THE IMPACT OF A ROBOTIC PET ON SOCIAL AND PHYSICAL FRAILTY IN COMMUNITY-DWELLING OLDER ADULTS DURING THE COVID-19 PANDEMIC

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Social and physical frailty are common geriatric syndromes related to adverse health outcomes, including falls, hospitalization, institutionalization, and death. Social frailty leads to physical frailty in older adults who were not frail. Previous studies have demonstrated that pet ownership and robotic pets have physical and mental health benefits for older adults; however, no studies were found investigating the impact of robotic pets on social and physical frailty in community-dwelling older adults.

The purpose of this study was to investigate the impact of a robotic pet on social and physical frailty in community-dwelling older adults using the Technology Acceptance Model as a framework. This was a clinical trial of adults aged 65 and over, hospitalized at a community hospital in Westchester County, New York. Intervention group participants received a robotic pet, and control group participants received usual post-discharge care. Participants were assessed at enrollment and at the 30-day discharge point using the Questionnaire to Define Social Frailty Status, FRAIL Questionnaire, the Geriatric Depression Scale Short Form, and the Short Portable Mental Status Questionnaire.

For this study ,220 participants were enrolled; 107 in the intervention group and 113 in the control group. Continuous outcomes were compared between groups using t-tests or

Wilcoxon rank sum tests, as appropriate. Categorical outcomes were compared between groups using chi-square tests or Fisher's exact tests, as appropriate. The threshold for statistical significance was considered a p value of less than 0.05. There was no significant change in social frailty or physical frailty, cognitive status, or depression between the two groups. Participants who enjoyed doing things with their robotic pet had a statistically significant improvement in their SPMSQ scores ($p = 0.02$), which indicated a positive effect on cognition in participants who used their pet more.

Prevalence of social frailty was high, likely attributable to pandemic control measures and unlikely to change on the social frailty questionnaire used in this study due to the ongoing pandemic. In contrast to this study, previous research has shown that robotic pets were effective for improving well-being in older adults and showed more positive impact in a group setting compared to individual use. A significant limitation of this study was that it took place during the COVID-19 pandemic. Other limitations were related to self-report of some measures which may introduce bias. Additionally, the social frailty questionnaire has not been validated in diverse populations; thus, its validity in the study population is not known. The geographic area where the study took place is non-diverse, which may impact generalizability to wider populations.

The robotic pet positively impacted cognitive status in participants who reported they enjoyed doing activities with their pet. This supports the theoretical premise of this study that greater use of the robotic pet would yield greater benefit. Regarding implications, technology is an important tool to ameliorate social and physical frailty, especially in light of pandemic-related restrictions where in-person socialization is restricted. More research is needed on the impact of robotic pets in older adults living at home, particularly on social frailty, loneliness, and cognitive status, with larger sample sizes and diverse populations.

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Chapter I

THE RESEARCH OBJECTIVE

This chapter introduces and defines the research topic and describes the significance of the problem to nursing. Further, the purpose and aims of the study are described next. Finally, the chapter also discusses the theoretical basis for this study.

Introduction

For the first time in history, most people can expect to live well beyond the age of 60. According to the World Health Organization (WHO, 2018), the number of people over the age of 60 will rise from 900 million to two billion by 2050, or 22% of the world population. Population estimates from the U.S. Census Bureau (2020) showed an exponential rise in the U.S. population of adults over the age of 65, largely driven by the aging of the Baby Boomer generation. The Baby Boomer generation includes individuals born between 1946 and 1964, who started turning 65 in 2011 (U.S. Census Bureau, 2020). Since 2010, the 65 and older population has grown by more than 34.2%, or 13,787,044 (U.S. Census Bureau, 2020). The rise of the older adult population has been accompanied by a concomitant increase in geriatric syndromes. One geriatric syndrome with far-reaching implications for this population is frailty.

Rationale

The rise of the older adult population mandates alternative ways to meet the needs of this population. Frailty increases the risk for adverse health outcomes and thus must be addressed early on to allow older adults to remain living in the community independently. Various technologies have been explored to enhance the lives of older adults and improve health outcomes. This researcher proposed that a robotic pet that served as a social companion for older

adults living at home would decrease the incidence of social and physical frailty in this population.

Purpose

The purpose of this study was to evaluate the impact of a robotic pet on social and physical frailty in community-dwelling older adults.

Specific Aims and Hypotheses

1. To explore the impact of a robotic pet on the incidence of social and physical frailty in a population of community-dwelling older adults over age 65 who were recently hospitalized, compared to usual post-discharge care.
   a. Hypothesis 1: The use of a robotic pet will decrease rates of social frailty in the intervention group, compared to the control group, after controlling for cognitive function and depression.
   b. Hypothesis 2: The use of a robotic pet will decrease rates of physical frailty in the intervention group, compared to the control group, after controlling for cognitive function and depression.
2. To explore the impact of a robotic pet on the incidence of cognitive function and depression in a population of community-dwelling older adults over age 65 who were recently hospitalized, compared to usual post-discharge care.
   a. Hypothesis 3: The use of a robotic pet will improve cognitive function in the intervention group, compared to the control group.
   b. Hypothesis 4: The use of a robotic pet will decrease rates of depression in the intervention group, compared to the control group.

3. To explore the impact of perceived enjoyment on the use of a robotic pet in the intervention group.
    a. Participants who find the pet useful and easy to use will have greater improvement on the primary and secondary outcomes of the study—social frailty, physical frailty, cognitive function, and depression.

Definitions

Older adults are defined as individuals aged 65 and older.

Community dwelling is defined as those living in the community in their own homes, the home of a relative, independent senior living, retirement community, or assisted living facility.

Usual post-discharge care in the community hospital from where this sample was drawn includes patient-specific needs for when they return home, as determined by the inpatient care management team. Needs may include visiting nurse services, which range from visits by a nurse, physical therapy, aide services, paramedicine services, home infusions, and the like, depending on patient needs. Patients may also receive assistance setting up follow-up appointments and obtaining medications via bedside delivery if there is an identified need for these services. All patients receive a post-discharge phone call by an Advanced Practice Registered Nurse (APRN) or Registered Nurse (RN) post-discharge as part of routine, post-discharge care.

Robotic pets are life-like, interactive pets covered with soft fur. The pets respond to petting, hugging, and motion via built-in sensors and produce animal-like sounds such as purring, meowing, and barking.

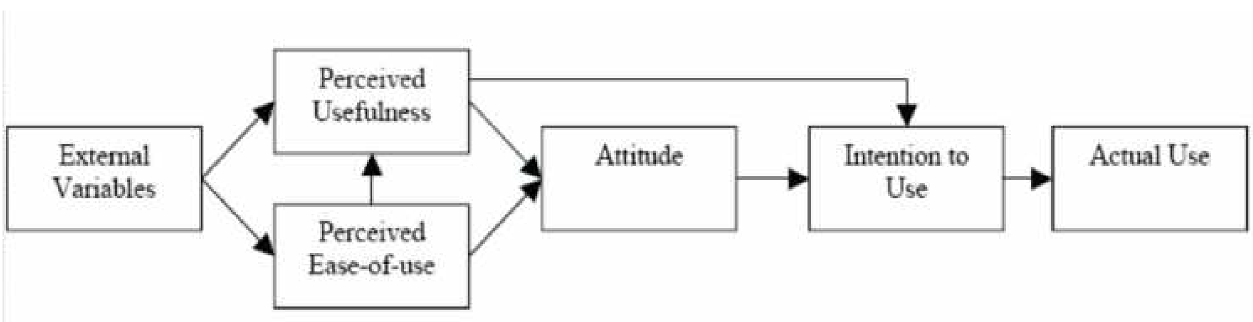
COVID-19 pandemic is an ongoing global pandemic of the Coronavirus Disease 2019 (COVID-19) caused by the SARS-CoV-2 virus. The pandemic began as a cluster of atypical pneumonia cases in China in 2019 and rapidly spread throughout the world.

Social distancing refers to physical distancing behaviors where individuals keep a safe distance between themselves and others who do not live in their households. A safe distance is considered 6 feet or more from others.

Theoretical Framework

The theoretical framework for this study was the Technology Acceptance Model (TAM). The TAM was chosen as the theoretical basis for this study because it addresses individual intention to use technology. This model was originally developed by Davis (1989) based on two fundamental constructs—perceived usefulness and perceived ease of use—to address underuse of information technology systems in the workplace. The theoretical model was developed to predict and explain why people use technologies; it is depicted in Figure 1.

Figure 1. *The Technology Acceptance Model*



Note. This figure demonstrates the original Technology Acceptance Model (Davis, 1989).

The model posits that users' positive perceptions of technology, such as perceived usefulness and perceived ease of use, influence actual use of technology. Perceived usefulness is defined as the degree to which a person thinks his/her performance could be improved by the

technology (Davis, 1989). In the context of this study, this would translate as the degree to which a participant thinks the robotic pet serves his or her needs. Perceived ease of use is defined as the degree to which a person thinks he/she can use the technology with little effort and that it is easier to use than any other option (Davis, 1989). In terms of the robotic pet, use requires little to no effort. Davis (1989) further explained perceived usefulness in the context of outcome judgments, as one judging an action by the extent to which, once it is performed successfully, it is believed to be linked to valued outcomes. According to the model, perceived usefulness is directly influenced by perceived ease of use because the easier the system is to use, the more useful it can be (Venkatesh & Davis, 2000).

In the original study of the theoretical model, Davis (1989) found perceived usefulness of a technology to be more important than ease of use in terms of whether an individual is likely to use the technology. This makes sense in that users are often willing to accept a level of difficulty for a system that provides a critically needed function, such as maintaining physical function or the need for companionship. This concept is also discussed in this study regarding older adults' attitudes towards technology in that they indicated a willingness to adopt new technologies if they thought it to be useful. On the other hand, no amount of ease of use can compensate for a lack of usefulness (Davis, 1989). This highlights the significance of usefulness within the context of technology acceptance.

The anticipated benefits of a technological intervention relied on participants' willingness to use it. Using TAM constructs, this intervention was framed as a tool to prevent physical and social frailty and maintain independent living as long as possible. This researcher adapted the Perceived Enjoyment Questionnaire (PEQ) (refer to Appendix F), which had demonstrated effect on technology acceptance (Heerink et al., 2008) to evaluate how these attitudes influence use of

the robotic pet. The rationale behind this is: the more useful the participant found the robot, the more he or she was likely to use it. By this logic, if the participant used the technology more, the technology would have a greater impact.

Significance

According to data from the U.S. Census Bureau, one in five adults between the ages of 65 and 74 live alone (Roberts et al., 2018). Contrary to the popular misconception that most older adults live in nursing homes, among the 85 and older age group, 4 out of 10 lived alone, with only 11% living in nursing facilities or other residential facilities (Roberts et al., 2018). The Administration on Aging (2018) reported that the proportion of older adults living alone increases with age. In 2018, 28% of older adults, or 14.3 million individuals, lived alone (Administration on Aging, 2018). Fifty-nine percent of older adults over 65 lived with a spouse or partner, and a relatively small number of individuals lived in institutions (Administration on Aging, 2018). Notably, living alone represents a significant risk category for disability onset (Lund et al., 2010). Furthermore, frailty is the most common condition leading to death in older adults living at home (Gill et al., 2010). This represents a significant population of older adults living alone at risk for frailty and the accompanying adverse effects of this syndrome, including falls, hospitalization, institutionalization, and death. Since most older adults prefer to live at home, frailty and disability prevention and amelioration are crucial when caring for the older adult population.

According to the Global Health and Aging Report from the WHO (2011), reducing disability from disease and health conditions is critical in terms of limiting healthcare expenditures. Environmental factors that allow older adults to remain independent despite functional limitation can decrease healthcare costs while also maintaining quality of life for the

individual. This is especially important as research has shown that older adults prefer to live independently, even if that means living alone (WHO, 2011). According to the WHO report, healthcare spending rises with older age; thus, interventions that maintain health and functional status in older age, such as robotic companionship, will theoretically reduce healthcare costs.

Medicare, the national health insurance program for U.S. adults 65 and over, is the biggest spender of healthcare dollars (Thorpe et al., 2010). As such, Medicare data are informative in terms of where healthcare dollars are expended. The projected increase in the older adult population has significant implications for future Medicare spending as beneficiaries over 80 years old account for a disproportionate share of Medicare costs (Thorpe et al., 2010). Specifically, the aging of the Baby Boomer Generation creates a tremendous cost burden on the healthcare system as older adults age into Medicare. An important driver of increased healthcare spending is chronic disease prevalence and associated comorbidities, particularly hypertension, hyperlipidemia, arthritis, diabetes, ischemic heart disease, chronic kidney disease, depression, heart failure, COPD and Alzheimer's Disease among the top 10 (Centers for Medicare & Medicaid Services [CMS], 2012; Thorpe et al., 2010). People with multiple chronic diseases account for 93% of total Medicare spending, and beneficiaries with multiple chronic conditions had higher healthcare utilization in terms of home health visits, primary care visits, emergency department visits, and hospital admissions (CMS, 2012).

Not surprisingly, chronic disease prevalence increases with age. According to the U.S. Department of Health and Human Services (USDHHS, 2010), one in four Americans have multiple chronic conditions. In adults aged 65 and older, that number rises to 3 in 4 Americans living with at least one chronic condition. Additionally, chronic disease is associated with functional limitations and frailty, which further drives up healthcare spending (USDHHS, 2010).

Functional limitation is important in terms of healthcare spending as this identifies individuals with increased healthcare needs and thus increased healthcare utilization and costs (USDHHS, 2010). Furthermore, frailty tools that include a comorbidity measure are more predictive of disability and mortality (Malmstrom et al., 2014). This highlights yet another complicated relationship between frailty, multimorbidity, and disability, where multimorbidity and disability increase the risk for frailty (Rockwood & Mitnitski, 2011), and frailty increases the risk for multimorbidity and disability (Fried et al., 2001), all of which are associated with increased healthcare spending.

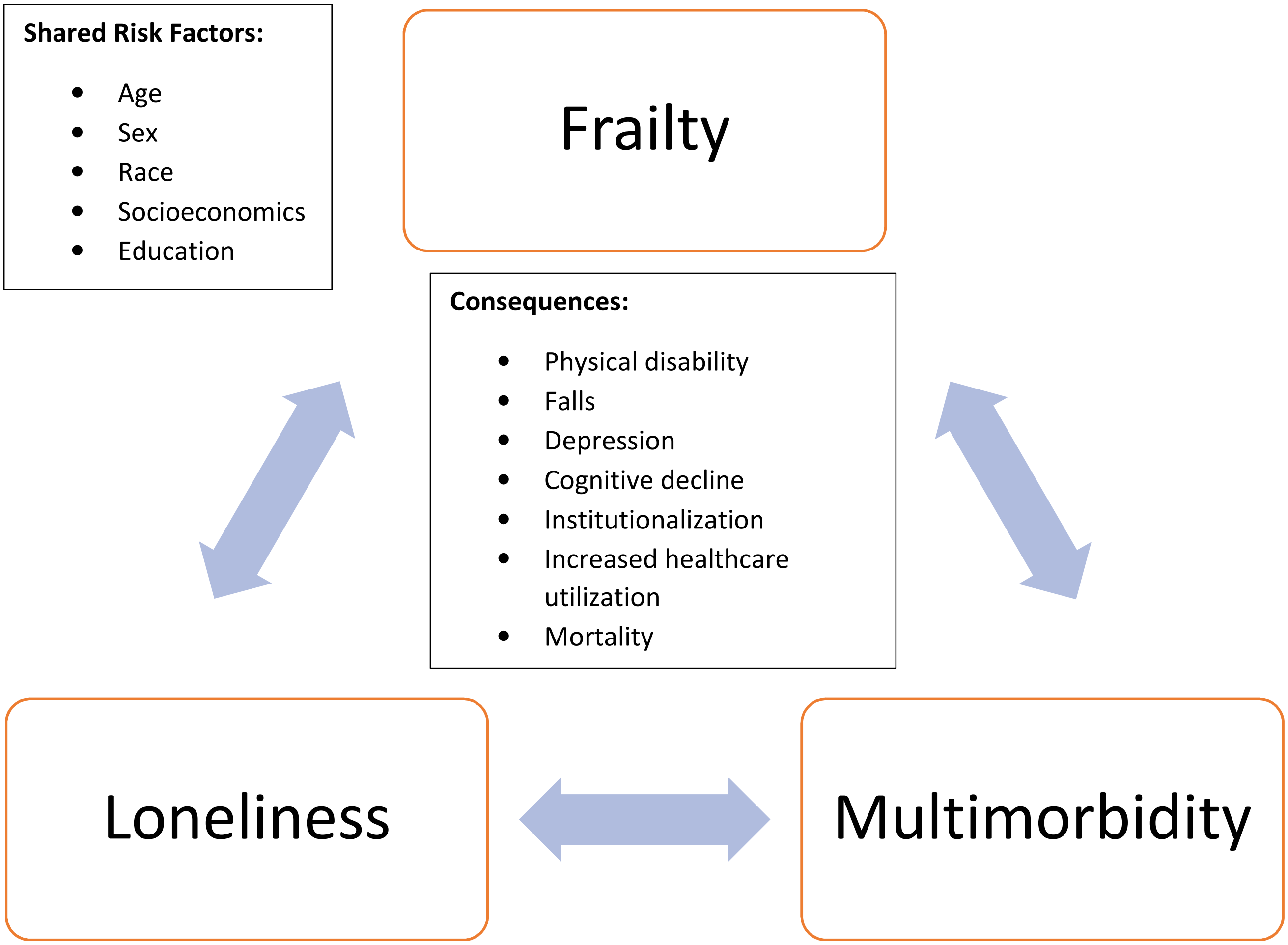
Loneliness was linked to multiple chronic conditions, including coronary artery disease, stroke (Valtorta et al., 2016), physical disability (Perissinotto et al., 2012) depression (Cacioppo et al., 2010), and cognitive decline in older adults (Lara et al., 2019; Shankar et al., 2013). Multimorbidity was associated with increased loneliness (Hajek et al., 2020). This suggests a reciprocal relationship between loneliness and multimorbidity, where loneliness increases the risk for multimorbidity and multimorbidity increases the risk for loneliness (Hajek et al., 2020). Loneliness was also an independent risk factor for nursing home admission (Hanratty et al., 2018) and represented significant healthcare burden in terms of increased healthcare utilization and increased costs of care (Heinrich & Gullone, 2006). Loneliness was used as a proxy for social frailty in this study as social frailty is not yet well established conceptually and there is no established social frailty assessment.

The overlapping relationships among multimorbidity, frailty, and loneliness are depicted in Figure 2. Multimorbidity, frailty, and loneliness share common risk factors and consequences. The shared risk factors may lead to multimorbidity, which in turn may lead to frailty, which in turn may lead to loneliness, with feedback mechanisms enhancing the presence of shared risk

factors and poor outcomes. A self-sustaining pathwaylike this results in poor health outcomes, such as disability, dependence, institutionalization, and death. Finally, targeting multimorbidity decreases the risk for both frailty and loneliness.

Loneliness is an increasingly recognized public health issue across the world. The WHO (2020) included social support networks as a determinant of health. Physical and psychological health maintenance are key to independent living for older adults. This is also important in the context of the larger healthcare system because multi-morbidity, loneliness, physical disability, and frailty are all risk factors for increased healthcare utilization and cost. Interventions for loneliness can improve overall well-being and quality of life and, importantly, keep older adults living at home where they want to be as long as possible.

Figure 2. *Relationship among Multimorbidity, Frailty, and Loneliness*



Chapter II

THE RELATED LITERATURE

The review of literature begins with a discussion on the target population for this study. The discussion continues with related literature on geriatric syndromes and physical and social frailty. This chapter also discusses existing interventions for social frailty and their effectiveness in targeting various aspects of frailty, including pets as an intervention. Lastly, this chapter describes existing literature on older adults and technology and how older adults were impacted by the COVID-19 pandemic.

Population of Community-dwelling Older Adults

The prospective rise in the population aged 65 and over demands a closer look at the health implications of this aging imperative. The expected increase in the elderly population will be impactful on society in terms of increasing numbers of frail older adults who will have a substantial need for support and interventions. This study focused on community-dwelling older adults, or older adults living independently, because this population is more commonly pre-frail or in the early stages of frailty, and thus will benefit most from early intervention (Feng et al., 2017; Xue, 2011). Additionally, the community-dwelling population is more likely to have fewer social interactions compared to an institutionalized setting and, thus, is at increased risk for social frailty. This also eliminates potential confounding factors of a group setting that is inherently more social than the home setting.

Geriatric Syndromes

The projected rise in the elderly population represents an accompanying increase in geriatric syndromes. In geriatrics, the presence and number of geriatric syndromes is more important than biological age when considering an individual's clinical course (Kane et al.,

2012). Geriatric syndromes are common, multifactorial health conditions in older adults resulting from impairment across multiple systems, rendering the older adult vulnerable to situational stressors (Inouye et al., 2007). The term *geriatric syndrome* encompasses clinical conditions commonly associated with older adults that do not fit into discrete disease categories, including delirium, falls, dizziness, syncope, urinary incontinence, and frailty (Inouye et al., 2007). Since geriatric syndromes share common risk factors, the presence of one leads to the development of another. The accumulation of syndromes leads to the final outcomes of disability, dependence, and death (Inouye et al., 2007).

Geriatric Syndrome: Frailty

The geriatric syndrome investigated in this study was the frailty syndrome. Frailty is an identifiable clinical state of vulnerability, due to a decline in reserve across multiple systems, that leaves the individual with a diminished ability to respond to acute stressors (Clegg et al., 2013; Rockwood & Mitnitski, 2011; Siriwardhana et al., 2018). This decline in reserve is caused by age and disease-related challenges that a robust individual can compensate for with system redundancies (Clegg et al., 2013). Frailty results when the accumulation of stressors reaches an aggregate mass where redundancies are inadequate and an ordinarily simple stressor such as surgery or urinary tract, infection for example, leads to a precipitous decline in health (Clegg et al., 2013). Frailty is a complex, multi-system disorder that places the individual at greater risk for poor health outcomes, including falls, disability, hospitalization, institutionalization, and mortality (Buckinx et al., 2015; Fried et al., 2001; Kane et al., 2012; Xue, 2011). Frailty is a public health concern as it is associated with increased need for healthcare intervention and high risk for dependency (Buckinx et al., 2015). Frailty is reversible, with potential for improvement rather than an inevitable trajectory to disability and death (Conroy & Elliot, 2016). Individuals

transition between frailty states with potential for recovery from frail, to pre-frail, to robust status (Siriwardhana et al., 2018). Still, worsening is more common than improvement. Frailty often leads to a spiral of decline that leads to worsening frailty and the consequences thereof (Clegg et al., 2013). Because frailty risk rises with increasing age (Collard et al., 2012), the expected prevalence and resulting toll of frailty will rise accordingly with the aging population if there is no standard of prevention or treatment.

Currently, there is no clear consensus regarding the definition of frailty, creating challenges in the identification and evaluation of frailty in older adults. One systematic review found 51 different instruments for the identification of frailty (Faller et al., 2019). The two most commonly used definitions of frailty are the Fried phenotype and the Frailty Index (FI) (Clegg et al., 2013; Kojima, 2018; Siriwardhana et al., 2018). The frailty phenotype defines frailty as a condition meeting three out of five phenotypic criteria, including weight loss, exhaustion, low physical activity, slowness, and weakness, reflecting underlying loss of physiologic reserve (Fried et al., 2001). The phenotype further identifies three stages of frailty, ranging from robust and pre-frail to frail (Fried et al., 2001). The pre-frail stage is a transitional state, where one or two criteria are present, and suggests a higher risk of progression to frailty (Fried et al., 2001). Critique of this definition is that it is limited to physiologic and functional domains and does not reflect frailty's multidimensionality. With complex, multifactorial geriatric syndromes such as frailty, it is crucial to consider relevant domains outside of a discrete biological framework (Inouye et al., 2007).

The FI measures frailty by the number of accumulated deficits across multiple domains, including physical and cognitive impairment, comorbidities, disability, psychosocial risk factors, and geriatric syndromes such as falls, delirium, and incontinence (Rockwood & Mitnitski, 2011).

The increased number of deficits are predictive of adverse health outcomes, including mortality (Kojima, 2018; Mitnitski et al., 2017). People, on average, accumulate deficits as they age; however, the nature of the deficits and the rate at which they accumulate vary from person to person, reflecting the heterogeneity and complexity of the frailty phenomenon (Rockwood & Mitnitski, 2011). The use of the FI requires a comprehensive geriatric assessment (Rockwood & Mitnitski, 2011), thus limiting its practicality in everyday clinical practice due to potential time constraints.

The lack of a standardized frailty measure creates challenges in terms of defining frailty, quantifying the problem, and organizing and understanding the research, given that frailty measurement tools vary between different studies, settings, and countries. Most frailty instruments primarily focus on the physical domains of frailty (Faller et al., 2019). More recent tools incorporate a more holistic view of frailty, including cognitive, social, and environmental domains (Faller et al., 2019). Notably, assessment tools that account for the multiple dimensions of frailty reveal higher levels of frailty than tools that only incorporate the physical dimension of frailty (Collard et al., 2012); this suggests that one-dimensional assessment tools may underestimate prevalence of frailty. Social frailty is important in an increasingly lonely and isolated society, particularly for older adults living at home. This is especially apt during the COVID-19 pandemic, when necessary public health measures have forced older adults to isolate and social distance.

Social Frailty

Frailty is a multidimensional construct and includes physical, social, and psychological domains. The physical dimension of frailty is widely researched and well established; however, social frailty has been less commonly explored. Social frailty, defined generally as decreased

social engagement, can lead to physical frailty in community-dwelling older adults who are not physically frail (Ma et al., 2018; Makizako et al., 2018; Pek et al., 2020). With no clear, universal definition of social frailty as a concept, there are a variety of different approaches to this concept in the literature. Bunt et al. (2017) conceptualized social frailty based on a theoretical approach as a loss or risk of losing social and general resources, activities, or abilities that are necessary for the fulfillment of social needs. The three basic needs for social fulfillment were affection, status, and behavioral confirmation (Bunt et al., 2017). The model conceptualized general resources, social resources, and social behaviors and activities that would lead to the fulfillment of those needs (Bunt et al., 2017). This model highlights specific areas of social needs fulfillment that would be useful to target when designing interventions for social frailty. The operational definition of social frailty involves addressing the risk of disability and physical frailty related to decreased social engagement in older adults (Tsutsumimoto et al., 2017). In practice, this involves assessment questions addressing social isolation risk, including inquiries regarding daily social activity, social role, and social relationships (Makizako et al., 2015; Tsutsumimoto et al., 2017).

Several studies have demonstrated an association between social frailty and physical disability (Makizako et al., 2015; Pek et al., 2020; Teo et al., 2017; Tsutsumimoto et al., 2017). The risk for functional disability is compounded when both physical and social frailty are present (Teo et al., 2017). Additionally, studies have also demonstrated a link between social frailty and cognitive dysfunction (Tsutsumimoto et al., 2017). This highlights frailty as a multidimensional construct. It is thus impossible to consider this syndrome without acknowledging the link between the physical, cognitive, and social frailty domains.

Many frailty models are one-dimensional, largely focusing on the physical phenotype (Fried et al., 2001) or the deficit accumulation model that includes a combination of physical symptoms, diseases, and disability (Rockwood & Mitnitski, 2011). The physical phenotype includes five components of frailty: weight loss, exhaustion, low energy expenditure, slowness, and weakness (Fried et al., 2001). One systematic review of frailty assessment tools revealed several that included at least one question addressing the social dimension of frailty (Bessa et al., 2018). The most oft-included social domains were social activities, social support, social network, loneliness, and living alone (Bessa et al., 2018). However, there is no gold standard for the assessment of frailty. More work is needed on the operationalization of social frailty with universal application (Bessa et al., 2018).

Similar to its frequent absence from frailty assessment, the social dimension of frailty is often not addressed in frailty interventions. The frailty phenotype is largely physical; however, social frailty impacts physical health as well. Furthermore, social frailty may be a precursor of physical frailty (Makizako et al., 2018). A multidimensional view of frailty that includes cognitive, social, and physical aspects must be considered for the most accurate prediction of risk for physical disability as well as to prevent the development or progression of physical frailty. This study addressed social frailty as a means of preventing physical frailty and functional decline.

Social frailty was associated with multiple outcomes known to be precursors to physical frailty and disability, including depression, poor nutrition, and decreased physical activity and performance (Pek et al., 2020). Social frailty was also linked to multiple geriatric syndromes including multimorbidity, cognitive impairment, depression, sarcopenia, impaired mobility, falls, polypharmacy, and malnutrition (Park et al., 2019). Furthermore, social frailty was

independently associated with increased risk for disability and mortality (Ma et al., 2018). Social isolation and loneliness also compound disability and mortality risk of physical frailty such that when both social and physical frailty are present, mortality risk is increased more than in the presence of physical frailty alone (Hoogendijk et al., 2020; Yamada et al., 2018). The same was true regarding the presence of social and physical frailty; the presence of both simultaneously increased the risk of disability and geriatric syndromes more than the presence of one or the other alone (Park et al., 2019). Social vulnerability is a crucial aspect of health in older age and should be considered an important part of frailty management to preempt physical frailty as well as other known health problems associated with social isolation.

The terms *social isolation* and *loneliness* are often used interchangeably in the literature. Specifically, social isolation is an objective measure of social network size, diversity, and frequency of contact with others (Heinrich & Gullone, 2006). Loneliness is a subjective feeling of dissatisfaction with closeness and frequency of social contacts (Heinrich & Gullone, 2006; Holt-Lunstad et al., 2015). The frequency of social contact is unrelated to feelings of loneliness as an individual with frequent social contacts may still feel lonely and one with infrequent social contact may not feel lonely (Heinrich & Gullone, 2006). Thus, the objective number of social contacts is less consequential when looking at the subjective distress of loneliness and its impact on health and quality of life. As such, loneliness is synonymous with social frailty as a function of decreased social engagement and dysfunctional social participation (Makizako et al., 2018).

Social relationships are increasingly important in older age, especially in the context of today's healthcare environment where there is diminished availability and access to formal care and support for older adults. Recent data from the Irish Longitudinal Study on Ageing showed

while most older adults were not often lonely, living alone, lower level of education, and physical disability predisposed older adults to loneliness (Ward et al., 2020). Pre-frail and frail older adults were lonelier and had a smaller social network than robust older adults (Hoogendijk et al., 2016). Low social participation and poor social relationships represent increased risk for disability onset in community-dwelling older adults (Makizako et al., 2015). Loneliness is linked to adverse outcomes, including depression (Cacioppo et al., 2010), cognitive impairment (Lara et al., 2019), and mortality (Holt-Lunstad et al., 2015). Additionally, loneliness leads to increased healthcare utilization and, thus, increased healthcare costs (Heinrich & Gullone, 2006). Functional status influences social participation in older adults. Physical frailty may confound levels of social frailty as individuals may be restricted in their movements due to functional or mobility issues rather than intentional social disengagement**.** Furthermore, loneliness is linked to increased risk for physical frailty and functional decline (Gale et al., 2018). The causal relationship between disability and loneliness appears to be reciprocal, where the presence of one leads to the other. Thus, interventions to alleviate loneliness in community-dwelling older adults may delay the risk of frailty and disability onset.

In today's healthcare environment, where there is reduced funding of formal care and support, particularly following hospital discharge, older adults increasingly rely on informal social networks for assistance and support. Individuals with diminished or dysfunctional social networks have fewer social resources to draw on for physical or emotional assistance. Importantly, a decline in social roles and social disengagement precedes the development of functional disability in non-frail older adults (Makizako et al., 2018; Pek et al., 2020). Social functioning requires a higher level of engagement, and a decrease in functioning is likely to precede disability in instrumental activities of daily living (Makizako et al., 2018). Furthermore,

studies have found perceived social support and social support utilization can mediate effects of frailty on depression in older adults (Jin et al., 2020). This mediating effect of social relationships on frailty and syndromes such as depression that may accompany frailty supports the underlying assumption of this study of a social intervention to target physical frailty. As a precursor to physical frailty, interventions that target social frailty exploit the opportunity for early intervention to prevent the development of physical frailty.

This topic is also timely, considering the ongoing COVID-19 pandemic. The morbidity and mortality burden of COVID-19 is disproportionately shouldered by older adults (Petrilli et al., 2020). Additionally, frail older adults have worse outcomes and are more likely to die from COVID-19 (Hewitt et al., 2020). Aside from the cost in years of life and health due to disease, the toll of necessary public health measures to contain the pandemic such as lockdowns, physical distancing, and isolation on older adults is beginning to emerge and could potentially be catastrophic in terms of diminished social contact, increased loneliness, increased mental health challenges, reduced physical function, and fragmentation of care. Recent data from the Irish Longitudinal Study on Ageing reported an increase in loneliness in older adults since the start of the COVID-19 pandemic, particularly in individuals living alone and those with disability or multimorbidity (Ward et al., 2020). One international survey revealed that social isolation was positively associated with psychological distress in older adults, and levels of distress were positively associated with geographic COVID-19 mortality rates (Kim & Jung, 2020). Inequitable access to digital technologies, such as smart phones and other electronic devices that connect people to others while physically distanced, can exacerbate social frailty among certain groups that are already at higher risk for physical and social frailty, including socioeconomically disadvantaged and less educated populations that may have less access to devices and lower

digital literacy. More studies are sure to come as the pandemic and associated control measures continue.

There are clear, often reciprocal relationships among social disengagement, loneliness, cognitive impairment, comorbidities, disability, hospitalization, institutionalization, and physical frailty. These factors combined play a role in the ability of older adults to remain functionally independent and living in the community. Since social frailty and loneliness lead to the development of physical frailty, interventions to reduce social frailty and loneliness can reduce risk of physical frailty and associated adverse outcomes in this population.

Frailty Prevalence Trends

Prevalence estimates of frailty in older adults vary based on frailty measures, age, region, and living environment (community-dwelling versus institutionalized). In the absence of a gold standard defining frailty, prevalence rates in community-dwelling adults aged 65 and older vary widely from 4-59%, across multiple frailty measures (Buckinx et al., 2015; Collard et al., 2012), which presents a potentially large population at risk. Reportedly, frailty prevalence in community-dwelling older adults was an estimated 11%, and pre-frailty was estimated to be 42% (Collard et al., 2012). Trends suggest frailty increases with age; affects more women than men; is greater among African Americans than Caucasians; and is more prevalent among people with lower education, lower income, and higher rates of comorbidities (Buckinx et al., 2015; Collard et al., 2012; Feng et al., 2017; Xue, 2011). Feng et al. (2017) further noted that living in a high-density neighborhood and having low socioeconomic status and insurance status are positively associated with frailty. Additionally, nursing home residents are more likely to be frail than community-dwelling people; however, institutionalization could be a consequence of frailty itself (Buckinx et al., 2015). These prevalence trends are consistently found in studies conducted

worldwide with increased frailty prevalence in middle-income countries compared to high-income countries (Siriwardhana et al., 2018).

Reported prevalence of social frailty is unclear related to lack of a standardized social frailty measure; thus, loneliness trends are considered here alongside social frailty. Several studies have reported prevalence of social frailty in specific populations of community-dwelling older adults. One study conducted in Singapore found 7.4% of community-dwelling older adults were socially frail and 28.8% were pre-frail (Pek et al., 2020). Another study of 1,697 Chinese community-dwelling older adults reported a social frailty prevalence of 7.7% (Ma et al., 2018). A study of Japanese older adults reported social frailty prevalence was 18% (Yamada et al., 2018). Social frailty rates may vary widely by geographic regions as well as by mode of evaluation. Similarly, prevalence estimates of loneliness vary widely across available studies due to variability in loneliness measures, age, and populations used. A longitudinal study of 1,604 participants reported loneliness in U.S. adults over the age of 60 was up to 43% (Perissinotto et al., 2012). Additionally, the U.S. Census Bureau regularly collects information on relevant social indicators such as living situation and marital status. According to census data, the likelihood of living in a family household declined with age, and the likelihood of living alone increased with age (Roberts et al., 2018). Women were more likely to be widowed and less likely to be married with older age (Roberts et al., 2018). Men aged 65 and older were more likely to be married, reflecting the longer life expectancy for women compared to men (Roberts et al., 2018). Functional disability, particularly difficulty walking or climbing stairs, also increased with age (Roberts et al., 2018). These social conditions, particularly mobility restrictions and living alone, confer increased health risk as well as increased potential for disrupted social connection.

Interventions for Social Frailty and Loneliness

Interventions for loneliness are considered here as a proxy for social frailty. Various interventions were proposed for loneliness, including one-on-one interventions such as befriending or mentoring and group and community-wide interventions (Cacioppo et al., 2015). Interventions that increased social support such as bereavement groups and other support groups were also conducted to decrease loneliness (Masi et al., 2011). Additional loneliness models proposed reducing loneliness by increasing opportunities for social engagement such as group activities, animal-assisted therapy, or teaching social skills (Cacioppo et al., 2015; Orourke et al., 2018). Some interventions were designed to increase social interaction, including community blood pressure check programs and senior food distribution programs (Masi et al., 2011). Cognitive behavioral therapy was also utilized as an intervention for loneliness (Cacioppo et al., 2015). Importantly, interventions that provided social engagement opportunities or social support and those designed to improve social skills improved loneliness; however, the effect size was small, compared to interventions that implemented social cognition therapy (Masi et al., 2011). These interventions targeted social isolation rather than loneliness, which may explain the lack of effectiveness as a loneliness intervention (Masi et al., 2011). Comparatively, addressing maladaptive social cognition targeted quality of social interaction, which directly addressed loneliness and was more effective in terms of reduced loneliness (Masi et al., 2011). The various loneliness interventions explored in the literature targeted a variety of different aspects of loneliness and social isolation. More clarity is needed on what conceptual factors the interventions are targeting in order to gauge effectiveness (Orourke et al., 2018).

The concept of social frailty is especially important during the COVID-19 pandemic, where older adults have been increasingly isolated for over a year at the time of this writing

(April 2021). The assumption is not that all older adults are lonely due to pandemic control measures such as social distancing since, as discussed previously, not all individuals who are alone are lonely and not all individuals who are lonely are alone. However, it is safe to assume that with increased isolation that is not chosen or desired, loneliness will increase.

Pets as an Intervention

The use of live pets as an intervention for older adults is well established in the literature, particularly to improve psychosocial well-being. Robotic pets are an artificial intelligence system designed with animal-like qualities that can potentially mimic therapeutic benefits of live pets without safety or infection control issues. The therapeutic benefits of live pets are well established (Cherniack & Cherniack, 2014). However, live pets often present issues for older adults, including cost, housing, and mobility issues that preclude caring for a pet. Given these barriers to pet ownership for older adults, robotic pets offer a potentially practicable alternative.

Goal-directed therapy with live animals is often termed animal-assisted therapy (AAT) in the literature. Animal-assisted therapy improves social engagement and cognitive function and increases physical activity (Chang et al., 2020). AAT showed consistent benefit for depression and loneliness (Chang et al., 2020; Kojima et al., 2020; Lai et al., 2019), especially interventions using dogs (Chang et al., 2020). Many of the studies on AAT in older adults were conducted with older adults in institutionalized settings and older adults with dementia (Lai et al., 2019). Studies have also investigated the effects of personal pet ownership on older adults living in the community. They found that pet ownership was associated with decreased loneliness in older adults who lived alone (Stanley et al., 2015). Pet ownership was also associated with a lower risk of physical frailty in older adults, potentially because of the physical demands associated with caring for a pet (Kojima et al., 2020). Older pet owners were more likely to walk, had higher

levels of physical activity and fewer sedentary behaviors, and maintained their activities of daily living (ADLs) (Kojima et al., 2020).

Robotic pets were explored as an alternative to live pets for older adults. Several studies investigated the impact of robotic pets on the physical and mental health of older adults in a variety of settings. Not all pets used in these studies are commercially available. As with AAT, most studies were conducted in institutionalized settings (Pu et al., 2019). Most studies on robotic pets in older adults assessed older adults with dementia, and most were conducted in nursing homes (Abdi et al., 2018; Chen et al., 2018; Pu et al., 2019). The seal robot Paro was the most utilized pet robot, particularly with older adults with dementia (Abdi et al., 2018; Pu et al., 2019). Robotic pets reduced loneliness (Khosravi et al., 2016; Pu et al., 2019), depression (Chen et al., 2018), stress, and medication use in older adults (Pu et al., 2019).

Several studies investigated the use of the same robotic pet as was used in the present study. The pet reduced loneliness in hospitalized older adults (Wexler et al., 2018) and older adults living in the community (Hudson et al., 2020; Tkatch et al., 2020). A randomized controlled trial showed that the robotic pet reduced falls, delirium, and the use of 1:1 sitters in hospitalized older adults (Wexler et al., 2018). In community-dwelling older adults, the robotic pet improved quality of life and psychological well-being (Tkatch et al., 2020). Greater interaction with the robotic pet was associated with more positive outcomes, including improved mental well-being and optimism (Tkatch et al., 2020). Qualitative data regarding the use of the robotic pet in community-dwelling older adults showed that the pet was most effective for alleviating loneliness in older adults who lived alone, had fewer social connections, and lived less active lifestyles (Hudson et al., 2019).

Different pets have different utilities and are worth investigating in a wider range of older adults. This may be particularly applicable for pets that are similar to house pets and may be part of the cultural experience of the participants, such as dogs and cats rather than a seal, for example. Additionally, these reviews identified gaps in the current research base that require further examination, including studies with various robotic pets, in various populations and settings with adequate sample sizes to evaluate effectiveness of the intervention. Additionally, methodological weakness found in the current evidence base included a lack of specific outcome measures (Abbott et al., 2019; Abdi et al., 2018), small sample sizes, and a dearth of randomized controlled trials (RCTs) (Bemelmans et al., 2012; Chen et al., 2018); thus, the effectiveness of the robotic pet was difficult to evaluate quantitatively. This may be a contributory factor to slow adoption of robotic pets in the routine care of older adults, since the added value this intervention may provide is still unclear in the literature in terms of patient outcomes. While preliminary results from robotic pet studies have indicated the positive effects of this intervention, Bemelmans et al. (2012) noted that for a robotic pet intervention to be potentially reimbursable by health plans, there must be a clear link between the intervention and health outcomes.

No studies were found in the literature investigating the impact of robotic pets on social and physical frailty in community-dwelling older adults. One can expect this population to be more functionally intact in the sense that it is able to live independently in the community. The potential impact of robotic pets on this population is not as well studied. The present study attempted to fill the gap on the impact of a robotic pet specifically on social and physical frailty in community-dwelling older adults.

Older Adults and Technology

For the abovementioned technologies to be efficient and successful, older adults must be willing and able to use them. A 2017 PEW Foundation report noted while older adults have lower rates of technology adoption than the general population, more older adults, particularly those who are younger, more affluent, and more educated, reported owning and using various technologies at rates similar to adults under the age of 65 (Anderson & Perrin, 2017). Notably, the age and demographics of the population with higher rates of technology use were inversely related with those at highest risk of frailty and loneliness. This is important to consider when designing a technology intervention for older adults with frailty. According to the PEW report, 4 in 10 adults over the age of 65 owned smartphones, up 24% from 2013 (Anderson & Perrin, 2017). Additionally, an increasing number of older adults use the internet and/or have an internet connection at home, particularly the young-old age group. Some barriers to technology use include physical challenges and comfortability with technology, but most seniors reported a positive view of technology (Anderson & Perrin, 2017).

Some barriers to technology adoption in this age group are related to age-related sensory or cognitive decline and a lack of technical support (Heart & Kalderon, 2013). According to U.S. Census Bureau data, 80% of people aged 65 and older in the United States lived in a household that has a computer and 76% lived in a household with internet access. The number of people over aged 65 living alone with internet access declined with age, with only 55% of people aged 85 and older with internet access (Roberts et al., 2018). Heart and Kalderon (2013) reported the primary reason for non-use was a perceived lack of need; however, if convinced the technology conferred significant benefits, older adult users were willing to make the effort or acquire new, technology-related skills.

Several qualitative and mixed-methods studies investigated older adults' acceptance and perception of robotic technology specifically to inform development and user-friendly design for robotic technologies. The needs and preferences of the target population are critical in the design of these products for maximal impact. Older adults found robots useful for domestic tasks (Hall et al., 2019) and expressed a stronger preference for service-oriented robots, compared to companion robots or a robot that can fulfill functional and companionship needs (Chu et al., 2019). Frail older adults preferred robots that were able to assist where their functional capabilities were diminished, such as for household chores, reminders about medications and appointments, and other day-to-day tasks (Garcia-Soler et al., 2018). This was a theme across studies describing technology, and the service robot specifically, as a tool for the maintenance of independent living in older age (Chu et al., 2019; Garcia-Soler et al., 2018; Hall et al., 2019; Peek et al., 2016). Participants also expressed a preference for human-like robots compared to machine-like robots (Bedaf et al., 2019; Chu et al., 2019). Moreover, older adults preferred the robot to be unobtrusive (Bedaf et al., 2019). The most universal concern regarding service robots in one study that conducted focus groups among individuals in three different countries found that older adults agreed service robots should be customized according to the personal preferences of the user in appearance, communication, data collection, and task execution (Bedaf et al., 2019).

Several studies investigated the use of the robotic pet as a social companion in a variety of settings and populations and with various study designs. Some studies implemented a group intervention, and some utilized an individualized intervention (Birks et al., 2016; Robinson et al., 2013). A group intervention may influence results in a study that investigates the use of the robot as a social companion because the social aspect of the group setting may confound results. The

same could be said for a robotic pet intervention in a facility setting compared to the home setting since the facility setting has a different level of social interaction as an older adult may have living at home.

One particular concern related to robotics and other assistive technologies is that financial cost increases with the level of complexity of the technology. This is an important factor to consider, particularly for the older adult population with limited financial resources. This is particularly true for smart technologies such as service robots that require complex algorithms in order to meet the personal needs and preferences of individual users.

Older Adults and COVID-19

Older adults are at increased risk for severe illness, hospitalization, and death related to COVID-19 infection (Centers for Disease Control and Prevention [CDC], 2020). In addition to the significant morbidity and mortality burden in this age group related to COVID-19, necessary pandemic control measures instituted by the state, such as mandatory shelter in place and social distancing measures, significantly increase the risk for social isolation, loneliness, mental health challenges, physical disability, and cognitive decline. These public health measures, while necessary to curb the spread of the virus, can result in social isolation and a precipitous decline in physical activity, which can lead to deconditioning, weakness, falls, and frailty. Importantly, social distancing measures may lead to reduced availability of formal and informal social and functional supports on which community-dwelling older adults rely, from professional services to decreased interaction with family, in order to avoid exposure. Additionally, overall nutrition status may be affected by changes in food availability due to sheltering in place or simply avoiding public exposure in places like the supermarket. These public health measures are necessary and important to curb morbidity and mortality related to COVID-19 infection;

however, interventions to address the myriad sequelae of extended periods of social distancing should be prioritized to minimize and mitigate adverse health effects. Interventions may include utilizing technologies to maintain social connection, including the telephone, social media, video games, online video chats, and robotic pets. These interventions were positively related to decreased loneliness (Khosravi et al., 2016). Caring for a pet at home and robotic pet companions are also a means of social engagement during socially distant times. Physical activity interventions are also crucial and can be moved to online platforms in place of physical meetings. The pandemic has forced individuals and groups to be inventive in adapting to life while being physically and socially distanced, and technology is one innovative way to maintain well-being while remaining conscious of public health behaviors.

Chapter III

RESEARCH DESIGN AND METHODS

Design and Methods

This study was a randomized controlled trial in which participants who met inclusion criteria were randomized to the intervention group or the control group via a computer-generated randomization table. Participants from designated inpatient units who met inclusion/exclusion criteria were recruited prior to discharge from the hospital. Eligible participants were drawn from two inpatient units with a high number of daily discharges. Participants were recruited during their hospital stay and enrolled prior to discharge. This was done to eliminate a home visit due to the ongoing COVID-19 pandemic and related control measures. The Principal Investigator (PI) worked in conjunction with care management teams on the unit to determine which patients were likely to be discharged within 72 hours in order to approach patients as close to discharge as possible.

The technological intervention consisted of a robotic pet that looks, feels, and vocalizes like a live animal and a discharge phone call. Intervention group participants also received a post-discharge phone call from an Advanced Practice Registered Nurse (APRN) or Registered Nurse (RN) in addition to usual post-discharge care (i.e., home care services, outpatient physical therapy, follow-up appointments, etc.). The control group received a discharge phone call from an APRN or RN in addition to usual post-discharge care. All study instruments were administered at the enrollment point and at the 30-day discharge point. Pre- and post-outcomes were compared in both groups.

Intervention

Participants randomized to the intervention group received a robotic dog or cat, pictured in Figure 3. The robot utilized in this study was developed by Ageless Innovation and is designed to provide companionship and comfort for older adults, similarly to a live pet (Ageless Innovation, n.d.). The robotic pet is a life-like, interactive pet covered with soft fur. The pet responds to petting, hugging, and motion via built-in sensors and produces animal-like sounds such as purring, meowing, and barking. The pet is powered by four size C batteries that accompany the pet upon purchase (Ageless Innovation, n.d.).

Technical instructions on how to use the pet were given, according to the manufacturer. No parameters were given in terms of how or how often to interact with the pet; participants were encouraged to utilize the pet in a personalized manner. Each pet was for individual use. The participant received the pet at the enrollment point and was allowed to keep the pet after the study. Additionally, the participant received a discharge phone call within 48 hours after discharge. Control group participants followed the discharge plan determined by the hospital team prior to discharge and received a discharge phone call within 48 hours after discharge.

There is a dearth of evidence for the required frequency and duration of use of robotic pets for maximum therapeutic effect. Based on the Principal Investigator’s experience with previous studies analyzing the impact of the robot over a short timeframe, a 1-month study period was utilized for this study (Wexler et al., 2018). The 30-day post-discharge period represents the high-risk readmission window. Thus, the potential impact of this intervention can be important during this high-risk period.

Figure 3. *Robotic Pets*

Sample

The population for this study was drawn from a sample of hospitalized individuals aged 65 and over, staying at a 292-bed, not-for-profit community hospital in Westchester County, New York, who were discharged home from inpatient units. The hospital serves Westchester County and surrounding areas, with most of the patient population originating from the central and southern areas of the county.

A power analysis was performed to determine sample size. The analysis included a two-tailed t-test with same-subject groups, as the same individuals were compared before and after the intervention. Additionally, an effect size of 0.2 was used, as the researcher posited a conservative improvement in outcomes in an at-home setting with potentially less frail older adults, compared to institutionalized or hospitalized older adults. A significance level of 0.05 and a power of 0.8 were utilized for this power analysis and yielded a total sample size of $n = 199$. An estimated 10% loss to follow-up was expected, based on previous work with robotic pets in older adult populations (Wexler et al., 2018). Loss to follow-up was expected due to inability to contact participants after discharge, lack of interest in participating post-discharge, or a lack of interest in using the technology once enrolled. Additionally, the nature of this population was such that there was the potential for mortality due to older age, frailty, and comorbidities. The final sample size resulting from this analysis was $n = 219$.

Data Collection/Study Procedures

Participants were recruited from two inpatient units with a large number of daily discharges. One unit was a step-down telemetry unit, and the other unit was a medical surgical telemetry unit. All patients who met the inclusion criteria were approached for recruitment. Inclusion criteria were: (a) age 65 and over, (b) discharge to home or assisted living residence,

and (c) able to provide informed consent. Exclusion criteria were: (a) nursing home resident, and (b) non-domiciled. Eligible patients were approached for recruitment by the PI, informed about the study, and invited to participate. For patients who agreed to participate, informed consent was obtained at the time of recruitment. Participants were randomized to the intervention group or the control group via a computer-generated randomization table. Participants randomized to the intervention group chose either a robotic dog or robotic cat and took it home with them after discharge. The PI demonstrated use of the robot and verified the participant understood how to use it. Study instruments were administered to participants randomized to both groups following informed consent. Participants in both groups received a standardized discharge phone call from an APRN or RN within 24-48 hours after discharge. The post-discharge phone call is part of routine post-discharge care at this hospital to check in with the patient and ensure needs are met post-discharge, such as medications and follow-up appointments. The phone call is also used to reinforce nursing education, such as medication education, wound care, and post-operative teaching.

Demographic data were obtained through both the electronic medical record (EMR) and self-report (see Appendix A for demographic data collection form). Demographic variables including age, gender, education, race/ethnicity, marital status, living arrangements, pet ownership, and discharge disposition were collected. These data were used to describe the sample population.

Outcomes

This study compared outcomes on social and physical frailty in community-dwelling older adults before and after the intervention. The primary outcomes for this study were physical and social frailty. Secondary outcomes for this study were cognitive function and depression.

Instruments

All instruments were administered at two points in time—at enrollment and at discharge—for both the intervention and control groups.

Social Frailty

Social frailty was measured using the Questionnaire to Define Social Frailty Status (QDSFS). The five questions included in this questionnaire are based on self-report. This questionnaire was validated by Makizako et al. (2015) in a longitudinal cohort study that included 4,304 Japanese older adults and has since been utilized in other studies (Park et al., 2019; Tsutsumimoto et al., 2017). The questions were significantly related to incident disability in community-dwelling older adults (Makizako et al., 2015). Two of the abovementioned studies utilized the same community-dwelling population cohort in Japan (Makizako et al., 2015; Tsutsumimoto et al., 2017). The five questions assessed social frailty status of participants (refer to Appendix B). Since the implementation of the current study, other studies that further explored the use of social frailty scales have been published. A study by Park et al. (2019) utilized the same social frailty questionnaire with a population based in South Korea. No studies were found using this questionnaire in other countries. Pek et al. (2020) used factor analysis to validate questions previously used to evaluate social frailty in a population of Asian older adults. Their eight-item questionnaire included four of the items used in this study, with the addition of the following questions:

- Do you turn to friends or family for advice?
- Do you eat with someone at least one time in a day?
- Do you have someone to confide in?

- Are you limited by your financial resources to pay for needed medical service? (Pek et al., 2020).

Physical Frailty

Physical frailty was measured using the FRAIL questionnaire. The FRAIL questionnaire was a publicly available tool developed by the American Geriatric Advisory Panel to rapidly identify individuals at risk for frailty in busy clinical environments. This questionnaire was intended to identify individuals who would most benefit from the more intensive, time-consuming geriatric assessment and targeted interventions to prevent adverse outcomes associated with frailty (van Kan et al., 2008). The FRAIL questionnaire was an interview-based instrument which was easily administered via five questions to identify individuals with frailty (refer to Appendix C). The questionnaire did not need to be administered by a clinician or trained provider and does not require a face-to-face examination. The questionnaire consists of five domains, including fatigue, resistance (inability to climb one flight of stairs), ambulation (inability to walk one block), illness (more than five comorbidities), and loss of weight (more than 5% of body weight) (van Kan et al., 2008). Frail scores range from 0-5. A score of 3-5 is considered frail; 1-2 pre-frail; and 0 represents robust health status (van Kan et al., 2008). For this study, fatigue was measured by asking participants how much time during the past 4 weeks they felt tired. Responses of “All of the time” or “Most of the time” were scored 1 point. Resistance was assessed by asking participants if they had trouble walking up 10 steps alone without resting and without ambulatory aids. Ambulation was assessed by asking if they had difficulty walking several hundred yards alone and without aids; “Yes” responses equal 1 point. Illness was scored 1 for participants who self-reported a medical diagnosis of 5 or more chronic illnesses, defined as a condition lasting more than 3 months. This was validated by EMR review

if the participant could not answer. Loss of weight was scored 1 for participants reporting weight loss of 5% or more within the past 12 months. This questionnaire was validated in several studies in comparison to other validated frailty assessment tools and in various populations (Malmstrom et al., 2014; Maxwell et al., 2018; Morley et al., 2012; Woo et al., 2015). In contrast to the frailty phenotype which requires performance measures and the Frailty Index which requires collection of a number of deficits, the FRAIL questionnaire was a validated tool that, similarly to the frailty phenotype, includes a range of frailty definitions, including robust, pre-frail, and frail (Kojima, 2018).

Cognitive Function

Cognitive function was measured using the Short Portable Mental Status Questionnaire (SPMSQ). The SPMSQ is a 10-question instrument that assesses cognitive status (refer to Appendix D). On the SPMSQ, 0-2 errors indicate normal mental functioning; 3-4 errors indicate mild cognitive impairment; 5-7 errors indicate moderate cognitive impairment; 8 or more errors indicate severe cognitive impairment (Pfeiffer, 1975). One additional error was allowed for individuals with less than a high school education and one less error was allowed for individuals with education beyond high school (Pfeiffer, 1975).

Depression

Depression was assessed using the Geriatric Depression Scale—Short Form (GDS-SF). The GDS-SF is a 15-item screening questionnaire for depression in older adults (refer to Appendix E). Scores 0-4 are considered normal; scores of 5-8 indicate mild depression; scores of 9-11 indicate moderate depression; scores of 12-15 indicate severe depression (Yesavage et al., 1983). Cognitive function and depression can confound frailty scores; thus, these scores were accounted for in the analysis.

Enjoyment

The Perceived Enjoyment Questionnaire (PEQ) (Heerink et al., 2008) was adapted for this study to establish the relationship between perceived enjoyment and intention to use the technology. This questionnaire was previously validated for use with robots as social companions and aligned with the theoretical basis for this study, such that if the robot was deemed useful and enjoyable as a social companion to the user, he or she was more likely to use it. This questionnaire was administered to intervention group participants post-intervention to examine the relationship between intention to use this technology and the impact on the primary and secondary outcome variables (refer to Appendix F).

Data Analysis

All study data were summarized with descriptive statistics. Continuous variables were summarized with means, standard deviations, medians, and ranges. Categorical variables were summarized with counts and percentages. Data were summarized overall and separately by each group. Continuous outcomes were compared between groups using t-tests or Wilcoxon rank sum tests, as appropriate. Categorical outcomes were compared between groups using chi-square tests or Fisher's exact tests, as appropriate. In addition, groups were compared on QDSFS and FRAIL, while controlling for possible differences in depression (GDS) and cognitive (SPMSQ) scores using regression modeling methods. Data were entered into the Statistical Package for the Social Sciences Software (SPSS, Inc., Chicago, IL). Statistical analysis was performed using SPSS software (SPSS, Inc., Chicago, IL). The threshold for statistical significance was considered a p value of less than or equal to 0.05.

Human Subjects

Approval for this study was obtained from the Institutional Review Boards (IRBs) of the university and the hospital (refer to Appendix G for Institutional Review Board approval letters). Eligible subjects were all patients aged 65 and over who were being discharged home. Each subject was approached by the PI, informed about the study, and invited to participate. It was made clear that participation was voluntary and refusal to participate would in no way affect their care or treatment in the hospital or post-discharge. Individual informed consent was obtained from all participants prior to enrollment. Participants could withdraw from the study at any time. Study data were separated from any identifying information, and individual study ID numbers were used to track individuals. Only the PI had access to these codes which were maintained in her password-protected computer in her office.

Chapters IV

RESULTS

This chapter discusses the results of the study, including a description of the population and study outcomes. The main purpose of this study was to examine the effect of a robotic pet on social and physical frailty in community-dwelling older adults. The primary outcomes of the study were change in social frailty and physical frailty in the intervention group, compared to the control group, while controlling for cognitive status and depression. The secondary outcomes of this study were change in cognitive status and depression in the intervention group, compared to the control group.

Sample Characteristics

The researcher enrolled 220 participants in the study: 107 in the intervention group and 113 in the control group. All eligible participants—namely, those aged 65 and over who were expected to be discharged home and were admitted to two inpatient units—were approached for recruitment to the study. The main reasons for refusal were lack of interest, concern about sharing personal information, already having pets at home, or feeling too ill to participate in a research study. If the participant could not provide informed consent and a proxy was unavailable to consent, the participant was not enrolled. At the start of the study in September 2020, hospital policy denied visitation due to pandemic control measures. This policy was later changed to allow very limited visitation (4-6 p.m., limited to one designated visitor); thus, potential participants generally did not have family present at the bedside, as was common prior to the pandemic. If proxy consent was required, they were called via phone by the Principal Investigator (PI). Most participants enrolled in this study were able to consent on their own. One participant required consent via proxy, which was obtained while the proxy was visiting with the

patient. Three participants requested that the PI speak to their daughters prior to enrollment; the PI reached the family members via phone at a phone number provided by the participant, and the participant was enrolled following the phone call. Twenty-three participants in the intervention group and 23 participants in the control group dropped out of the study, reflecting a 20% loss to follow-up. Seven participants in the intervention group and two in the control group died prior to discharge from the study. Three participants in the intervention group and two in the control group withdrew voluntarily. Reasons given were feeling too ill or overwhelmed to respond to study questionnaires, lack of interest, or concern about sharing personal information. One participant in the intervention group withdrew due to concern about hallucinations related to the robotic pet and privacy concerns in the presence of the robot. Thirteen participants from the intervention group and 19 from the control group were unreachable by phone for disenrollment either due to a wrong number or not responding to phone call or voicemail at the phone number provided during enrollment. If participants were unreachable by the phone number they provided at enrollment after three attempts, additional attempts were made to reach out to the patients' listed contacts in their medical record. Because this was an exploratory study, there was no plan for imputation of missing data. Only observed data were analyzed. The final sample included 220 participants, 107 in the intervention group, and 113 in the control group. Data were collected over a 6-month period. The enrollment period for all participants was 30 days.

Demographic characteristics of the sample are presented in Table 1. The baseline characteristics were similar in the two groups, except for gender. There was an imbalance in genders between the two groups ($p = 0.02$), with more males in the control group. The mean age of participants was similar in the intervention and control groups (76.5, SD 7.66 vs. 75.7, SD 7.85, respectively). The median age for intervention group participants was 76, and the median

age of control group participants was 74, with a range of 65-93 for both groups. For both groups, most participants were female, White/Caucasian, with more than 12 years of education. Participants were most commonly married or widowed. Other than gender, no statistically significant differences were found between the two groups in any of the demographic characteristics.

Table 1. *Sample Characteristics*

Characteristic	Statistic/Category	Intervention (N = 107)	Control (N = 113)	P-Value
Sex	Female	90 / 107 (84.1 %)	80 / 113 (70.8 %)	0.02
	Male	17 / 107 (15.9 %)	33 / 113 (29.2 %)	
Age (yrs)	N	107	113	0.45
	Mean±SD	76.5 ± 7.66	75.7 ± 7.85	
	Range	65.0 to 93.0	65.0 to 93.0	
	Median	76.0	74.0	
Marital Status	Divorced	17 / 107 (15.9 %)	14 / 113 (12.4 %)	0.17
	In relationship	1 / 107 (0.9 %)	0 (0.0%)	
	Married	44 / 107 (41.1 %)	62 / 113 (54.9 %)	
	Single, never married	5 / 107 (4.7 %)	7 / 113 (6.2 %)	
	Widowed	40 / 107 (37.4 %)	30 / 113 (26.5 %)	
Race	Asian	0 (0.0%)	1 / 113 (0.9 %)	0.99
	Black/African American	17 / 107 (15.9 %)	18 / 113 (15.9 %)	
	Hispanic/Latino	4 / 107 (3.7 %)	4 / 113 (3.5 %)	
	White/Caucasian	86 / 107 (80.4 %)	90 / 113 (79.6 %)	
Education	2 years college	14 / 107 (13.1 %)	10 / 113 (8.8 %)	0.25
	4 years college	12 / 107 (11.2 %)	25 / 113 (22.1 %)	
	Grade school or less	7 / 107 (6.5 %)	5 / 113 (4.4 %)	
	High school	38 / 107 (35.5 %)	37 / 113 (32.7 %)	
	Graduate school/ Postdoc	36 / 107 (33.6 %)	36 / 113 (31.9 %)	
Ambulatory Device	No	66 / 107 (61.7 %)	72 / 113 (63.7 %)	0.76
	Yes	41 / 107 (38.3 %)	41 / 113 (36.3 %)	
House Pets	No	82 / 107 (76.6 %)	83 / 113 (73.5 %)	0.59
	Yes	25 / 107 (23.4 %)	30 / 113 (26.5 %)	

Table 1 (continued)

Characteristic	Statistic/Category	Intervention (N=107)	Control (N=113)
Living Arrangements	Assisted living	1 / 107 (0.9 %)	0 (0.0%)
	Lives alone	38 / 107 (35.5 %)	32 / 113 (28.3 %)
	Lives with children	25 / 107 (23.4 %)	16 / 113 (14.2 %)
	Lives with roommates/other	2 / 107 (1.9 %)	3 / 113 (2.7 %)
	Lives with spouse	41 / 107 (38.3 %)	62 / 113 (54.9 %)
Discharge Disposition	Died	1 / 107 (0.9 %)	0 (0.0%)
	Home with services	47 / 107 (43.9 %)	43 / 113 (38.1 %)
	Rehab	10 / 107 (9.3 %)	3 / 113 (2.7 %)
	Self/home	48 / 107 (44.9 %)	66 / 113 (58.4 %)
	Transferred to acute facility	1 / 107 (0.9 %)	1 / 113 (0.9 %)
Reason for withdrawal	Died	7 / 23 (30.4 %)	2 / 23 (8.7 %)
	Unreachable	13 / 23 (56.5 %)	19 / 23 (82.6 %)
	Withdrew voluntarily	3 / 23 (13.0 %)	2 / 23 (8.7 %)

Most participants were discharged home, with or without home care services. Eleven participants in the intervention group and four from the control group were discharged to a rehabilitation facility or transferred to another acute care facility; all of these patients were admitted from home and targeted for discharge home at the time of study enrollment. One participant in the intervention group died prior to discharge from the hospital. In the intervention group, 35.5% of participants lived alone, compared to 28.3% of the control group. In the intervention group, 38.3% of participants lived with a spouse, compared to 54.9% of the control group. In the intervention group, 23.4% of participants lived with children, compared to 14.2% of the control group. A small number of participants lived with a roommate or siblings, or in an assisted living facility.

Specific Aims, Hypotheses, and Research Questions

Specific Aim 1

To explore the impact of a robotic pet on the incidence of social and physical frailty in a population of community-dwelling older adults over age 65 who were recently hospitalized, compared to usual post-discharge care.

The main finding of this study was that there was no difference in percentage change in social or physical frailty between the two groups. The five-item Questionnaire to Define Social Frailty Status (QDSFS) was utilized to assess social frailty in this study (Makizako et al., 2015). Results are presented in Table 2. A score of 0 indicated robust status. A score of 1 indicated social pre-frailty, and a score of 2 or more indicated social frailty. Social frailty status was similar in both groups at baseline, with 3.7% of intervention group participants and 3.5% of control group participants being robust; 23.4% of intervention group participants and 29.2% of control group participants were socially pre-frail; 72.9% of intervention group participants and 67.3% of control group participants were socially frail. The average scores for the intervention group and control group were 2.1 and 2.0, respectively (SD 0.98 vs. 0.93). The average change in scores between the two groups was 0.2 in the intervention group and 0.1 in the control group (SD 0.75 vs. 0.84). There was no significant change in social frailty status between the two groups ($p = 0.42$), even after controlling for possible differences in depression (GDS, $p = 0.98$) and cognitive function (SPMSQ, $p = 0.34$), and after adjusting for age ($p = 0.39$), sex ($p = 0.31$), race ($p = 0.54$), education ($p = 0.26$), marital status ($p = 0.51$), and living arrangements ($p = 0.41$).

Table 2. *Effects of Robotic Pet on Social Frailty*

Characteristic	Statistic/Category	Intervention (N = 107)	Control (N = 113)	P-Value
QDSFS admin (categorized)	0:Robust	4 / 107 (3.7 %)	4 / 113 (3.5 %)	0.60
	1:Pre-Frail	25 / 107 (23.4 %)	33 / 113 (29.2 %)	
	2+:Frail	78 / 107 (72.9 %)	76 / 113 (67.3 %)	
QDSFS dc (categorized)	0:Robust	3 / 84 (3.6 %)	2 / 90 (2.2 %)	0.33
	1:Pre-Frail	11 / 84 (13.1 %)	19 / 90 (21.1 %)	
	2+:Frail	70 / 84 (83.3 %)	69 / 90 (76.7 %)	
QDSFS admin	N	107	113	0.22
	Mean±SD	2.1 ± 0.98	2.0 ± 0.93	
	Range	0.0 to 5.0	0.0 to 5.0	
	Median	2.0	2.0	
QDSFS dc	N	84	90	0.21
	Mean±SD	2.3 ± 1.00	2.2 ± 0.95	
	Range	0.0 to 5.0	0.0 to 4.0	
	Median	2.0	2.0	
QDSFS Change	N	84	90	0.42
	Mean±SD	0.2 ± 0.75	0.1 ± 0.84	
	Range	-1.0 to 2.0	-2.0 to 2.0	
	Median	0.0	0.0	

The five-item FRAIL scale was used to assess physical frailty (van Kan et al., 2008). Results are presented in Table 3. A score of 0 was considered robust. A score of 1-2 was considered physically pre-frail. A score of 3 of more was considered physically frail. The number of robust participants at baseline was 23.4%, compared to 34.5% of participants in the control group; 48.6% of participants in the intervention group and 46.9% of participants in the control group were physically pre-frail; 28% of participants in the intervention group were physically frail, compared to 18.6% of participants in the control group. Participants in the

intervention group scored an average of 1.7, compared to 1.4 in the control group (SD 1.40 vs. 1.36). The average change in scores was 0.1 in both groups (SD 0.98 vs. 1.02, intervention vs. control). There was no significant change in physical frailty status in both groups ($p = 0.99$). Additionally, modeling techniques revealed no statistically significant differences between groups on the FRAIL scale, even after controlling for possible differences in depression (GDS, $p = 0.14$) and cognitive status (SPMSQ, $p = 0.14$), and after adjusting for age ($p = 0.06$), sex ($p = 0.14$), race ($p = 0.33$), education ($p = 0.90$), marital status ($p = 0.31$), and living arrangements ($p = 0.94$).

Table 3. *Effects of Robotic Pet on Physical Frailty*

Characteristic	Statistic/Category	Intervention (N = 107)	Control (N = 113)	P-Value
FRAIL admin (categorized)	0:Robust	25 / 107 (23.4 %)	39 / 113 (34.5 %)	0.11
	1-2:Pre-Frail	52 / 107 (48.6 %)	53 / 113 (46.9 %)	
	3+:Frail	30 / 107 (28.0 %)	21 / 113 (18.6 %)	
FRAIL dc (categorized)	0:Robust	23 / 84 (27.4 %)	35 / 90 (38.9 %)	0.29
	1-2:Pre-Frail	40 / 84 (47.6 %)	36 / 90 (40.0 %)	
	3+:Frail	21 / 84 (25.0 %)	19 / 90 (21.1 %)	
FRAIL admin	N	107	113	0.08
	Mean±SD	1.7 ± 1.40	1.4 ± 1.36	
	Range	0.0 to 5.0	0.0 to 5.0	
	Median	1.0	1.0	
FRAIL dc	N	84	90	0.09
	Mean±SD	1.6 ± 1.39	1.3 ± 1.33	
	Range	0.0 to 5.0	0.0 to 4.0	
	Median	1.0	1.0	
FRAIL Change	N	84	90	0.99
	Mean±SD	-0.1 ± 0.98	-0.1 ± 1.02	
	Range	-2.0 to 2.0	-2.0 to 3.0	
	Median	0.0	0.0	

Specific Aim 2

To explore the impact of a robotic pet on the incidence of cognitive function and depression in a population of community-dwelling older adults over age 65 who were recently hospitalized, compared to usual post-discharge care.

The 10-question Short Portable Mental Status Questionnaire (SPMSQ) (Pfeiffer, 1975) was used to assess cognitive function. Results are presented in Table 4. Total number of errors were calculated, with one more error allowed for individuals with less than a high school education and one less error allowed for individuals with education beyond high school. Based on the SPMSQ, 0-2 errors indicated normal cognitive function, 3-4 errors indicated mild cognitive impairment, 5-7 errors indicated moderate cognitive impairment, and 8 or more errors indicated severe cognitive impairment. A total of 79.4% of intervention group participants had normal cognitive function, compared to 88.5% of the control group; 16.8% of intervention group participants had mild cognitive impairment, compared to 9.7% of the control group. Only a small percentage of participants in both groups were moderately impaired. None of the participants enrolled had severe cognitive impairment. Participants had an average of 1 error in the intervention and control groups at baseline (SD 1.50 vs. 1.31). The average change in scores was 0.3 for both the intervention and control groups (SD 1.08 vs. 1.11). There was no significant change in cognitive status in both groups ($p = 0.69$).

Table 4. *Effects of Robotic Pet on Cognitive Status*

Characteristic	Statistic/Category	Intervention (N = 107)	Control (N = 113)	P-Value
SPMSQ admin (categorized)	0-2:Normal	85 / 107 (79.4 %)	100 / 113 (88.5 %)	0.17
	3-4:Mild	18 / 107 (16.8 %)	11 / 113 (9.7 %)	
	5-7:Moderate	4 / 107 (3.7 %)	2 / 113 (1.8 %)	
SPMSQ dc (categorized)	0-2:Normal	75 / 84 (89.3 %)	85 / 90 (94.4 %)	0.46
	3-4:Mild	7 / 84 (8.3 %)	4 / 90 (4.4 %)	
	5-7:Moderate	2 / 84 (2.4 %)	1 / 90 (1.1 %)	
SPMSQ admin	N	107	113	0.32
	Mean±SD	1.2 ± 1.50	1.0 ± 1.31	
	Range	0.0 to 6.0	0.0 to 6.0	
	Median	1.0	0.0	
SPMSQ dc	N	84	90	0.25
	Mean±SD	0.8 ± 1.27	0.6 ± 1.12	
	Range	0.0 to 6.0	0.0 to 6.0	
	Median	0.0	0.0	
SPMSQ Change	N	84	90	0.69
	Mean±SD	-0.3 ± 1.08	-0.3 ± 1.11	
	Range	-3.0 to 2.0	-3.0 to 3.0	
	Median	0.0	0.0	

The 15-item Geriatric Depression Scale Short Form (GDS-SF) (Yesavage et al., 1983) was used to assess for the presence of depression. Results are presented in Table 5. A score of 0-4 indicated normal functioning, a score of 5-8 indicated mild depression, a score of 9-11 indicated moderate depression, and a score of 12-15 indicated severe depression. At baseline, 64.5% of intervention group participants had normal affect, compared to 81.4% of control group participants; 22.4% of intervention group participants, compared to 14.2% of control group participants, were mildly depressed; 11.2% of intervention group participants and 4.4% of control group participants were moderately depressed; 1.9% of intervention group participants were severely depressed, compared to 0% of control group participants. Those in the control

group were more likely to have a normal score on the GDS scale, while those in the intervention group were more likely to be moderately/severely depressed at the time of enrollment (p = 0.02). Participants in the intervention group had an average of 4.1 positive responses, compared to 2.8 in the control group (SD 3.21 vs. 2.50). Using the actual scores rather than the categorized scores, those in the intervention group had statistically significant higher scores both at enrollment and at discharge (p = 0.003 and p = 0.0007, respectively); however, the change in scores was not statistically significantly different between the two groups after the intervention (p = 0.90).

Table 5. *Effects of Robotic Pet on Depression*

Characteristic	Statistic/Category	Intervention (N=107)	Control (N=113)	P-value
GDS admin (categorized)	0-4:Normal	69 / 107 (64.5 %)	92 / 113 (81.4 %)	0.02
	5-8:Mild	24 / 107 (22.4 %)	16 / 113 (14.2 %)	
	9-11:Moderate	12 / 107 (11.2 %)	5 / 113 (4.4 %)	
	12-15:Severe	2 / 107 (1.9 %)	0 (0.0%)	
GDS dc (categorized)	0-4:Normal	59 / 84 (70.2 %)	74 / 90 (82.2 %)	0.17
	5-8:Mild	19 / 84 (22.6 %)	13 / 90 (14.4 %)	
	9-11:Moderate	6 / 84 (7.1 %)	3 / 90 (3.3 %)	
	12-15 Severe	0 (0.0%)	0 (0.0%)	
GDS admin	N	107	113	0.003
	Mean±SD	4.1 ± 3.21	2.8 ± 2.50	
	Range	0.0 to 14.0	0.0 to 11.0	
	Median	3.0	2.0	
GDS dc	N	84	90	0.007
	Mean±SD	3.5 ± 2.95	2.3 ± 2.42	
	Range	0.0 to 11.0	0.0 to 10.0	
	Median	3.0	1.5	
GDS Change	N	84	90	0.90
	Mean±SD	-0.4 ± 1.84	-0.5 ± 1.89	
	Range	-4.0 to 4.0	-7.0 to 5.0	
	Median	-0.5	0.0	

Specific Aim 3

To explore the impact of perceived enjoyment on use of the robotic pet in the intervention group.

The Perceived Enjoyment Questionnaire (PEQ) was used to evaluate how attitudes towards the robotic pet affected use of the pet. This questionnaire included five questions and was administered to intervention group participants only, at disenrollment. Summary statistics are presented in Table 6. According to the data, 64.6% of participants reported they enjoyed talking to the robotic pet (Q1); 68.3% of participants reported they enjoyed doing things with their robotic pets (Q2); 95.1% of participants found the robotic pet enjoyable (Q3); 73.2% of participants found the robotic pet fascinating (Q4); and 4.9% of participants found the robotic pet boring (Q5).

Table 6. *Perceived Enjoyment of Robotic Pet*

Characteristic	Statistic/Category	Intervention (N = 107)
Enjoyment Q1	No	29 / 82 (35.4 %)
	Yes	53 / 82 (64.6 %)
Enjoyment Q2	No	26 / 82 (31.7 %)
	Yes	56 / 82 (68.3 %)
Enjoyment Q3	No	4 / 82 (4.9 %)
	Yes	78 / 82 (95.1 %)
Enjoyment Q4	No	22 / 82 (26.8 %)
	Yes	60 / 82 (73.2 %)
Enjoyment Q5	No	78 / 82 (95.1 %)
	Yes	4 / 82 (4.9 %)

Table 7 shows the relationships between the enjoyment scale questions (Q1-Q5) versus each outcome. Those who enjoyed doing things with their robotic pet (Q2) had a small but statistically significantly improvement in the SPMSQ scores, compared to those who reported they did not enjoy doing things with their robotic pet (mean change ± standard deviation for enjoy vs. did not enjoy = -0.4±1.2 vs 0±0.7, p = 0.02). The enjoyment of doing things with their robotic pet reduced the number of errors in SPMSQ by about a half of a point, while those who reported no enjoyment had no change in their scores. No statistically significant relationship was found on the other enjoyment questions.

Table 7. *Relationships Between the Enjoyment Scales vs. Each Outcome*

Enjoyment Question 1 *I enjoy talking to my robotic pet*							
Analysis Variable	Response to Enjoyment Question	N	Mean	SD	Median	Min	Max
QDSFS change p = 0.63	Yes	53	0.2	0.7	0.0	-1.0	2.0
	No	29	0.2	0.8	0.0	-1.0	2.0
FRAIL change p = 0.95	Yes	53	-0.1	1.0	0.0	-2.0	2.0
	No	29	-0.1	1.0	0.0	-2.0	2.0
SPMSQ change p = 0.38	Yes	53	-0.3	1.1	0.0	-3.0	2.0
	No	29	-0.2	1.1	0.0	-3.0	2.0
GDS change p = 0.67	Yes	53	-0.4	1.8	0.0	-4.0	4.0
	No	29	-0.6	1.9	-1.0	-4.0	4.0
Enjoyment Question 2 *I enjoy doing things with my robotic pet*							
Analysis Variable	Response to Enjoyment Question	N	Mean	SD	Median	Min	Max
QDSFS change p = 0.71	Yes	56	0.2	0.8	0.0	-1.0	2.0
	No	26	0.2	0.7	0.0	-1.0	2.0
FRAIL change p = 0.32	Yes	56	-0.1	0.9	0.0	-2.0	2.0
	No	26	-0.3	1.0	0.0	-2.0	2.0
SPMSQ change p = 0.02	Yes	56	-0.4	1.2	0.0	-3.0	2.0
	No	26	0.0	0.7	0.0	-2.0	1.0
GDS change p = 0.96	Yes	56	-0.5	1.9	0.0	-4.0	4.0
	No	26	-0.5	1.7	-1.0	-4.0	3.0

Table 7 (continued)

Enjoyment Question 3 *I find my robotic pet enjoyable*							
Analysis Variable	Response to Enjoyment Question	N	Mean	SD	Median	Min	Max
QDSFS change p = 0.87	Yes	78	0.2	0.8	0.0	-1.0	2.0
	No	4	0.3	0.5	0.0	0.0	1.0
FRAIL change p = 0.34	Yes	78	-0.1	1.0	0.0	-2.0	2.0
	No	4	-0.5	1.0	-1.0	-1.0	1.0
SPMSQ change p = 0.53	Yes	78	-0.3	1.1	0.0	-3.0	2.0
	No	4	0.0	0.0	0.0	0.0	0.0
GDS change p = 0.28	Yes	78	-0.4	1.9	0.0	-4.0	4.0
	No	4	-1.3	0.5	-1.0	-2.0	-1.0
Enjoyment Question 4 *I find my robotic pet fascinating*							
Analysis Variable	Response to Enjoyment Question	N	Mean	SD	Median	Min	Max
QDSFS change p = 0.96	Yes	60	0.2	0.8	0.0	-1.0	2.0
	No	22	0.2	0.7	0.0	-1.0	1.0
FRAIL change p = 0.36	Yes	60	-0.1	1.0	0.0	-2.0	2.0
	No	22	-0.3	0.9	0.0	-2.0	1.0
SPMSQ change p = 0.75	Yes	60	-0.3	1.0	0.0	-3.0	2.0
	No	22	-0.4	1.2	0.0	-3.0	2.0
GDS change p = 0.37	Yes	60	-0.7	1.7	-1.0	-4.0	3.0
	No	22	0.0	2.2	-0.5	-4.0	4.0
Enjoyment Question 5 *I find my robotic pet boring*							
Analysis Variable	Response to Enjoyment Question	N	Mean	SD	Median	Min	Max
QDSFS change p = 0.88	Yes	4	0.3	0.5	0.0	0.0	1.0
	No	78	0.2	0.8	0.0	-1.0	2.0
FRAIL change p = 0.66	Yes	4	0.3	1.5	0.0	-1.0	2.0
	No	78	-0.2	0.9	0.0	-2.0	2.0
SPMSQ change p = 0.16	Yes	4	-0.5	1.0	0.0	0.0	2.0
	No	78	-0.3	1.1	0.0	-3.0	2.0
GDS change p = 0.47	Yes	4	-1.0	0.0	-1.0	-1.0	-1.0
	No	78	-0.4	1.9	0.0	-4.0	4.0

Chapter V

DISCUSSION

This chapter discusses the study outcomes and provides a detailed explanation of the implications of these findings for both clinical practice as well as future research. There were two main findings of this study. First, there was no significant change in social or physical frailty status with use of a robotic pet. Second, there was a significant change in cognitive status in participants who reported they enjoyed doing things with their robotic pet.

Sample Characteristics

The population included in this study was non-diverse. This may reflect the setting chosen for this study and the population served in this area. Census data for Westchester County from 2019 reported 73.2% of respondents identified as White, 25.5% as Hispanic/Latino, 16.7% as Black or African American, and 6.5% as Asian (U.S. Census Bureau, n.d.). Compared to the rest of the United States, Westchester County is wealthier and more educated, with a higher percentage of individuals who were educated beyond high school and have a median income of $30,000-plus more than the national average (U.S.Census Bureau, n.d.). While every effort was made to include all eligible participants, sample diversity was affected by the geographic area where the study took place, which affects generalizability of results. There were also significantly fewer males in the sample, compared to females. This reflects the national trend of more females than males in the older population as females have a higher life expectancy compared to males (Roberts et al., 2018) and affects generalizability to the older adult population as a whole.

Prevalence of social frailty and social prefrailty in this sample was almost universal, with 70% of the study sample socially frail and 26% pre-socially frail. This contrasted sharply to

social frailty prevalence reported elsewhere, which was under 20% (Pek at al., 2020; Yamada et al., 2018) and is likely attributable to pandemic control measures as well as the method used to evaluate social frailty in this study. Physical frailty and prefrailty prevalence were 23% and 48%, respectively, in this sample. This compared to 11% of frailty and 42% of prefrailty in the general population (Collard et al., 2012). The sample was drawn from a population of hospitalized individuals, which may affect rates of physical frailty. Hospitalization is a consequence of frailty; thus, participants who are hospitalized may be frailer than a non-hospitalized sample.

About 20% of the total number of participants were lost to follow-up. The expected loss to follow-up in the power analysis calculation for this study was 10%. This may also affect the results as perhaps the study was not adequately powered to detect a change in status, related to an unexpectedly increased loss to follow-up. Another study with the same robotic pet as this one in community-dwelling older adults that also attempted to reach patients for follow-up via mail-in survey also reported a high rate of attrition, with only 48% of participants completing all study surveys (Tkatch et al., 2020).

Measures

Social Frailty

There was no significant change in social frailty in this study ($p = 0.42$). The social frailty scale used in this study may not be appropriate during the unique time of the COVID-19 pandemic, where isolation is hopefully temporary and borne out of extenuating circumstances. This scale included questions such as “Have you been going out of the house less frequently compared to last year?” (Makizako et al., 2015), to which the response almost inevitably was in the affirmative. The second and third questions were also potentially confounded by circumstances as they asked “Have you been visiting friends sometimes?” and “Do you feel

helpful to friends of family?" (Makizako et al., 2015). Participants reported they were isolating in their homes and were not visiting friends at all. Some allowed limited visitation with family members. Some participants expressed they did not feel as helpful as they used to due to limited interaction with others, including family. Social distancing measures forced older adults into isolation. The study took place from September 2020 until March 2021. During this time, the pandemic was ongoing and, while vaccination had begun in New York in December of 2020, as of this writing, only 18.5% of people in New York State had completed their vaccine series (New York State, 2021). Thus, social distancing-related behaviors would not have changed at this point and, as a result, forced social isolation was still in effect. Almost 100% of the study sample in either group were socially pre-frail or frail, which clearly reflects the tremendous impact of the necessary social distancing measures put in place due to the COVID-19 pandemic. This will require further qualitative study to understand; however, in this context, perhaps an alternative scale would have been more appropriate. Other studies that examined the impact of technologies on loneliness in older adults, including the use of robotic pets, utilized other validated measurement tools such as the UCLA Loneliness Scale, which was most widely used, or the de Jong Loneliness Scale (Khosravi et al., 2016).

In contrast to this study, other studies found social robots reduced loneliness in older adults with and without dementia (Abdi et al., 2018; Khosravi et al., 2016; Pu et al., 2019; Robinson et al., 2013). As loneliness specifically was not measured in this study, a conclusion cannot be made on the impact of this intervention on loneliness. Many of the abovementioned studies, however, were conducted in institutionalized settings; thus, results may not be generalizable to community-dwelling populations. Many studies also included group interventions, which may influence social frailty and loneliness. Studies indicated interventions

conducted in a group setting reported more positive findings compared to one-on-one interventions (Abdi et al., 2018; Chen et al., 2018). Additionally, robotic pet interventions conducted in a group setting stimulated more social interaction, compared to placebo (Abdi et al., 2018). This suggests that the benefit of the robotic pet is derived through the social interaction it stimulates with others, rather than through direct interaction with the robot. As with many of these studies, many of the positive outcomes were in older adults with dementia living in a group setting (Abdi et al., 2018; Pu et al., 2019). Indeed, two participants in the intervention group in this study, who were discharged to a rehabilitation facility before returning home, reported the robot served as a point of contact for them. They reported more people stopped to talk to them when their robotic pet was in view, and it helped them make friends. It was similarly reported in other qualitative studies that the robotic pet served as a point of contact with others (Hudson et al., 2020). Participants also said staff spent more time with them when they had the robotic pet as the pet proved to be a good conversation starter. This was also endorsed by participants who had the robotic pet with them for a few days while still in the hospital before being discharged home. This indicates the potential value of the robot in a group setting, compared to a one-on-one intervention. These companion pets may have particular utility in institutionalized settings where live pets are restricted due to safety, allergy, or infection concerns.

Anecdotally, several participants in the intervention group reported the robot made a profound positive impact on their lives and made them feel like they were not alone. They reported the robot provided comfort and companionship during an increasingly isolated time in their lives. It was similarly reported in other qualitative studies on robotic pets in community-dwelling older adults that the robotic pet provided comfort and companionship (Hudson et al.,

2020). While some participants reported a complete lack of interest in the robot, others reported that while they did not find value in it for themselves as they were still working or otherwise preoccupied in their lives, they could see the value of the robot for others who may be more isolated. This was found in other qualitative studies on robotic pets, where participants distanced themselves from what they imagined was the ideal user of a robotic pet as someone who was lonely or cognitively impaired (Hudson et al., 2020). Furthermore, some participants who declined to participate due to having a live pet at home expressed they derived great pleasure from their live pet and could therefore imagine the benefit of a robotic pet to individuals who could not own or care for a live pet. This anecdote is perhaps worth exploring further qualitatively to understand better the meaning a robot pet has to its owners as well as which population would most benefit from this type of intervention.

Physical Frailty

There was no significant change in physical frailty status between the two groups. Research on the impact of pandemic-related social distancing and physical isolation measures on physical function in older adults is only emerging. Study participants in both groups acknowledged they used to be generally more active, going to the gym, playing tennis, spending time outdoors, and even simply running errands such as trips to the grocery or pharmacy prior to the pandemic. In addition to the devastating impact on social activities, the potential harms related to increased sedentariness in older adults as they tried to avoid exposure to the potentially deadly virus are alarming. The benefits individuals derive from pet ownership may be related to increased physical activity related to caring for a pet, such as walking a dog (Kojima et al., 2020). Additionally, since caring for a pet can be taxing, some studies have posited that pet owners are inherently more robust than individuals who do not own pets (Kojima et al., 2020).

Physical activity may be the single most important intervention to prevent physical frailty. Perhaps a more interactive robotic pet would derive alternative benefits for physical frailty prevention.

Cognitive Status

There was no significant change in cognitive status based on SPMSQ scores in this study. This finding is supported by a review of randomized controlled trials that found no change in cognitive status with use of social robots (Pu et al., 2019); however, it is important to mention that most of these studies investigated the impact of a robotic pet on cognitive function in individuals with dementia. While individuals with and without cognitive impairment benefited from social robot interventions (Pu et al., 2019), those results would not be broadly applicable to that of this study as the population included here was more cognitively intact. Notably, there was a statistically significant change in cognitive function in participants who reported they enjoyed doing things with their robotic pet on the Perceived Enjoyment Questionnaire, compared to those who did not enjoy doing things with their robotic pet ($p = 0.02$). Other studies also reported that increased engagement with the robotic pet was associated with improvement in mental health (Tkatch et al., 2020). This aligns with the theoretical framework of this study that greater use of a robotic pet would yield greater benefit. Other studies investigating the use of robotic pets to improve cognition in both older adults with dementia and without dementia found an improvement in cognitive status, particularly in cognitively intact individuals (Abdi et al., 2018). These studies were conducted with various types of robots; thus, the impact of any one particular robot on cognitive function is inconclusive. For example, several of these studies utilized more communicative robots (Abdi et al., 2018), and these may have a different impact on cognitive function than a companion pet. Still, cognitive function is increasingly recognized as an

important aspect of frailty syndrome in older adults. The impact of social companion robots on cognitive function may merit further exploration based on these findings. Given the number of analyses conducted, one cannot rule out the possibility that this significant finding is a Type I error. Further investigation is warranted.

Cognitive function was also considered a potential confounding variable in this study as the presence of social frailty or loneliness increases the risk for cognitive impairment (Lara et al., 2019). Additionally, cognitive impairment is considered an aspect of frailty in multidimensional frailty models (Rockwood & Mitnitski, 2011) and is recognized as an important frailty domain, separate from dementia and other cognitive disorders (Kelaiditi et al., 2013). When controlling for cognitive function in regression models, no significant effect was found for the intervention on social or physical frailty.

Depression

There was no significant change in depression scores between the two study groups. Other studies with robotic pets investigated the use of robotic pets on depression or other mood symptoms. Some studies showed significant improvement in depression or mood related to a robotic pet intervention (Abdi et al., 2018; Chen et al., 2018). Additionally, group-based interventions showed greater reduction in depression, compared to individual interventions (Chen et al., 2018). Many of these studies were conducted in older adults with dementia and investigated the use of robots on dementia-related psychiatric symptoms such as agitation (Abdi et al., 2018). These findings are not applicable to a relatively cognitively intact community-dwelling population such as the sample included in this study. Depressive symptoms in this study were more important as a potential confounding variable. Since social and physical frailty are both positively associated with depressive symptoms (Ma et al., 2018; Tsutsumimoto et al.,

2018), depression was included in the analysis for this study as a potential confounder. No significant effect was found on social and physical frailty after controlling for depression.

Study Limitations

The most significant limitation of this study was that it was conducted during the COVID-19 pandemic, which significantly impacted older adults, as discussed in the related literature and discussion sections of this paper.

Another limitation of this study was reliance on self-report for some measures, such as responses to some of the instruments. Relying on self-report is inherently unreliable as the human memory is not infallible; however, for some measures, this was unavoidable and attempts were made to collect objective data when possible. Additionally, to this author's knowledge, the social frailty questionnaire utilized in this study was not universally validated and has thus far only been used with Asian older adults. Thus, the validity of this scale in other populations is unknown.

Most previous studies that implemented a robotic pet intervention took place over a longer period of time than the current study, ranging from several weeks, months, or years (Abdi et al., 2018; Pu et al., 2019). Additionally, use of a robotic pet increased over time (Bradwell et al., 2020), and increased use lead to more positive outcomes (Tkatch et al., 2020), suggesting that a longer study period may be needed for this intervention to be effective. This study was limited by time and resource constraints, and it is possible a longer period of time is needed to evaluate the impact of this intervention in a cognitively intact population living at home.

Another potential limitation was the inclusion of a generally homogeneous sample. The sample was drawn from a community hospital that primarily serves a particular demographic area in Westchester County and surrounding areas. This population may not be representative of

other counties across the country and limits generalizability of findings. Broad inclusion criteria and narrow exclusion criteria attempted to minimize bias in the sample.

Several other limitations were identified during the course of enrollment for this study. Participants were recruited during hospitalization. This may confound some results as participants may be in a physically and emotionally altered state when experiencing an acute illness that requires hospitalization. Additionally, due to the nature of the population, there was some difficulty identifying patients targeted for discharge home. Discharge time and disposition was highly unpredictable. Some patients who were targeted for discharge home were in fact discharged to rehab. Many patients admitted to the unit were discharged suddenly and, thus, missed for enrollment. Some patients were readmitted to the hospital during the course of the study period, which may also impact results. This highlights some issues with recruiting participants from a hospitalized sample.

Implications

Implications for Clinical Practice

Social participation and physical function are both amenable to intervention, especially in the early stages of frailty. Group interventions such as group exercise classes, for example, are well-researched and documented and present an opportunity to target social and physical frailty at the same time. During the pandemic, however, essential public health measures to reduce the spread of the virus prevented community interventions and in-person social gatherings, particularly for the high-risk older adult population. As much of the value of a robotic pet is increased social engagement, the impact of this intervention on community-dwelling older adults is still unclear as social engagement was restricted by state mandate during the time of this study. Various technologies represent novel, innovative solutions to address these issues. Robotic pets

are but one example of how technology can be used as a social intervention for older adults without compromising their health. Robotic pets require no supervision or administration by trained staff, nor do they require care from the older adult.

Implications for Further Research

More research is needed on the impact of a robotic pet on social frailty in older adults living at home, particularly older adults who live alone. More research is also needed on the impact of a robotic pet on cognitive function, particularly regarding which aspect of social engagement is most impactful on cognitive function. In addition, studies utilizing larger sample sizes are needed in this area of research to truly examine the effect of robotic pet interventions. Additional study is also needed for more diverse samples, especially since specific social determinants such as socioeconomic status, education, and race are all risk factors for social and physical frailty. This study examined the use of the robotic pet over a relatively short period of time. Additional study is needed to investigate the impact of the robotic pet on older adults over the long term, especially in the context of connection to live pets proving impactful in the long term. Longer intervention time may also reveal alternative impacts of this intervention. Lastly, development of robotic pets that can encourage physical activity similarly to a live pet may be the future direction of this technology.

Conclusion

This study showed a high prevalence of social and physical frailty in older adults during the COVID-19 pandemic, which can lead to adverse health outcomes in this population. Robotic pets have been utilized as an intervention for older adults with varying success. In this study, individuals who reportedly enjoyed doing things with their robotic pet technology had a significant improvement in cognitive function, compared to those who reported they did not

enjoy doing things with their robotic pet. No significant effect was found on social and physical frailty with the use of the robotic pet. Further study is needed to investigate the impact of robotic pets on social frailty, loneliness, and cognition in community-dwelling older adults.

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Appendix A

Survey

Name (Last, First): **STUDY ID**
Date of enrollment:
DOB/AGE:
Phone number:

Sex

1 - Female
2 -Male

Marital Status

1. Married
2. Divorced
3. Widowed
4. Single, never married

Race

1. – White/Caucasian
2. – Black/African American
3. – Hispanic/Latino
4. – Asian
5. – Native Hawaiian/Pacific Islander
6. - American Indian/Alaskan Native

Education

1. Grade school or less
2. High school
3. 2 year college
4. 4 year college
5. Graduate school or post grad

Ambulatory Device

1. Yes
2. No

Household Pets

1. Yes
2. No

Living Arrangements

1. Lives alone
2. Lives with spouse
3. Lives with children
4. Assisted living

Discharge Disposition

1. Self
2. VNS
3. Assisted living

Appendix B

Questionnaire to Define Social Frailty Status

Question	Response
Have you been going out less frequently compared to last year?	Yes
Have you been visiting friends sometimes?	No
Do you feel helpful to friends or family?	No
Do you live alone?	Yes
Do you talk to someone every day?	No

0 = robust; 1 = pre-frail; 2 or more = frail

Appendix C

FRAIL Questionnaire

Frailty Domain	Definitions
Fatigue	How much time during the past 4 weeks have you felt tired?
Resistance	Inability to climb 10 steps unassisted
Ambulation	Inability to walk one block
Illness	five or more comorbidities
Loss of Weight	Loss of more than 5% of body weight

0 = robust; 1-2 = pre-frail; 3-5 = frail

Appendix D

Short Portable Mental Status Questionnaire

Short Portable Mental Status Questionnaire (SPMSQ)

Patient's Name: ______________________________ **Date:** ____________________

Circle Appropriate Description: SEX: *M* *F* RACE: *White* *Black* *Other*
YRS OF EDUCATION: *Grade School* *High School* *Beyond High School*

Instructions: Ask questions 1 to 10 on this list and record all answers. (Ask question 4a only if the subject does not have a telephone.) All responses must be given without reference to calendar, newspaper, birth certificate, or other aid to memory. Record the total number of errors based on the answers to the 10 questions.

+	–	Questions	Instructions
		1. What is the date today? ____________	Correct only when the month, date, and year are all correct.
		2. What day of the week is it? ____________	Correct only when the day is correct.
		3. What is the name of this place? ____________	Correct if any of the description of the location is given. "My home," the correct city/town, or the correct name of the hospital/institution are all acceptable.
		4. What is your telephone number? ____________	Correct when the number can be verified or the subject can repeat the same number at a later time in the interview.
		4a. What is your street address? ____________	Ask only if the subject does not have a telephone.
		5. How old are you? ____________	Correct when the stated age corresponds to the date of birth.
		6. When were you born? ____________	Correct only when the month, date, and year are correct.
		7. Who is the president of the United States now? ____________	Requires only the correct last name.
		8. Who was president just before him? ____________	Requires only the correct last name.
		9. What was your mother's maiden name? ____________	Needs no verification; it only requires a female first name plus a last name other than the subject's.
		10. Subtract 3 from 20 and keep subtracting 3 from each new number, all the way down. ____________	The entire series must be performed correctly to be scored as correct. Any error in the series—or an unwillingness to attempt the series—is scored as incorrect.

_______ **Total Number of Errors**

- *0 – 2 errors = Intact Intellectual Functioning*
- *3 – 4 errors = Mild Intellectual Impairment*
- *5 – 7 errors = Moderate Intellectual Impairment*
- *8 – 10 errors = Severe Intellectual Impairment*

(Allow one more error for a subject with only a grade school education. Allow one less error for a subject with education beyond high school. Allow one more error for African-American subjects, using identical educational criteria.)

Source:
Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. *J Am Geriatr Soc.* 1975;23(10):433-41.

Appendix E

Geriatric Depression Scale: Short Form

Geriatric Depression Scale: Short Form

Choose the best answer for how you have felt over the past week:

1. Are you basically satisfied with your life? YES / **NO**
2. Have you dropped many of your activities and interests? **YES** / NO
3. Do you feel that your life is empty? **YES** / NO
4. Do you often get bored? **YES** / NO
5. Are you in good spirits most of the time? YES / **NO**
6. Are you afraid that something bad is going to happen to you? **YES** / NO
7. Do you feel happy most of the time? YES / **NO**
8. Do you often feel helpless? **YES** / NO
9. Do you prefer to stay at home, rather than going out and doing new things? **YES** / NO
10. Do you feel you have more problems with memory than most? **YES** / NO
11. Do you think it is wonderful to be alive now? YES / **NO**
12. Do you feel pretty worthless the way you are now? **YES** / NO
13. Do you feel full of energy? YES / **NO**
14. Do you feel that your situation is hopeless? **YES** / NO
15. Do you think that most people are better off than you are? **YES** / NO

Answers in **bold** indicate depression. Score 1 point for each bolded answer.

A score > 5 points is suggestive of depression.
A score ≥ 10 points is almost always indicative of depression.
A score > 5 points should warrant a follow-up comprehensive assessment.

Source: http://www.stanford.edu/~yesavage/GDS.html

The Hartford Institute for Geriatric Nursing would like to acknowledge the original author of this Try This, Lenore Kurlowicz, PhD, RN, CS, FAAN, who made significant contributions to the field of geropsychiatric nursing and passed away in 2007.

try this: general assessment series — Best Practices in Nursing Care to Older Adults

A series provided by The Hartford Institute for Geriatric Nursing, New York University, College of Nursing
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CLINICAL NURSING WEBSITE www.ConsultGeriRN.org

Appendix F

Perceived Enjoyment Questionnaire

Statement:
1. I enjoy talking to my robotic pet.
2. I enjoy doing things with my robotic pet.
3. I find my robotic pet enjoyable.
4. I find my robotic pet fascinating.
5. I find my robotic pet boring.

Appendix G

Institutional Review Board Approval

PACE UNIVERSITY OFFICE OF RESEARCH

Institutional Review Board – Notification of Review

To:	Chava Pollak, MSN, RN
From:	Pace University Institutional Review Board
Date:	September 7, 2020
IRBNet ID No. &	[1607187-1]
Title:	The Impact of a Robotic Pet on Social Frailty in Community Dwelling Older Adults
Review:	**Initial IRB Application**
Action:	**Approval (Expedited Review (§46.110)(a))(1a)) - Cat. 1(b) & 7))**
Next Status Check-in Due Date:	**September 4, 2021**

Thank you for the June 22, July 15 and August 4 submissions comprising the initial IRB application. The Pace University Institutional Review Board acknowledges receipt and has reviewed and approved of the following items in this submission:

- Pace University IRB Consent Form.doc (UPDATED: 07/15/2020);
- Pace University IRB Proposal Form 08-25-16.docx (UPDATED: 07/15/2020);
- Application Form - Pace University IRB Proposal Form 08-25-16.docx (UPDATED: 06/29/2020);
- Data Collection - study doc demographics.xlsx (UPDATED: 06/29/2020);
- Other - Pollak_Robotic Pet IRB approval 06 22 20.pdf (UPDATED: 06/29/2020);
- Questionnaire/Survey - spmsq_tool.pdf (UPDATED: 05/12/2020);
- Questionnaire/Survey - social frailty ques.docx (UPDATED: 05/12/2020);
- Questionnaire/Survey - perceived enjoyment ques.docx (UPDATED: 05/12/2020);
- Questionnaire/Survey - GDS-SF.pdf (UPDATED: 05/12/2020);
- Questionnaire/Survey - FRAIL ques.docx (UPDATED: 05/12/2020);
- Training/Certification - citi cert soc behav pace.pdf (UPDATED: 05/12/2020);
- Training/Certification - citi cert Pace.pdf (UPDATED: 05/12/2020);
- Training/Certification - citi cert IPS pace.pdf (UPDATED: 05/12/2020);
- Outlook e-mail from Chava Pollack, dated 8/4/20.

Note: The (attached) Consent Form (UPDATED: 07/15/2020) was revised to include the current Office

of Research contact information.

Please contact the IRB when you need to:

- Report any unanticipated problems involving risk to subjects or any serious adverse events;
- Revise any aspect of the approved protocol (e.g., change in procedure, key personnel, recruitment materials, etc.);
- Submit a Progress Report (at least 30 days before the next status check-in due date);
- Submit a Closure/Final report (within 60 days of the date the project is completed).

Additional conditions for the general conduct of human subjects research are detailed on the Office of Research website.

Best of luck with your research!

Sincerely,

Sharon Stahl Wexler, PhD, RN, FNGNA
Co-Chair of the IRB

Christopher John Godfrey, PhD
Co-Chair of the IRB

Enc. Pace University IRB Consent Form.doc (revised 09/7/20) – in redlined and clean formats

cc: Office of Research
OHRP IRB# 0003970 FWA00023526

This letter has been electronically signed in accordance with all applicable regulations and a copy is retained within the Pace University Institutional Review Board's records.

White Plains
Hospital

June 23, 2020

Chava Pollak, MSN, RN
White Plains Hospital
41 East Post Road
White Plains, NY 10601

Dear Ms. Pollak:

The White Plains Hospital Institutional Review Board (IRB), at a meeting held on June 3, 2020 approved the protocol **The Impact of a Robotic Pet on Frailty and Loneliness in Community Dwelling Older Adults** as low risk for a period of 12 months pending modifications to the protocol and informed consent documents. This approval is valid until June 2, 2021.

You are required, as outlined in the IRB operating procedures, to report immediately to the Secretary of the IRB any unanticipated problems involving risks to known subjects or others in the approved research. Six weeks prior to the approved expiration date, you must notify the Secretary of the IRB, in writing, of your intention to ask for re-approval or closure of the study. You will not receive any notice from the IRB of the expiration date. At that time you are also required to submit a written progress report outlining the following:

- Number of subjects entered into the study;
- Summary description of subject experiences (benefits, adverse reactions);
- Number of withdrawals to the study and the reason for the withdrawal;
- Research results to date;
- Current risk/benefit assessment based on study results; and
- New information since the IRB's last review.

The IRB further requires that all advertising related to the research be approved by the IRB. The IRB shall have the authority to suspend or terminate approval of the research project if it is not being conducted in accordance with the IRB's decisions, conditions, or requirements.

Sincerely,

Karen Banoff

Karen M. Banoff, DNP
Secretary, White Plains Hospital Institutional Review Board