-	0	0.0%

Subsection 6: Technology Use Summary

Being female, in the youngest age group (65-74), in the mid-to-high annual income brackets of $40,001 or more, and having some college education or a college degree were all associated with an increased variety of devices used and finding them easier to use. Age group seemed to be the strongest predictor, as participants in the older two groups, even those with higher educational levels or income, used fewer devices and had some difficulties. In the youngest age group, educational level and income bracket influenced device use the most.

Section 2: Interview Themes and Relationships

The codes and relationships table summarizes the themes that commonly appeared, the definitions of those themes, and how the themes related to one another.

Subsection 1: Privacy, Autonomy, Self-Image, and Denial of Health Concerns

For four of the seven participants, privacy, autonomy, self-image, and denial of health concerns often came together, as any threat to personal privacy was also seen as a potential threat to autonomy and their self-image, since many saw themselves as being healthier than others their age or felt the devices should only be used by sicker or older adults. For example, when asked about remote healthcare appointments, one woman said, “I think if I were older, that would be a very good thing. There are some health issues that have occurred in my family history. At present, I don’t feel it is necessary.” Four of them were concerned that devices used for remote healthcare or fall detection would make their relatives or doctors worry and/or lead to them being viewed as more dependent, such as one woman who said, “Well, my doctor tends to stay on the safe side, so I don’t know whether I would like that or not because, you know, I may have a spike, and I may have a little blood sugar, and he would be panicking. I don’t know if I want him to know that or not”.

When discussing the devices, participants often tried to focus on their independence, even when it contradicted some of their other statements, such as one woman who stated about the

infrared fall detection device, “Now, the infrared, yes, maybe I might be interested in that if the circumstances were that I needed something like that. I… I fell a lot, but knock on wood, I haven’t done that too many times.”

Table 7. Codes and Relationships			
Theme	Subthemes	Definition	Relationships
Self-Image Concerns		Feeling of the self being threatened by the technology	Threats to privacy and autonomy; denial of health; rejection
	Denial of Health	Refusal to acknowledge or deal with their obvious health problems, such as tendency to fall or heart issues	Rejection; threats to self-image
	Autonomy Concerns	Fears about possible threats to independence	High privacy and self-image threats; rejection
	Privacy Concerns	Feeling threatened (or not) by various devices that may pose personal, data, or environmental prvivacy risks	Acceptance and rejection
Financial Acceptance		Dependent upon how secure the participants feel about being able to afford the technology, particularly with help from Medicare/Medicaid	Acceptance
Technology Understanding		Ability to comprehend basics of what the technology in the videos does and how it works	Ease of use; acceptance
	Ease of Use	How much difficulty participants have with technology	Acceptance; technology issues
Covid-19 and Technology		Pandemic has increased acceptance of technology	Acceptance
	In-Person Contact	Visiting people outside the home after the begnning of the pandemic	Covid-19 and technology
Safety		Increased feelings of security from technology	Acceptance
Convenience		Technology decreases effort needed to achieve a goal	Acceptance
Stigma/ Ageism		Concerns about or experience of discrimination due to technology	None
Acceptance		Likelihood of accepting the technology	Low privacy, autonomy, self-image, and financial threats; practicality and increased safety; Covid-19
Low Acceptance		Participants accepted the technology but only for future use when they were older or sicker	Threats to self-image; reluctance
Rejection		Likelihood of rejecting the technology	Impracticality; threats to privacy, self-image, and autonomy; denial of health issues

They often rejected fall cameras outright due to constant monitoring posing too many privacy and control concerns, while they were more willing to consider other fall detection devices when they were older and sicker. One woman stated, "Right, sometimes your personal privacy has to be given up for personal safety, so I figure that is a future that we all have to come to grips with and understand more as you get older or as your health issues change. Fortunately, I'm still kind of obstinate enough to take care of myself, but I do know when I need help, I can call someone." One participant specifically linked privacy and autonomy concerns when she discussed the devices in general, stating, "I have a little reservation about personal activity while you are still mobile and cognizant. I don't know that that would be a necessity because as your ability to express yourself or not be able to monitor your health or medication, I think it would be much more important to have one." About cameras, one participant stated, "Well, I don't like the idea of cameras. If there could be some other type, that would be alright. But, I am not comfortable with a camera watching me all of the time." Remote healthcare devices were also rejected by two participants who felt the devices were for older, sicker people who needed to be monitored more closely, such as one participant who stated, "I think if I were older, that would be a very good thing. There are some health issues that have occurred in my family history. At present, I don't feel it is necessary."

Data privacy concerned six of the participants but to a lesser degree. They wanted the information only sent to their doctor, but one felt data privacy was virtually non-existent due to hackers, another felt her data had no value, and one said he would use the device as long as his doctor approved of it even if data was sent to a company. For example, one woman stated about companies or larger organizations accessing her data, "Now, if they wanted to follow up with details, statistics, without any personal data, that would be approved of, I would think. I would also make sure he [the doctor] knew what I felt about it." Thus, older adults

expressed concern about data privacy but were mixed with how strongly it concerned them and how much they would enforce it.

Subsection 2: Safety

The majority of the participants related this theme to smart home security devices. Safety of possessions over themselves seemed to be the priority for three of the participants, with one stating,

> "It depends on how active you actually are, whether you're outside or homebound. I can see where if you are more homebound, you feel like your space might be violated, I can see where a[n emergency alert] system like this might reassure you greatly. If you have a mindset and you are still active, not socially, but to take care of some of your basic needs, get outside your home, I can see being protective of you then [by providing you phone alerts about intrusions], but not so much for your personal security, [but] for your property. I think it just depends on the way your mind's centered."

Two felt home security devices were primarily aimed at those who live in larger communities, apartments, or expensive homes. For example, one woman stated, "Monitoring, depending on where you live, whether it was an apartment complex or house, I could say yes or no. An apartment complex where you're above ground and your primary access point is through your door, I definitely think it is a necessity."

Two participants felt the need for personal safety was not being met by fall mats due to them only providing fall detection in small areas. For example, on the fall mat in the video, one participant stated, "But those that seem to kind of be in particular areas bother me. I know people that fall, not just in the bathroom. We had people here that fall. We had a lady fall in her bedroom the other day. And you fall other places. You trip on a rug in your kitchen or something. That kind of concerned me." Finally, one felt videoconferencing appointments could increase personal safety by reducing exposure to diseases in doctor's offices.

Subsection 3: Convenience

Three of the participants thought remote healthcare devices were convenient to reduce travel to see doctors for those who were sick, disabled, lacked transportation, or were afraid of the virus. One male participant felt it would be useful to save time, "I think it is just… It could cut down [travel and wait] time. While she [patient] does that [takes vital signs with remote health technology], she [the remote nurse] is working on the lady at the same time. What it boils down to."

Subsection 4: Ease of Use and Technology Understanding

All participants felt their current devices were easy or only somewhat difficult to use. Most participants in the youngest age bracket mentioned retiring recently, and they were accustomed to using smartphones and computers at their work. All of the participants felt the devices would be easy to use and that, if their doctors recommended them, they would receive adequate training on how to use the devices, though one noted older adults who had retired before computers were widespread might have some trouble, saying, "Well, I think that is probably more age restriction if you were not familiar with basic emails and that sort of thing. I would see that you would probably need to have a member of your family or caregiver to handle that for you. So, it could be a concern, but I think it would be dependent on the age and cognition."

However, five of the seven participants were confused about what some of the devices did, with the infrared fall detection device being the most common source of confusion. For example, there was one who asked, "Then there was one that I didn't really understand completely how it worked but it was that intelligent camera that sounded like it was for nursing homes. And, I don't know what I think about that one either. It was just… is that the only place it would be used, like in nursing homes, like if someone fell in their room?" One

of them also did not understand the fall mat was for detection, not protection, from falls and seemed confused about the home security system as well. He stated, "I like that you could probably get up from that if I fell. [Interviewer clarifies it is just a detection device.] I know but it could protect my fall."

Explaining the technology when they asked questions about the videos increased understanding and acceptance in the confused participants. For example, after explaining how the device worked, one woman responded,

> "The one about mapping the house [infrared scanner] is good in a way unless it has Wi-Fi features that it requires. When discussing installation, it said you had to have an electric connection as well as a Wi-Fi possibly, but I can't remember. A lot of senior seniors don't know and understand that. I have to admit that I am not as fluent on it, but I do have a family member, a beneficiary, who could help me with that."

Subsection 5: Financial Issues

Five of the seven participants mentioned having limited income for extra expenses. Their acceptance and willingness to adopt the technology increased or was dependent upon the devices being covered by Medicare and/or Medicaid. For example, when the interviewer asked, "It sounds like if Medicaid paid for this type of device, you would be fine with getting one," the participant responded, "Oh yes, absolutely. Because electronic and technical type of things can be too expensive for older people." Both male participants, one of whom was in the highest income bracket, did not feel insurance coverage affected their decisions, with one stating, "No, it doesn't matter. I don't do things just for somebody to pay for it. I got mine [money]." One of the females who was in the highest income bracket already had a home security device, so she primarily wanted the coverage for other devices or people she knew rather than herself.

Subsection 6: Concerns about Discrimination

In contrast to other studies, the older adults in this study did not seem concerned about stigma. A few had trouble understanding the question, but the majority who did stated they were not concerned about ageism, such as one who stated, "Oh, heck no (laughs). There is some that would want to know if I could show them how to use it, so they could ask their doctors for it (laughs)."

Subsection 7: Covid-19, Technology, and In-Person Contact

Some admitted to seeing doctors, relatives, and/or friends in-person during the pandemic despite knowing videoconferencing was available. For example, one woman stated, "And then, when [Covid-19] first came out, we did family meetings because we were afraid to get around each other for a while until we knew everybody was kind of quarantined for their two weeks, so we did lots of Zoom meetings in the beginning. And, I am just glad we had that, to be able to do that, so we could get, you know, families from six-seven households, and we all got together, and you know, once a week and talked. And, that was kind of nice to be able to do that. We aren't doing it so much anymore 'cause now we get around each other, but when we weren't getting around stuff… So, I think that's been very helpful."

Three felt their opinions on remote healthcare had not changed due to Covid-19, and all felt their opinions on home security and fall detection devices had not changed. For example, when asked about fall detection, home security devices, and Covid-19, one woman stated, "Well, I don't know that the coronavirus itself has affected how I feel about that kind of thing …. The coronavirus is what it is. It's out there, it's a thing we have to deal with, but it has no effect on how I initially feel about my safety or other people's safety or their falling or any of those things. Those are things that you need to be aware of at any time, whether we have a coronavirus or not." However, five participants, including one who stated her opinion on remote healthcare had not changed, said they were more aware or accepting of telehealth

appointments. For example, the participant who stated her opinion had not changed said, "It hadn't changed my ideas on it, but I think some of it is a good idea. I like the remoting in if you wanted to talk to your doctor and not go in. I think that is a good idea." Another participant noted,

> "Oh, actually I have kind of wondered, when am I gonna get one? On coronavirus, the pandemic is driving me nuts. You know, I don't know very many people that have had virtual appointments or anything like that. But, I am kind of thinking, if this continues, if this pandemic continues, I would like to be able to do that. Especially, like I say, with a routine exam where the doctor doesn't really have to physically look at me or do something to me, bring it on. I just don't because I myself have issues that would… I don't want to be out there and taking a chance on getting sick with something like that."

Finally, the two participants who felt home security devices were more for larger communities noted even small towns were more insecure since the pandemic.

Subsection 8: Acceptance, Low Acceptance, Reluctance, and Rejection

Participants defined acceptance as how willing they were to adopt a device immediately. Conclusions from the previous subsections are as follows: first, most participants found home security devices acceptable. Among the fall detection devices, the infrared device was the most commonly accepted and accepted by four of the participants, while the fall mat was accepted by some but rejected more often due to concerns it was not practical enough due to only covering small areas of the household. Device acceptance was often dependent on receiving Medicaid or Medicare assistance for those not in the top income bracket. Also, devices that were not seen as major threats to personal privacy, autonomy, and self-image were more accepted.

Lower acceptance was defined as participants who said they would accept the technology but made their acceptance conditional, such as stating they would only accept it if they were sick, or showing general reluctance to accept the technology without giving a

reason. Rejection was defined as a complete refusal to consider the technology. Fall detection cameras were rejected by all of the participants, though one was willing to consider them for older, sicker people. Both male participants rejected or showed very low acceptance of all but one device. One male participant was only interested in the fall mat and showed very low acceptance of home security and telehealth devices. Of the females, one rejected remote healthcare devices and fall detection devices due to how it would affect her self-image. Four of the other participants had low acceptance or some reluctance concerning remote healthcare. Two female participants lacked interest in home security devices due to living in rural areas or small towns they felt were safe. Most commonly, rejection or low acceptance were related to beliefs that the technology was for older and/or sicker people, personal privacy concerns, autonomy concerns, and impracticality. Finally, data privacy was a concern brought up by the researcher, but most participants were not concerned as long as their information was sent to only their doctor or their doctor approved of their information being sent to another place for analysis.

CHAPTER V

DISCUSSION

Section 1: The Core Category, Subcategories, and Their Relationships

Overall, the study found various related themes that seemed to increase the likelihood of acceptance or rejection. However, it should be noted that there seem to be clusters of themes that are heavily interrelated, and perhaps in a larger study, would prove to be clusters of causality. These themes were privacy, autonomy, self-image, and denial of health status. When participants rejected or accepted a device, these themes almost always were brought up, and often all four could be brought up by a participant about a device about which they had strong feelings. For example, as noted, most participants rejected fall detection while younger, and some rejected remote healthcare devices due to self-image issues. These self-image issues stemmed from seeing themselves as not old or sick enough to use assistive devices. They often seemed to believe that using these threatened their autonomy and independence, and if they had personal privacy concerns as well, these concerns were intensified. Furthermore, these self-image issues and autonomy and privacy concerns seemed to lead them to deny the seriousness of their health issues. Many of the participants had heart or blood pressure issues, and some admitted to refusing to monitor them consistently, or if they did, refusing to seek medical help, such as one woman who refused to contact relatives or medical services when she was having bad tachycardia episodes. Several also admitted to falling regularly, typically shortly after stating they did not need fall devices. In all of these cases, these choices were strongly justified without prompting

by the participant, who would make claims such as being in better health than others their age.

The main theme that seemed to influence acceptance and rejection and that was related to almost all other major themes that involved psychological issues to some degree was self-image. The ideas participants had about their personal privacy, autonomy, independence, health, and need for safety all tended to depend on their need to create a certain identity for themselves, one that was grounded in strength, independence, and self-control, and anything that threatened that self-image was likely to be rejected or only reluctantly accepted. The increased likelihood of rejecting devices that may make older adults feel their autonomy and control are threatened and imply they are dependent and not as healthy as they would like to believe is in line with other studies reviewed for North Americans and Europeans and in contrast to Asian studies (Mathew, 2005; Portet et al., 2013; Peek et al., 2015; Himmel & Ziefle, 2016; Fritz et al., 2015; Kirchbuchner et al., 2015; Yusif et al., 2016; Pal et al., 2018; Demiris et al., 2008; Zwijsen et al., 2011; Peek et al., 2014; Chernbumroong et al., 2010; Townsend et al., 2011; Chen & Chan, 2014; Batsis et al., 2019a; Kwan, 2019). All of this was amplified even more in the studies available on the rural elderly, who tended to be even more distrustful of technology (Mathew, 2005; Satpathy & Mathew, 2007; Batsis et al., 2019a; Kwan, 2019). However, two rural studies showed they were at least becoming more accepting of telehealth, which seems to agree with these results, which showed increased awareness among most and acceptance among some (Moo et al., 2019; Batsis et al., 2019b). This leads to the conclusion that outside of hard barriers discussed by Li et al. (2019), Batsis et al. (2019a), and Kwan (2019), such as low income, ease of use, and lack of education, the primary barrier is self-image, and it is the core psychosocial category that influences the overall likelihood of acceptance.

The reason for self-image and its strong influence on acceptance is likely grounded in the marginal status of the elderly in our society. Becker et al. (2020) discussed how this led to Baby

Boomers in her study engaging in self-stigma. Potential discrimination or fears of being treated as a second-class citizen were not present in this study overtly. However, their defensiveness regarding their health implies this is a concern for them and would be in line with other studies that evaluated stigma (Peek et al., 2015; Yusif et al., 2016; Zwijsen et al., 2011). This concern may not have come up because of the wording of the question and the devices being discrete and mainly aimed at home use rather than public use. However, there is a possibility this would be more of an issue if the technology were implemented, and older adults feared or experienced behavioral changes in others, such as increased concern from visitors.

In terms of the other themes, financial acceptance, ease of use, and Covid-19 were the most prominent. Many of the participants were in the low-to-mid income range, and all of these participants expressed a preference for financial help, as they were on a tight budget. This is likely to be exacerbated for older adults in rural areas, who often rely on social and health resources, and could lead to delays in seeking and obtaining care because of the economic impact of Covid-19, less budgetary cushions for programs, and slower financial recovery of rural communities (Henning-Smith, 2020; Berlin-Broner & Levin, 2020). Many emphasized that even if they wanted the devices, they might not be able to afford them without help. The other two main themes, ease of use and Covid-19, seem to be tied to self-image more loosely.

Ease of use and its related theme, understanding of technology, were also major issues. Although most felt they could easily use the devices in the study, they often had trouble understanding how the fall detection devices worked and what they did. Furthermore, those in the older two age groups admitted to having significant difficulties or lack of experience with technology during or after the interview, despite claiming they only found it somewhat difficult to use, and in one case, a participant needed help with his phone during the interview. It should be noted this seems to match a theory that a previous rural study proposed, which is that younger

older adults, such as Baby Boomers, would have a much easier time with technology due to having more exposure (Satpathy & Mathew, 2007). A few admitted after their interview to needing help from a relative to watch the videos. The participants in the youngest age group seemed to understand the devices after a more detailed explanation from the interviewer, but some of the participants in the older two groups seemed to still have trouble. Overall, this seems to indicate that participants might have more issues understanding the purpose of the devices, why they might need them, and how to use them than they indicate in the demographics questionnaire and interviews. They would likely need to use the devices to provide more accurate feedback. As for why some stated they found the technology easy to use or only somewhat difficult despite later admitting they had major difficulties or needed assistance, there is a possibility this is also related to self-image and their need to portray themselves as independent and in control. Home security was by far the most accepted technology, even if some refused it because they lived in a small, safe community. This is likely because home security technology targets all age groups instead of targeting older adults specifically, which is much less threatening to the older participants' self-image and may even boost it, since having the technology may be viewed as a status symbol.

Finally, Covid-19, its relation to technology, and in-person contact was a major theme that primarily affected remote healthcare. It is commonly known that rural areas were less likely to impose social distancing and personal protective equipment mandates, and people in rural areas are more likely to be conservative, both of which were related to not following safety measures during the pandemic in rural and suburban areas compared to urban ones (Rothgerber et al., 2020; Latkin et al., 2021; Hamidi & Zandiatashbar, 2021). While three participants felt their views had not changed on telehealth due to Covid-19, others, including one who felt their views had not changed, felt they had become more aware of remote technology or more accepting of it. The sample was split on whether they accepted the technology. Those who were accepting of it

seemed to feel it was for everyone, while those who rejected it often felt it was for older, sicker people. This implies once again that self-image is a major factor in how their views changed based on Covid-19. Those who were more accepting of the technology generally seemed concerned about Covid-19 to varying degrees, and those who were most accepting felt Covid-19 was a major threat in general. Those who were less accepting or rejected it seemed less concerned about Covid-19 and more concerned about maintaining their image of being in better health than other adults and thus having no need for technology that could reduce their likelihood of contracting the virus at the doctor's office.

Overall, the findings indicate a need for a policy on assistive technology and health behavioral approach changes. With regards to policy, a national standard for assistive technology needs to be set by federal agencies for types of technology covered, who qualifies for coverage, and what types of insurances are required to include it in their coverage. Medicaid already covers some assistive devices in various states, such as pendant alarms and some smart home technology, such as activity monitors (Berridge, 2018). However, Berridge (2018) notes which devices are covered varies wildly, and purchases are not even tracked or evaluated for effectiveness in some states. Because of these limitations, there are many coverage gaps with regards to the wide range of assistive devices available, which means it is currently not possible to meet the diverse needs of the older adult population. There is also a large coverage gap because, as noted by many of the middle-class participants in this study, they would be unable to afford the devices. These participants are unlikely to be covered by Medicaid due to their income level. Therefore, financial policy changes need to include not only expansion of Medicaid coverage but the addition of Medicare coverage for those who are above the income cutoff. Expanding financial coverage and advertising this expanded coverage for all older adults may help normalize the devices and make them a regular part of healthcare for the elderly. This is particularly likely if doctors are recruited and serve as advocates by working with their patients to

increase awareness of the devices and the benefits the devices can provide for autonomy and health.

In terms of health behavioral changes, there need to be health campaigns to increase awareness and get older adults to act. Although some older adults are unlikely to modify their behavior, others who are fascinated with the technology, like the participant with the smartwatch, or those who can be convinced the benefits of the technology outweigh the negatives, likely will change their behavior if targeted by campaigns. Assistive technology, particularly preventative and safety technology, may only be effective if older adults respond appropriately to cues from the devices and take appropriate action. There is a wide range of tactics that could be used to do this based on some of the cluster of causality elements. If autonomy needs, for example, are being targeted, the focus of health campaigns could be on how the device can assist in living at home longer and allow older adults to monitor and control their health instead of having their relatives or doctors be the primary monitors. Targeting denial of health concerns could be done by doctors or healthcare providers with an honest discussion about the condition and its consequences if some sort of preventative measure is not put in place, with assistive technology being one of the options offered. The healthcare providers could tie this back into autonomy and self-image needs by pointing out preventative care can help ensure longer independent living and greater health compared to older adults who ignore their problems. Finally, self-image needs could be addressed by preferably offering devices that are or appear to be the same as other popular devices, like smartwatches and smart speakers, or are unobtrusive, repeatedly bringing up how popular the devices are with younger age groups and other older adults, and how using the devices will make them seem more independent, self-controlled, and young. However, for successful health campaigns and assistive technology program implementation, there need to be long-term studies, better planning, strict policies to evaluate cost-effectiveness, information on types of data users are willing to share and on who users are willing to share it with, and

standards for ethical use for those with cognitive issues (Berridge, 2018). A theory for conducting these studies and targeting the cluster of causality needs is developed and explained in the next section.

Thus, in conclusion, self-image is the core theme related to rejection and acceptance because it seems to influence all of their decisions regarding preventative technology. For many, acceptance and potential use of this technology were driven more by their emotions rather than need. Although studies on assistive technology often discuss the need for the technology, for devices to be adopted, the emotional needs of the participants will likely need to be prioritized. Policy, financial coverage, and behavioral needs will need to be targeted to enact long-term change.

Section 2: Theory of Self-Image and Assistive Technology

The results of the Grounded Theory advanced coding imply the core category that affects most of the others is self-image. This category in turn is part of a probable cluster of causality that includes privacy, autonomy, and denial of health status. Figure 1. Theory of Self-Image and Assistive Technology Illustration shows the relationship between self-image and the other cluster of causality. Thus, this theory proposes targeting self-image and its strongly related categories when advocating for a device with older adults instead of focusing just on health and preventative benefits.

Rural older adults have a strongly formed self-image. This seems to create a clear cycle that leads to rejection when self-image is threatened. The pattern seems to be 1) technology is proposed; 2) if the technology threatens any of the elements in the cluster, reluctance to accept it is increased, and acceptance may become conditional; 3) if the technology not only threatens these elements but also major self-image themes, the technology is rejected; and 4) if the

technology is increasingly widespread like remote healthcare devices and thus is less threatening to self-image, the likelihood of acceptance is increased.

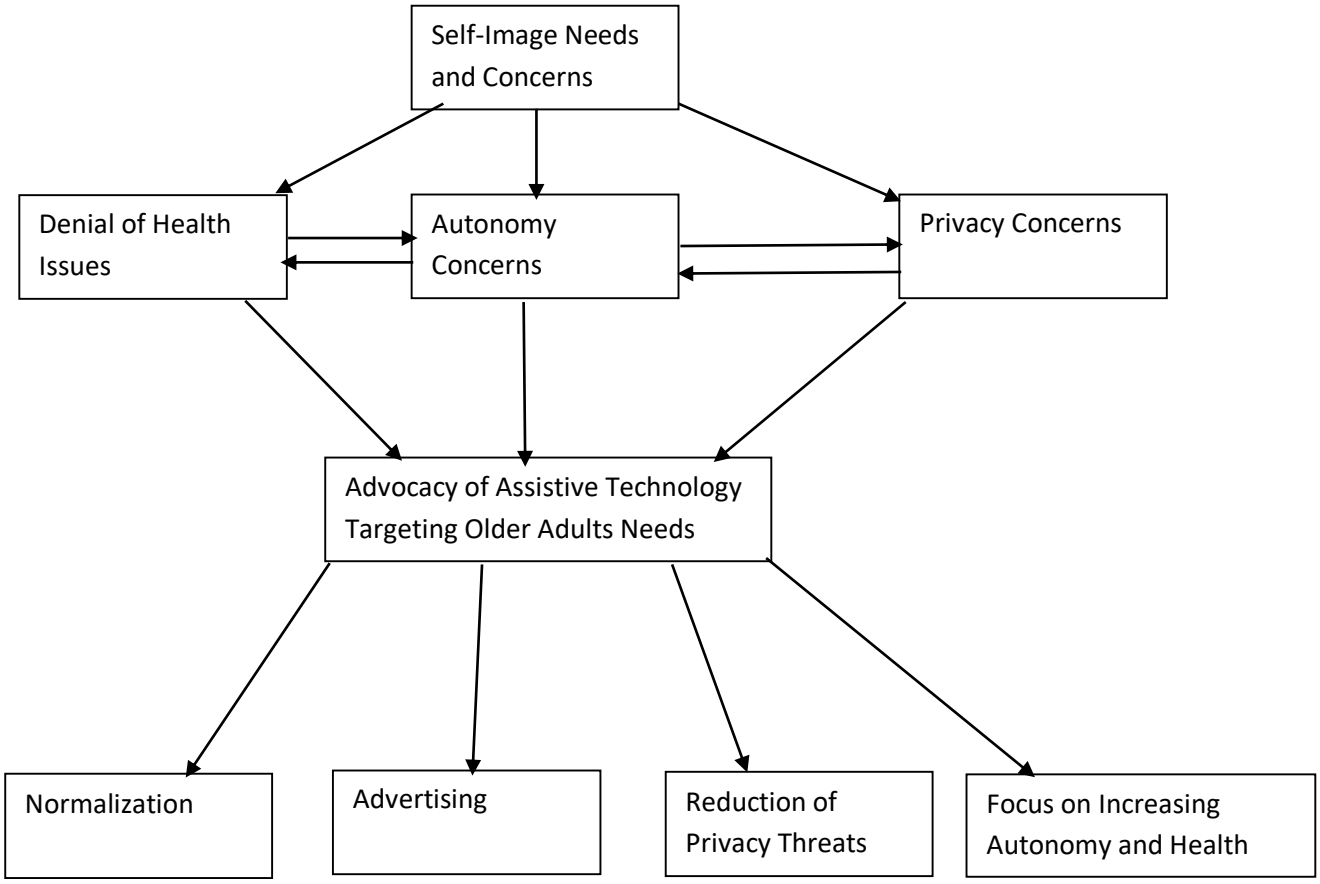

Figure 1. Theory of Self-Image and Assistive Technology Illustration

Therefore, it is proposed that assistive technology and its advocacy should focus on targeting self-image needs in addition to health and preventative needs. Participants clearly indicated throughout their interviews that they do not want to be classified as very elderly and were often offended when targeted by technology for this population, as this contrasts with their self-image. Thus, researchers, policymakers, and others involved in advocating for the technology should focus on how it can benefit all elderly. Figure 1. Theory of Self-Image and Assistive Technology Illustration shows the key elements of advocacy for assistive technology

for older adults, which are normalization, advertising, addressing privacy issues, and increasing autonomy and health.

For example, advocacy for remote healthcare technology should consider displaying a range of users of different ages and racial groups to normalize its use. Fall detection may be able to be normalized as well by making it a standard feature in devices such as smartwatches. As noted, one participant had a smartwatch and liked its fall detection features despite otherwise rejecting fall devices. Adding fall detection to more devices such as smartphones, which most older adults in this study owned, could increase its acceptance further, as it would become something most people have and use.

Thus, the goal this theory proposes is targeting elderly adults' acceptance by treating the technology aimed at them as normal for all elderly. Their self-image and related needs can be further targeted by showing how the technology can help them meet those needs, such as how having the option for an in-person versus a telehealth appointment can increase their freedom to choose how they want to see their doctor. As for issues that will always occur with technology, such as privacy threats, there should be an emphasis on making the technology as safe as possible and discussing these measures in layman's terms, such as discussing briefly how monitoring or data accessed by companies is limited by certain measures, such as opt-in consent. Thus, this theory proposes advocacy and normalizing assistive technology, focusing on minimizing privacy issues, and emphasizing autonomy benefits to address self-image, privacy, autonomy, and denial of health issues.

Section 3: Limitations

One of the main limitations of this pilot study was the low number of participants. Due to Covid-19, the study was changed from an in-person interview where the primary interviewer would meet with the participants, show them the videos and ask for consent, answer their

questions, and then administer the questionnaires. Some of the participants, particularly those in the older two groups, struggled to watch the videos due to having poor Internet connection or because they were just learning how to watch videos on their phone or computer. A few of those in the older age groups had relatives assist them. Some people who were interested in the study decided not to participate because of the need for an email and stable Internet connection. Furthermore, some of the participants mentioned during the interviews or afterward that many older adults they knew lacked Internet access. Also, while those in the youngest age group seemed to understand the devices after asking some questions of the interviewer about the more complex ones, some of the older participants still seemed confused.

Outreach was also hindered, as instead of being able to attend in-person meetings at places like the local community center to advertise the study as originally intended, the primary researcher instead left flyers in key community areas and sent flyers to local community Facebook pages. This lack of in-person contact in the initial recruitment stage also probably impacted the number of participants interested. Overall, the low number of participants limited the range of responses and the statistical power and coding strength because it limited the population sample to a small, relatively homogeneous group.

In the sample, there were no racial and ethnic minorities or participants within the lowest income bracket, few males, and few people in the 75-84 and 85 and up age groups. Fewer participants in the lowest income bracket, older age groups, and racial and ethnic minorities were expected, as other studies tended to have similar issues and these groups tend to have reasons, such as being more distrustful of technology or viewing it as unaffordable, that lead to lower participation (Demiris et al., 2004; Coughlin et al., 2007; Zwijsen et al., 2011). However, due to the small sample size and limitations on outreach, none of these groups were represented. Overall, the sample population was relevant for older, rural, white adults with average to high

income, particularly females between 65-74, but its application to other rural older adults is questionable, and it is unlikely to be relevant to other distinct populations such as urban or international older adults.

Phone interviews and self-reporting accuracy were also limitations. Some of the participants struggled with their phones or were less conversational than they might have been in person. Although most gave details on their thoughts and answered most questions, a few seemed reluctant at first to talk in detail over the phone, which may have limited their responses to the first few questions.

Finally, self-reporting bias could have also been an issue. Although it is unlikely they falsified basic demographic and technology use information, there were multiple implications before and after the interviews that some of the participants exaggerated how easy they found technology to use. A few, particularly in the older two groups, struggled with their phones during their interview and needed assistance from the relative or spouse with whom they lived while on call. Many also seemed confused about the devices like the infrared fall detector, though in most cases, they were able to understand how it worked and what it could be used for with further explanation from the interviewer. Thus, this implies that an assessment of their technological capabilities and understanding would have placed some of the participants in the 'difficult to use' or 'needs assistance often' categories on the survey.

Section 4: Study Implications

The findings from this study were primarily obtained to determine how rural Oklahoma older adults felt about accepting remote healthcare and preventative smart devices in their home and create a theory of acceptance based on an exploration of their biopsychosocial needs using Grounded Theory. The results clearly show that outside of affordability and ease of use issues for some, the primary barriers to acceptance of these devices relate to psychosocial threats such as

self-image, personal privacy, and autonomy issues. Failure to address these problems by accommodating older adults' psychosocial needs when designing, advocating, and disseminating technology will greatly reduce acceptance among older adults who could benefit from using it but are not at the point where they are forced to use it to stay in their home or monitor a severe health issue. Furthermore, this research supports the need for financial assistance programs for older adults who may otherwise not be able to afford health, preventative, and assistive technology, and the need for user-centered design to address the psychosocial and ease of use problems older adults may face earlier in the design process. Thus, future research should focus on addressing older adults' psychosocial and ease of use issues with the technology, and future advocacy should also attempt to address the financial barriers.

Specifically, future research should focus on creating non-threatening procedures and technology. There should be a focus on reducing explicit and implicit biases against older adults that may skew results, particularly in user-centered design and implementation studies, as this will likely lead to self-image and autonomy threats, researchers' distortions of participants' experiences, and result in higher rates of rejection. In addition, any technology designed or tested, even those specifically aimed at a condition or disability, should be as unobtrusive as possible to avoid threats to self-image. Ideally, features should be implemented as a regular part of popular, widespread devices like smartphones, smartwatches, and smart home devices to reduce their links specifically to the aged, such as how fall detection and tachycardia monitoring is increasingly being implemented in smartwatches, home security and task assistance for those with vision or physical issues have been added to smart home hubs, and accessibility features are being added to smartphones to make them more usable for those with vision, hearing, or other physical issues.

Future advocacy and community programs should consider advertising that these devices or features can be used by people of a wide range of ages. They should also seek out devices that are cost-effective and relatively easy to use, as this study and others indicate this is critical for success among various subgroups of older adults (Li et al., 2019; Batsis et al., 2019a; Kwan, 2019). Furthermore, they should serve as advocates to policy-makers to emphasize the importance of extending financial coverage to assistive technology devices that have shown clear benefits for older adults but may be unaffordable for many in low-to-mid income brackets. Finally, increased Internet and technology access in general for rural older adults is needed, as some of the participants implied and other studies showed that this was a primary barrier to adoption for rural users (Batsis et al., 2019a; Kwan, 2019).

Section 5: Conclusion

To summarize, this study obtained and examined the attitudes of rural older adults toward three types of health and assistive smart devices and what affected their acceptance. It was determined that the core category that resulted in rejection was threats to self-image, which was part of a probable cluster of causality with privacy and autonomy concerns and denial of health issues. Other important categories that influenced acceptance were ease of use, particularly for those with little experience with technology, and financial issues for those in low-to-mid income ranges.

Additional research on rural older adults is needed, as this was a small pilot study that attempted to determine the initial main causes and correlations that led to acceptance or rejection. Future research should consider exploring the opinions of a larger, more diverse sample and determining how devices can be modified to be less threatening to self-image. The latter could be done by testing the proposed theory and integrating features targeting older adults into everyday devices that are popular, and thus, serve a wide age and health range not directly related to aging,

declining health, and dependency. Without this research and changes to the way assistive technology is currently proposed to older adults, potential rural users, particularly those with lower incomes or less education, will likely continue to strongly reject any assistive technology. Urban, high income, and/or more educated older adults tend to be more accepting of assistive technology for preventable health problems and danger compared to rural ones, who have distinct needs, and will likely adopt it earlier (Mathew, 2005; Satpathy & Mathew, 2007; Fritz et al., 2015; Li et al., 2019). This study confirms the results of previous studies in this regard and indicates that if barriers to acceptance among rural older adults are not addressed with new approaches, the healthcare disparities between urban and rural older adults are likely to increase, especially in situations like pandemics.

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APPENDICES

APPENDIX A

Interview Questionnaire

Smart home technology for aging-in-place can fulfill functions such as remote health monitoring for vital signs, fall detection, and home security. We are trying to learn how older adults feel about using this technology to monitor their health conditions and prevent safety problems. We are especially interested in how your acceptance of smart home devices might have changed after Covid-19 and if you think this new technology could help you stay in your home longer as you grow older? Do you have any questions before we start the interview?

1. What do you think about a remote health monitoring tablet to report your vital signs to your doctor on a videoconferencing appointment? Follow-up probes: What could you add to these thoughts? Can you tell me why you feel that way?

2. Would you be interested in sending your vital signs to your doctor that way, particularly if the device could alert your doctor to problems and if Medicare would cover it? Follow-up probes: If Medicare would not cover it or not fully cover it, would you still use it? Can you tell me why you feel that way?

3. What do you think about privacy issues that health monitoring for vital signs may pose? Follow-up probes: Is there anything you disliked in particular in the video? Is there anything that could be done to solve your problem with it?

4. If your doctor recommended this device, would you require the information only be sent to your doctor's office? Follow-up probes: If the device sent information to a broader medical database or company, would you reject it due to privacy concerns? What would have to change for you to consider using it?

5. If you used this technology, would you have any worries about the ease of using it? Follow-up probes: Are there any likes or dislikes you have when it comes to using it, such as voice controls? Do you feel it might be difficult for others you know?

6. Do you have any general worries about how others may react if you were to use this technology? Follow-up probes: What can you add to that? What changes do you feel would need to be made to the device?

7. Do you feel that any of your thoughts on health monitoring for vital signs might have changed since coronavirus started? Follow-up probes: Can you add anything to that? What new elements do you think coronavirus might have introduced to this issue?

8. What do you think about the fall detection devices in the videos? Follow-up probes: Do you have any specific worries about these devices? Would a device like this be useful for you or others you know? Which of the fall detection devices do you like best and why?

9. Of the three types of fall detection systems, the mat, infrared, and camera, which do you like best? Follow-up probes: Why do you like that one? Could you or others you know use a device like that?

10. If you are not using one of these devices, your doctor asked you to use one as part of a health monitoring system, and it was covered by Medicaid, would you use it? Follow-up probes: Do you feel the doctor would be overstepping their boundaries in this case? Do you feel your attitude might have changed on fall detection devices because of coronavirus?

11. What do you think about the home security system in the video? Follow-up probes: Can you add to that? Are there any additional ideas you would like for a home security system?

12. Would you find a home security system acceptable if Medicaid would pay for it? Follow-up probes: Do you feel it is less intrusive than the home monitoring device for vital signs or the fall detection devices? If you would accept it, how do you feel it could help you?

13. Do you feel coronavirus might have changed your attitude about home security devices? Follow-up probes: Can you add to that? Do you think others you know feel the same way?

14. Finally, do you feel like there is anything else about any of the above devices you dislike or feel is not acceptable? Follow-up probes: Can you tell me more about this? What would you do to fix the biggest problems?

15. In summary, what are your final thoughts about whether coronavirus may have changed your acceptance of smart home devices in general for aging in place, do you think these devices could help you stay safely in your home longer, and what do you see in the future in this regard, even after coronavirus?

APPENDIX B

Demographic Questionnaire

1. What is your race? Please choose all that apply.
   a. American Indian or Alaska Native
   b. Asian
   c. Black
   d. Native Hawaiian or Pacific Islander
   e. White
   f. Other
2. What is your ethnicity?
   a. Hispanic
   b. Non-Hispanic
3. What is your age?
   a. 65-74
   b. 75-84
   c. 85 and up
4. What is your gender?
   a. Female
   b. Male
   c. Other
5. What is your annual household income?
   a. Up to $21,000
   b. Between $21,001-$40,000
   c. Between $40,001-$60,000
   d. Between $60,001-$100,000
   e. Above $100,000
6. What is your educational level?
   a. Less than high school completion
   b. High school or GED completion
   c. Some college
   d. Bachelor's degree
   e. Graduate degree
7. What is your marital status?
   a. Single
   b. Married
   c. Partnered

d. Divorced
e. Widowed

8. What types of devices or software have you used? Please select all that apply.
    a. Flip phone
    b. Smartphone
    c. Tablet
    d. Computer (laptop or desktop)
    e. Smartwatch
    f. Home monitoring system
    g. Streaming device or smart TV
    h. Video chat software like Skype or Zoom
    i. Robots or drones, including hobby versions
9. How often do you use these types of devices and software?
    a. Daily
    b. At least once a week
    c. At least once a month
    d. Less than once a month
10. How easy do you find the devices and software you use overall?
    a. Easy to use
    b. Somewhat difficult
    c. Difficult to use
    d. Need assistance often

APPENDIX C

Links to Videos for Participants

Remote health monitoring:

- https://www.mercy.net/newsroom/2018-07-19/remote-monitoring-keeps-patients-with-chronic-conditions-out-of-/

Home Security Video:

- https://www.youtube.com/watch?v=yYFaQJrY7N8

Fall Prevention Devices:

- https://www.youtube.com/watch?v=wClPvfFOJiQ
- https://www.youtube.com/watch?v=1RdDMp8g_Jg
- https://www.youtube.com/watch?v=PRx7ND8A7ng

VITA

Rachel Higgins

Candidate for the Degree of

Master of Public Health

Thesis: AGING-IN-PLACE: THE INFLUENCE OF COVID-19 ON SMART DEVICES ACCEPTANCE

Major Field: Public Health

Biographical:

Education:

Completed the requirements for the Master of Public Health at Oklahoma State University, Stillwater, Oklahoma in May, 2021.

Completed the requirements for the Bachelor of Science in Computer Science at Oklahoma State University, Stillwater, Oklahoma in 2019.

Experience:

Graduate Research Assistant, Department of Design, Housing, and Merchandising, Oklahoma State University, May 2019-Present. Responsibilities include annotating over 400 articles on assistive technology for people with dementia, creating over 30 literature reviews and presentations on the subtopics of assistive technology, assisting with interviews of caregivers for people with dementia, preparing articles for publication in journals, and presenting findings for team members.

Undergraduate Teaching Assistant, Department of Psychology, Oklahoma State University, August 2018-December 2018. For over 20 students, analyzed and graded essays by evaluating the quality of content, sources, and APA style with a rubric, encouraged participation in, supervised, and graded online student discussion boards, and graded short-answer exam questions and video presentations for content.