Implementation of a Strength Training Intervention for Treating Sarcopenia Among Older Residents in a Skilled Nursing Facility

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Abstract

Problem: Sarcopenia is a well-known geriatric syndrome characterized by the progressive and generalized loss of muscle quantity or quality. Physical activity is the most prevalent recommendation for treating and preventing sarcopenia. At the Advent Health Care Center, residents are neither screened for sarcopenia nor engaged in exercise programs outside of prescribed physical therapy when appropriate for rehabilitation due to injury.

Background/Significance: The incidence of sarcopenia increases with age and is associated with adverse outcomes such as increased risk of falls, cognitive impairment, loss of independence, diminished quality of life, increased health costs, need for care in a skilled nursing facility, and increased mortality.

Intervention: The intervention for this DNP project was a 90-day strength training program designed to improve measures of muscle mass, muscle strength, physical performance, and quality of life. The program was implemented in two phases. During Phase 1 (1 week), baseline data were collected and participants (*N* = 22) were oriented to the upcoming exercise regimen. During Phase 2 (12 weeks), the participants exercised and I collected 30-day, 60-day, and 90-day data for comparative purposes.

Outcomes: Data showed the strength training program was an effective intervention for reducing the characteristics associated with sarcopenia. Significant gains were made on muscle mass from baseline to 60 days and on grip strength, balance, gait speed, chair stand, and quality of life over the intervention period. Reduction in the incidence of sarcopenia among long-term care residents in skilled nursing facilities may, subsequently, contribute to reduced adverse effects of the disease process such as falls, hospital readmissions, morbidity, and mortality and help residents achieve an overall higher quality of life.

Chapter 1. Introduction

Sarcopenia is a well-known geriatric syndrome, characterized by the progressive and generalized loss of muscle quantity or quality (Cruz-Jentoft et al., 2019). The incidence of sarcopenia increases with age (Cruz-Jentoft et al., 2019) and is associated with adverse outcomes such as increased risk of falls (Bischoff-Ferrari et al., 2015; Schaap et al., 2018), cognitive impairment (Chang et al., 2016), loss of independence (dos Santos et al., 2017), diminished quality of life (Barthalos et al., 2016; Olsen et al., 2019), increased health costs, need for care in a long-term facility (Akune et al., 2014), and increased mortality (Batsis et al., 2014; De Buyser et al., 2016). Physical activity is the most prevalent recommendation for treating (Dent et al., 2018) and preventing (Steffl et al., 2017) sarcopenia. However, not all residents in long-term care or skilled nursing facilities are screened for sarcopenia or provided the opportunity to engage in regular physical exercise. The purpose of this DNP project was to determine if strength training is an effective intervention for treating sarcopenia among older adults at a skilled nursing facility.

The remainder of this chapter extrapolates on the ideas introduced here. Specifically, the background and the significance of the problem are discussed, the problem statement is presented, and the DNP project purpose and aim are identified.

Background and Significance

Defining Sarcopenia

Early history. As the father of modern gerontology, Nathan Shock brought attention to the changes in physiologic function associated with aging in his 1970s report to the International Congress of Gerontology (Rosenberg, 1997). In the 2 decades that followed, the scientific community gained insight into the relationship between muscle mass and lean body mass, and discovered connections between these types of functional decline and (a) increased admissions to assisted living facilities, and subsequent loss of independence; (b) loss of strength; (c) falls; and (d) fractures. Driven by the lack of urgency to better understand age-related decline in lean body mass evident in the literature, in 1988, Rosenberg (1997) coined the term *sarcopenia* from the Greek *sarx*, meaning flesh, and *penia*, meaning loss, as means to generate interest in more extensive clinical exploration of the phenomenon. Of greatest importance, Rosenberg proposed that research be conducted to distinguish the characteristics of sarcopenia: Is it strictly a normal stage in the aging process? Is it loss of muscle mass and function? Is it a disease, and if so, when does it become a disease? It would take more than 2 decades before the scientific community would come together to answer Rosenberg's questions.

Recent activity. In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP) came to a consensus regarding diagnostic criteria for age-related sarcopenia and put forth a practical clinical definition as a first step toward identifying and creating effective evidence-based treatment interventions (Cruz-Jentoft et al., 2010). To define sarcopenia, the group also focused on identifying the parameters for building the definition and appropriate measurement tools. Based on research from Goodpaster et al. (2006) and Delmonico et al. (2007), the EWGSOP defined sarcopenia as "a syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death" (p. 413). In 2018, the EWGSOP met again (ESGSOP2) to update the definition and to focus greater emphasis on determining severity of diagnoses and the establishment of low muscle strength as a key defining characteristic and diagnostic indicator (Cruz-Jentoft et al., 2019). The group defined sarcopenia as "a progressive and generalised skeletal muscle disorder that is associated with increased likelihood of adverse outcomes including falls, fractures, physical disability and mortality" (p. 18). They also emphasized muscle strength in their explanations of diagnoses and sarcopenia severity indicating that low muscle strength is a probably indicator of sarcopenia and that "a sarcopenia diagnosis is confirmed by the presence of low muscle quantity or quality; [and] when low muscle strength, low muscle quantity/quality and low physical performance are all detected, sarcopenia is considered severe" (Cruz-Jentoft et al., 2019, p. 18). These definitions have been accepted by a number of international scientific societies and are the most widely cited definitions of sarcopenia (Cruz-Jentoft & Sayer, 2019). This standardized definition has allowed for the collection and comparison of scientific data and rates of occurrence.

Considerations of the Literature

When considering the literature on sarcopenia, it is important to examine the definitions used by the study's author(s) and the focus of the study findings. Because loss of muscle mass (but not muscle strength) is one of the three key characteristics of malnutrition (according to the Global Leadership Initiative on Malnutrition (Cederholm et al., 2019), study outcomes that demonstrate loss of muscle mass but not muscle strength are more indicative of malnutrition as opposed to sarcopenia as defined by EWGSOP2 (Cruz-Jentoft & Sayer, 2019). A similar situation exists with cachexia, which refers to severe weight loss and muscle mass associated with complex pathophysiology present with end-stage organ failure, cancer, HIV, and AIDS.

Prevalence

Sarcopenia is typically a function of old age but may be mediated by behavioral and emotional factors such as "sleep, depression, fatigue, and self-efficacy" (Brady et al., 2014). The prevalence of sarcopenia can be determined in multiple ways, including the use of biochemical markers (Tosato et al., 2017) and diagnostic imaging to measure muscle mass (Cruz-Jentoft &

Sayer, 2019) and the use of dynamometry to measure grip strength (Beaudart et al., 2019). Gait speed also can be used as a physical diagnostic of lower-limb muscle strength (Beaudart et al., 2019; Dent et al., 2018). Additionally, various patient-reported outcome tools are available for collecting self-reported data, including the SarQol, used to measure quality of life of patients with sarcopenia (Beaudart et al., 2015a, 2015b), and the SARC-F (strength, assistance walking, rise from chair, climb stairs, and falls) questionnaire (Malstrom et al., 2016). Although some measurement tools used in practice have not demonstrated good validity (Bruyére et al., 2016), results of instrument testing show the SarQol is both a valid and reliable instrument (Malstrom et al., 2016). The SARC-F, which has been endorsed as an international clinical practice for diagnosing sarcopenia (Dent et al., 2018), also has demonstrated good validity and reliability (Beaudart, Biver et al., 2017).

Despite the availability of measures, there is no internationally accepted standard for measuring sarcopenia (Cruz-Jentoft et al., 2019). This means that different tools are based on different cut-offs for diagnosing sarcopenia (Beaudart et al., 2019); further complicating things is the use of varied definitions of sarcopenia (Kim et al., 2017). As a result of these inconsistencies, comparing prevalence rates of sarcopenia is challenging. For example, results in a cross-sectional study of almost 3,500 people in Norway showed differences in outcomes based on the type of diagnostic tool used; data showed that the prevalence of sarcopenia more than doubled when the condition was diagnosed using chair stands as opposed to grip strength (Johansson et al., 2020).

Prevention

Although there are no federally approved drugs for the treatment of sarcopenia, 10 pharmacological treatments have been suggested including vitamin D and a variety of hormone therapies among others (Cruz-Jentoft & Sayer, 2019). However, physical activity is the most prevalent recommendation for treating (Dent et al., 2018) and preventing (Steffl et al., 2017) sarcopenia. Although the international clinical practice guidelines for sarcopenia specifically recommend resistance-based physical activity (Dent et al., 2018), in a systematic review of the association between physical activity and sarcopenia, several types of physical activity resulted in decreased incidents of sarcopenia (Steffl et al., 2017).

Negative Outcomes Related to Sarcopenia

Sarcopenia is associated with greater risk of mortality for men (De Buyser et al., 2016) and women (Batsis et al., 2014) as well as with overall diminished quality of life (Malstrom et al., 2015). However, in a study of 387 patients assessed using the SarQol tool, low quality of life outcomes differed based on the definitions suggested by “Cruz-Jentoft (56.3 ± 13.4 vs 68.0 ± 15.2, $p < 0.001$), Studenski (51.1 ± 14.5 vs 68.2 ± 14.6, $p < 0.001$), Fielding (53.8 ± 12.0 vs 68.3 ± 15.1, $p < 0.001$), and Morley (53.3 ± 12.5 vs 67.1 ± 15.3, $p < 0.001$)” (Beaudart et al., 2018). Beaudart et al. (2018) recommends careful consideration of testing parameters when making determinations about quality of life findings among patients with sarcopenia.

The elderly with sarcopenia have increased risk of falls (Bischoff-Ferrari et al., 2015; Schaap et al., 2018), decreased mobility (Morley et al., 2011), cognitive impairment (Chang et al., 2016), increased hospital-related costs (Antunes et al., 2016), loss of independence (dos Santos et al., 2017), and need for care in a long-term care facility (Akune et al., 2014). Finally, the literature indicates a relationship between sarcopenia and and frailty-related cognitive impairment (e.g., Bone et al., 2017). However, a diagnostic overlap has been identified between sarcopenia and physical frailty (Bone et al., 2017), both of which have been described as subsets of general frailty (Cruz-Jentoft & Sayer, 2019). Because of the complex and uncertain nature of this relationship, a discussion of sarcopenia as it relates to frailty is beyond the scope of this DNP project.

Problem Statement

Although prevalence rates vary, it is clear that the incidence of sarcopenia increases with long-term survival, as is the case with patients in end-of-life care (Henwood et al., 2017) and residents in long-term care facilities. Sarcopenia is associated with greater risk of mortality (Batsis et al., 2014; De Buyser et al., 2016), overall diminished quality of life (Malstrom et al., 2015), increased risk of falls (Bischoff-Ferrari et al., 2015; Schaap et al., 2018), decreased mobility (Morley et al., 2011), cognitive impairment (Chang et al., (2016), increased hospital-related costs (Antunes et al., 2016), loss of independence (dos Santos et al., 2017), and the need for care in a long-term facility (Akune et al., 2014).

Physical activity is the most prevalent recommendation for treating (Dent et al., 2018) and preventing (Steffl et al., 2017) sarcopenia. As an intervention for sarcopenia, exercise can improve overall quality of life (Barthalos et al., 2016; Olsen et al., 2019), physical performance, muscle strength (Cruz-Jentoft et al., 2014), and muscle mass (Vlieststra et al., 2018). Although the international clinical practice guidelines for sarcopenia specifically recommend resistance-based physical activity (Dent et al., 2018), in a systematic review of the association between physical activity and sarcopenia, several types of physical activity resulted in decreased incidents of sarcopenia (Steffl et al., 2017). Although it is evident that physical activity may have a positive effect on sarcopenia, it was noted that residents at a local skilled nursing facility, the Advent Health Care Center, were neither screened for sarcopenia nor engaged in exercise programs outside of prescribed physical therapy when appropriate for rehabilitation due to injury.

DNP project Goal and Aims

The goal of this DNP project was to determine the effectiveness of a strength training program in decreasing the incidents of sarcopenia among residents at the Advent Health Care Center. Six specific aims were identified as necessary to achieve that goal:

- Aim 1: increase residents’ muscle mass.
- Aim 2: increase residents’ grip strength.
- Aim 3: increase residents’ balance.
- Aim 4: increase residents’ gait speed.
- Aim 5: increase residents’ chair stand.
- Aim 6: increase residents’ quality of life.

Chapter 2: Literature Review

Literature Search, Retrieval, and Appraisal Processes

To determine if ample evidence existed in the literature to support strength training as an intervention for sarcopenia, it was necessary to conduct a literature review. The PICOT question that guided the review was,

> In older residents in a skilled nursing facilities (population) who have sarcopenia (problem), how does a strength training program (intervention), compared with no strength training program (comparison) affect muscle strength, physical performance, and overall quality of life (outcome) after 90 days of participation in the muscle-strengthening program (time)?

The literature search was conducted in the CINAHL, PubMed, and Health Source (nursing/academic edition) databases accessed through the Florida Southern College Roux Library in July, 2021. The search parameters were studies published in peer-reviewed journals between 2016 and 2021. The key search terms were *sarcopenia*, *intervention*, *strategy*, *strength training*, *resistance training*, and *skilled nursing facilities*. Boolean terms were used to incorporate outcome variables such as *muscle strength*, *grip strength*, *gait speed*, and *quality of life*. Inclusion criteria were Level I or II studies written in or translated into English that included the use of strength or resistance training to treat sarcopenia among the elderly. Studies that included supplemental intervention components in addition to strength or resistance training also were included. Level of evidence was determined using the Melnyk and Fineout-Overholt's (2019) hierarchy of evidence for evidence-based practice (EBP) in nursing.

The initial search resulted in 357 articles. After removing duplicate records and articles that did not meet the basic inclusion criteria, 15 studies remained and were included in the review that makes up the remainder of this chapter. The PRISMA flow chart demonstrating the article vetting process is presented in Appendix A. A table of this evidence is presented in Appendix B.

Synthesis of Evidence

All 15 studies included in the literature review examined the effectiveness of strength training for treating sarcopenia. Three of the studies were randomized control trials (RCTs), one was a blinded longitudinal intervention study, one was a single blind, two groups, cluster randomized trial, five were systematic reviews with metaanalysis, and five were systematic reviews without metaanalysis. One third of the studies ($n = 5$) included either a supplemental intervention component or a secondary type of exercise. Outcome measures were muscle strength, physical performance, and quality of life.

Outcomes of Strength Training on Indicators of Sarcopenia

Of the 10 studies that included only a strength training program, the general theme in the outcomes was that strength training programs had positive impacts on muscle strength, physical performance, and quality of life in sarcopenic patients.

Muscle strength. Vikberg et al.'s (2019) RCT reported findings indicating that resistance training programs were effective in maintaining functional strength and increased muscle mass in older adults with pre-sarcopenia. Talar et al.'s (2021) systematic review and meta-analysis examined the effects of resistance training programs on muscle strength, physical function, and body composition of adults older than 65 years of age that were diagnosed with pre-sarcopenia, sarcopenia, or frailty. Twenty-five RCTs studies were reviewed and revealed the common theme of resistance training being a highly effective preventive strategy to delay and attenuate the negative effects of sarcopenia and frailty in both early and late stages.

In Vlietstra et al.'s (2018) systematic review and meta-analysis, findings from six RCTs reviewed, reported similar outcomes of exercise resistance-type exercises such as strength training, significantly improving strength, balance, and functional outcomes in older adults. Zhang et al. (2021), like Vlietstra et al. (2018), found through their systematic review and meta-analysis of seventeen RCT, that exercise interventions have positive effects on muscle strength, physical performance, and skeletal muscle mass for sarcopenic elderly. Bandeira de Mello et al. (2019), like Talar et al.(2021), through a systematic literature review of five RCTs, found that physical training with resistance training as the main intervention, improved muscle strength, muscle quality, and muscle control in sarcopenic elderly adults.

Physical performance. Del Campo Cervantes et al.'s (2019) blinded longitudinal intervention study, in evaluating the effects of a resistance training program on sarcopenia and functionality of the elderly nursing home residents, reported significant outcomes of improved strength and physical performance with a reduction in severe sarcopenia. Liao, Tsauo, Lin et al.'s (2017) compliant prospective randomized controlled trial reported data demonstrating the clinical efficacy of elastic resistance exercise training. The clinical findings suggested that applying elastic resistance exercises exerted benefits on the body's composition and physical function, especially in patients with sarcopenic obesity.

Beckwee et al.'s (2019) systematic review of fourteen studies found outcomes that are congruent with those of Bandiera de Mello et al. (2019) and Talar et al. (2021). Findings of these studies provided high quality evidence for a positive and significant effect of resistance training on muscle mass, strength, and physical performance in countering sarcopenia in older adults.

Quality of life. Barthalos et al.'s (2016) RCT, reported outcomes of the application of physical activities in improving physical condition and physical mobility in older adults.

Findings from the study indicated that a more physically active lifestyle has a positive effect on the elderly daily functions and therefore improves certain attributes of their quality of life. Olsen et al.'s (2019) systematic literature review of fourteen RCTs provides evidence that resistance training has a moderate positive effect on self-reported disability and function in older people with, or at risk for disability.

Outcomes of Strength Training and Supplemental Activities on Indicators of Sarcopenia

Of the five studies that included strength training and a supplemental intervention component, three included a supplemental nutritional component. The other two studies included a supplemental exercise component. The main treatment outcomes were muscle strength, physical performance, and quality of life.

Muscle strength. In Beaudart, Dawson et al.'s (2017) systematic review of 37 RCTs, the researchers examined the effectiveness of either resistance training alone or in conjunction with one of five supplemental nutritional components: (a) protein; (b) essential amino acids; (c) β-hydroxy-β-methylbutyrate (HMB); (d) multi-nutrient intervention; or (e) other vitamin, mineral, or nutrients. Participants' ages ranged from 59.5 (± 4.5 years) to 87.1 (± 0.6 years). Increase in muscle strength (length muscle strength and grip strength) was found with resistance training alone (n = 29) but also when combined with supplemental nutrition interventions: protein (n = 3), multi-nutrient intervention (n = 1), and creatine (n = 4). The researchers surmised that the 20% of participants for whom no improved muscle strength was observed likely were especially frail and unable to complete the exercise protocols correctly or thoroughly. Differences in the number of sessions of exercise per week also may have contributed to ineffectual outcomes.

Like Beaudart, Dawson et al., (2017), Antoniak and Greig (2017) studied the effect of resistance training with a nutritional component; however, Antoniak and Greig focused only on vitamin D_3. In their systematic review with meta-analysis, the researchers reviewed seven studies in which strength training and supplemental vitamin D_3 interventions were implemented with a total of 792 healthy elderly participants with an average age of 72.8 years. In five of the studies, the participants lived independently. One study included only male participants, and three studies included only female participants. The studies were divided into two groups. Studies in Group 1 ($n = 3$) compared strength training without vitamin D_3 supplementation to strength training with vitamin D_3 supplementation. Studies in Group 2 ($n = 6$) compared the use of vitamin D_3 alone compared to vitamin D_3 with strength training. Two studies were included in both groups.

A large effect size was found for muscle strength of the lower limb in both Group 1 (0.98, 95% CI 0.73, to 1.24, $p < 0.00001$) and Group 2 (2.69, 95% CI 0.95 to 4.42, $p = 0.002$). These findings suggested that vitamin D_3 as a supplement to strength training was an effective means of increasing lost lower limb muscle strength due to sarcopenia. However, it is possible that the effects of the strength training and supplemental vitamin D_3 intervention was effective only in treating the negative effects of vitamin D_3 deficiency in some participants.

Like Beaudart, Dawson et al., (2017), Liao, Tsauo, Wu et al. (2017) also studied the effect of resistance training with a nutritional component; however, these researchers focused only on protein. In their study of 17 RCTs, the average age of the 892 participants was 73.4 (± 7.9). Measures of muscle strength included upper body strength ($n = 6$), handgrip strength ($n = 6$), leg strength ($n = 11$), isometric knee extensor strength ($n = 1$), and isokinetic knee strength ($n = 2$). Although strength training improved muscle strength overall, the addition of protein supplementation resulted in overall significantly greater increases in leg strength with a standard mean difference of 0.69 (95% CI: 0.39, 0.98; P, 0.00001; $I^2 = 67\%$, $P = 0.0001$).

In Lopez et al.'s (2018) systematic review, the researchers examined the effectiveness of strength training in combination with other components (e.g., gait retraining, endurance training, balance training, flexibility training) in improving muscle strength in physically frail elderly. Sixteen studies were included in the review. Of the 12 studies that evaluated muscle strength as an outcome, eight indicated that strength training alone enhanced participants' capacity to complete isometric knee extensions by 6.6–37.0% and leg presses by 13.1–20.5%. Effect was found after 8, 10, 12, and 48 weeks of participation in the interventions.

Similar to eight of the studies in Lopez et al.'s (2018) systematic review, Hassan et al. (2015) explored the impact of combined resistance training and balance exercise on grip strength. In their single blind, two-group, cluster randomized trial, the researchers studied 42 residents from four different care facilities. Twice a week, participants engaged in 50 hours of progressive resistance and balance training for 6 months. Results showed an increase in grip strength (p = .007). This indicates that a resistance and balance exercise regimen is beneficial for older adults residing in nursing care facilities in decreasing the progressing of disability and sarcopenia.

Physical performance. In Beaudart, Dawson et al.'s (2017) systematic review examining the effectiveness of either resistance training alone or in conjunction with one of five supplemental nutritional components, the researchers found that resistance training alone (n = 26) and when combined with supplemental nutrition interventions (creatine, n = 1; vitamin D_3, n = 1; multi-nutrient intervention, n = 1; other nutritional supplements, n = 2) increased physical performance, including gait speed and chair stand. The researchers concluded that resistance training had a positive influence on physical performance among participants ages 60 and older; however, support for the added effects of supplemental nutritional components is limited.

In Liao, Tsauo, Wu et al.'s (2017) study of resistance training with a supplemental protein component, physical performance was measured using gait speed (n = 5), 6-min or 400-m walk test (n = 5), timed up-and-go test (n = 3), chair rise time (seconds; n = 7), short physical performance battery (SPPB) test (n = 2), stair climbing (n = 1), physical activity test (n = 1), and functional reach test (n = 1). Although strength training improved physical performance overall, the addition of protein supplementation only resulted in significantly greater increases in physical performance for the SPPB after a long intervention period. The standard mean difference was 0.44 (95% CI: 0.11, 0.78, $P = 0.009$; $I^2 = 0\%$, $P = 0.89$).

Eight of the 16 studies Lopez et al. (2018) reviewed tested the effectiveness of resistance training with multimodal exercise on physical performance. Of those eight studies, four found improvement in gait speed after 10 and 12 weeks of participation in the intervention. Rates of improvement ranged from 5.88–14.5%.

Chapter 3: Methods

In this chapter, the DNP project design is described, the data collection processes are explained, and the data analysis plan is presented. The chapter also has discussions about the protection of human subjects, dissemination plan, and implications for practice. To provide the reader with a foundation for understanding the methods associated with this DNP project, this section begins with a discussion of the DNP project's conceptual framework.

Conceptual Framework

In this DNP project, Stetler et al.'s (2011) revised promoting action on research implementation in health services (PARIHS) framework was used to guide the development and implementation of an evidence-based intervention. More specifically, the framework helped guide decisions made while generating a strength training program intended to decrease the incidence of sarcopenia in older patients in a skilled nursing facility and guided the implementation of that program. In this section, the PARIHS framework is explained, and the application of the framework in this DNP project is presented.

PARIHS Framework

The PARIHS framework, classified as an impact or explanatory framework (Stetler et al., 2011), was developed to provide an understanding of the elements that contribute to the successful implementation of research into practice in the healthcare setting (Kitson et al. 1998). The framework provides a comprehensive explanation of the implementation process and influences, helps practitioners translate evidence into practice, and can be used for evaluation as it defines important aspects of the intervention and implementation processes (Stetler, 2011).

According to Kitson et al. (1998), there are three core elements required for successful implementation of EBP into healthcare: (a) the quality of the research evidence on which the intervention is based, (b), the context or setting into which the intervention is introduced, and (c) the processes by which the intervention is implemented (i.e., facilitation). The core elements are intended to be assessed on a continuum from low to high; considering the elements in this way helps provide an understanding of how interventions may be successful overall even when one or two of core elements are assessed as low in strength (Kitson et al., 1998). In a revised version of the PARIHS framework, Stetler et al. (2011) expanded the evidence element, renamed the context element, and added successful implementation as a fourth key element of the successful implementation of research into practice. The four key elements and their subelements are discussed in more detail here.

Evidence and EBP characteristics. Stetler et al. (2011) defined evidence as "codified and non-codified sources of knowledge, as perceived by multiple stakeholders" (p. 3). Sources of knowledge that come from national, large-scale, widely accepted, or highly esteemed organizations or associations that produce guidelines and standards based on evidence (Kitson et al., 1998) could be considered codified sources of knowledge. Expert opinion based on formal consensus (Kitson et al., 1998) could be considered an uncodified source of knowledge. Evidence also may be generated through locally generated standards and patient preferences (Kitson et al., 1998), experiences, and needs (Stetler et al., 2011). EBP characteristics, Stetler et al.'s (2011) expansion on the original evidence element, refer to characteristics of an innovation based on evidence that promote diffusion of the innovation; they are "relative advantage, observability, compatibility, complexity, trialability, design quality and packaging, and costs" (Stetler et al. 2011, p. 6).

Contextual readiness for targeted EBP implementation. Contextual readiness for targeted EBP implementation refers to the characteristics of the environment in which the intervention is to be implemented (Stetler et al., 1998). Essentially, context refers to the underlying forces that contribute to the impression given by a physical environment (Kitson et al., 1998). The factors that contribute to contextual readiness for targeted EBP implementation are "leadership support, culture, evaluation capabilities, and receptivity to the targeted innovation" (Stetler et al., 2011, p. 6). Stetler et al. (2011) added receptivity to the targeted innovation to underscore the importance of both task orientation during the implementation process and organizational or individual willingness to change, without which change will not occur. Also, reorganization of the subelements allowed leadership support to become the primary subelement, emphasizing the critical nature of leadership support.

Facilitation. Facilitation refers to the process of supporting change in others through adaptation of people's "attitudes, habits, skills, ways of thinking, and working" (Kitson et al., 1998, p. 152). Three subelements are related to facilitation with regard to the role of the facilitator: "purpose, external and/or internal role; expectations and activities; and skills and attributes of facilitator" (Stetler et al., 2011, p. 6). Internal facilitation is task driven and directed at specific behaviors whereas external facilitation reflects a holistic approach to effect a desired change in behavior. Facilitation also may include other implementations employed by the facilitator as deemed applicable based on formal assessment or valid sources. These additional interventions may be related to evidence and EBP characteristics or to contextual readiness; however, other unrelated but applicable interventions may be applied as well.

Successful implementation. Successful implementation refers to "the degree to which implementation strategies are both fielded in the intended form/format and related adoption activities reach the targeted audience" (Stetler et al., 2011, Additional File 4). The three subelements are "implementation plan and its realization, EBP innovation uptake: uptake of clinical interventions and/or delivery system interventions, [and] patient and organizational outcomes achievement" (Stetler et al., 2011, p. 6). When considering the implementation plan itself, assessment should be focused on how well each part of the intervention was operationalized, the degree of fidelity with which the intervention was implemented, and the extent to which the implementation strategy was delineated and expressed (Stetler et al., 2011).

Application of the PARIHS Framework

The PARIHS framework guided the design and implementation of this DNP project, a strength training program to treat sarcopenia among patients at the Advent Health Care Center. To ensure the successful implementation of the strength training program, I considered the four core elements and associated subelements when applicable.

Evidence. For this DNP project, I developed a strength-training intervention following guidelines published by the EWGSOP and based on other research published in scholarly peer-reviewed journals. Additionally, as a nurse practitioner, I had observed the positive effects of strength exercises on patients participating in physical therapy and have had conversations with residents at the Advent Health Care Center during which some residents expressed their fear of falling and their dissatisfaction with their quality of life. Also, the cost for the exercise program was minimal and the program (a) had the potential for prompting valuable change for the residents at the facility, (b) was compatible with the concept of care underlying the facility, and (c) was simple enough for the residents to manage. Finally, the measures used to determine improvement in muscle mass, muscle strength, and physical performance were based on observable actions.

Contextual readiness for targeted EBP Implementation. Advent Health Care Center has a history of strong leadership that supports a patient-first culture that is open to change. The administration enables and encourages teamwork and collaboration between all staff members, regardless of whether they are employees of the center or other healthcare networks on premises providing patient care. However, staff roles are clearly delineated, and those who initiate change through interventions are held accountable for demonstrating progress and desirable outcomes. The intervention for this DNP project was capable of being evaluated. Although no assessments unique to Advent Health Care Center were used for the intervention, established measures and instruments were used to record data for each of the four focus areas in the program (i.e., muscle mass, muscle strength, physical performance, and overall quality of life). Lastly, the Advent Health Care Center was receptive to the strength training program. Specifically, the center had space in which the residents could engage in physical activity, and the intervention was appropriate for the setting.

Facilitation. The change initiated through this intervention was task focused. As a nurse practitioner, I was fully capable of facilitating the muscle strengthening intervention with the given population. My role as the developer and sole facilitator of the intervention was clearly established among the center's staff, and the expectations for the intervention were clearly expressed to the center's administrators.

Successful implementation. I worked diligently to develop a plan for implementing the strength training program. The plan was based on high quality studies and recommendations from well-respected organizations in the field. Appropriate and established measures and instruments were chosen to ensure the accurate recording of data and to improve the validity of the findings. The exercise program was consciously designed with the physical capabilities of the elderly population in mind. Administrators at the Advent Health Care Center expressed their belief in the value of this intervention. Because I had heard residents express their dissatisfaction with their quality of life, I anticipated that the exercise program would be well-received among the residents.

DNP Project Design

This DNP project is best described as evidence-based pilot study using a pre- and posttest design. A pilot study is “a small-scale study, or trial run, done in preparation for a major study” (Polit & Beck, 2018, p. 412). In nursing intervention research, pilot studies are employed to generate evidence of (a) the effectiveness or value of the intervention, (b) the feasibility of implementing a rigorous large-scale study, and (c) to gain insight into improving existing intervention-focused nursing theory and protocols. This DNP project was considered a pilot study because it was a small-scale project conducted to generate evidence of the effectiveness of an intervention for treating sarcopenia.

Evidence-based research refers to “the use of prior research in a systematic and transparent way to inform a new study so that it is answering questions that matter in a valid, efficient, and accessible manner” (Robinson et al., 2021, p 151). In nursing science, evidence-based research is used to support EBP (Choi, 2021), where rigorous research is considered when treatment protocols and recommendations for practice are established (Melnyk & Fineout-Overholt, 2019). This DNP project used an evidence-based approach because (a) the design was informed by prior research demonstrating the effectiveness of strength-training exercises as a treatment for sarcopenia, (b) the intervention protocol was informed by a position statement from the American College of Sports Medicine (ACSM), and (c) the purpose was to answer a clinical question: Is strength training an effective intervention for treating sarcopenia among older adults at Advent Health Care Center?

The pre- and posttest research design refers to “an experimental design in which data are collected from research subjects both before and after introducing interventions” (Polit & Beck, 2018, p. 413). True experimental research includes the randomization of study participants and a control group (Polit & Beck, 2018). Although this DNP project was a pilot study using a small sample without a control group or subject randomization, participants’ muscle mass, muscle strength, physical performance, and overall quality of life was measured at baseline and after 30, 60, and 90 days of participation in the program. Thus, before-and-after measurements were recorded.

The DNP project was reviewed by Florida Southern College’s Institutional Review Board and conducted in accordance with the board’s rules and guidelines. Participants were informed about the details of the DNP project through informed consent. Participation was voluntary. All data were kept secure and no personal data were shared in the final report.

Setting

Advent Health Care Center, located in East Orlando, Florida, is a 120-bed skilled nursing and rehabilitation facility that offers therapeutic and rehabilitation services, including physical therapy, occupational therapy, and speech therapy, to patients 25 years of age and older. Care is available on an outpatient, short-term inpatient, or long-term inpatient basis. Direct care services include orthopedic care, cardiac care, post amputee care, post stroke care, postsurgical care, lymphoedema treatments, respiratory care, cognitive linguistic therapy, vital stimulation, hydrotherapy, and respiratory therapy. Other care services include pain, wound, medication and diabetic management; ostomy care; intravenous therapy, enteral nutrition; Alzheimer’s-dementia, respite, palliative, and hospice care; and management of complex care needs. To enhance the patient experience, the facility also offers a computer workstation with printer, flat-screen television with pillow speaker for each resident, Nintendo Wii (for therapy), wireless high-speed Internet, pet visitation therapy, personal hygiene services, and daily recreational activities.

Sample

The DNP project sample was a convenience sample of older residents from the Advent Health Care Center. There were four inclusion criteria:

- long-term residency,
- 65 years of age or older,
- English fluency, and
- score of 4 or more on the SARC-F.

To ensure participants would complete the 90-day program, only long-term residents were considered for the DNP project. Since sarcopenia is most prevalent among the elderly, this population was identified for participation in this DNP project. Language fluency was a necessary inclusion criterion because participants must be able to understand the expectations for participation in the DNP project and the procedures for the exercise program. A score of 4 or more on the SARC-F is a necessary inclusion criterion because that score indicates the presence of sarcopenia and the purpose of this DNP project is to determine the effectiveness of an intervention among a population with sarcopenia; therefore, it was essential that participants demonstrate the presence of sarcopenia. There were three exclusion criteria:

- a cognitive impairment,
- a physical or health limitation that impedes their capacity to engage in moderate exercise, or
- an active physical therapy order.

Residents were excluded from this DNP project if they had a cognitive impairment to ensure that they were voluntarily participating in the DNP project and that they could follow instructions. Residents also were excluded if they demonstrated a physical or health limitation that would impede their capacity to engage in moderate exercise; this exclusion criterion ensured resident safety. Also, if residents had an active physical therapy order, they were excluded from the DNP project as I would not have been able to collect accurate baseline measures or determine whether participant improvements were due to the existing physical therapy or the exercise program intervention.

Recruiting. All English-speaking, long-term residents of the Advent Health Care Center 65 years or older were considered for inclusion in the DNP project. Residents who had a cognitive impairment, had an active physical therapy order, or were physically incapable of participating in an exercise program were excluded from the DNP project.

Residents' age; cognitive, physical, and language capacities; and physical therapy status were determined through review of their medical records. Residents who meet the inclusion criteria and who were without cognitive impairments, physical limitations, and active physical therapy orders were recruited to participate in the DNP project using flyers delivered via the internal resident mail system following physician clearance. After 1 week, I sent a reminder flyer to any eligible participants who had not enrolled in the DNP project.

Residents who expressed interests in participating in the DNP project were screened for sarcopenia using a case-finding approach, which Cruz-Jentoft and Sayer (2019) suggested were appropriate in care settings where one might expect to find a high prevalence of sarcopenia. Following Dent et al.'s (2018) guidelines for diagnosis and screening of sarcopenia, residents with SARC-F scores of 4 or more were considered to have sarcopenia and included in the DNP project. A more detailed discussion of the SARC-F is presented in the Data Collection Instruments and Measures section.

Sample size. When the DNP project started there were 30 residents at the facility. It was anticipated that not all residents would meet the inclusion criteria and that some of the residents who met the inclusion criteria would be excluded or decline to participate. A reasonable estimate was that 20–24 participants would be included in the DNP project. It is important to note that the small sample size was the leading consideration in the decision to conduct a pilot study.

Intervention Protocol

The ACSM has suggested that older adults engage in moderate to vigorous resistance exercise at least twice a week and engage in balance exercises as needed to generate improvement (Chodzko-Zajkoet al., 2009). Participants in this DNP project exercised two times a week for 90 days. The resistance training and balance exercises followed the descriptions provided in the ACSM position stand on exercise and physical activity for older adults.

The resistance exercise portion of the intervention followed the guidelines from the ACSM so that it was a "progressive weight training program . . . [that included] (8–10 exercises involving the major muscle groups of 8–12 repetitions each), stair climbing, and other strengthening activities that use the major muscle groups" (Chodzko-Zajko et al., 2009, p. 1511). The balance portion of the intervention was

> 1) progressively difficult postures that gradually reduce the base of support (e.g., two-legged stand, semitandem stand, tandem stand, one-legged stand), 2) dynamic movements that perturb the center of gravity (e.g., tandem walk, circle turns), 3) stressing postural muscle groups (e.g., heel stands, toe stands), or 4) reducing sensory input (e.g., standing with eyes closed). (Chodzko-Zajko et al., 2009, p. 1511)

Data Collection

Data were collected at three points in this DNP project. First, SARC-F scores were collected to determine whether patients were sarcopenic and eligible for inclusion in this DNP project. Next, age and gender data were collected to provide a simple description of the sample. Because of the small sample size, no additional demographic data were collected. Lastly, to determine the effectiveness of the strength training program, data for muscle mass, grip strength, balance, gait speed, chair stand, and quality of life were collected at baseline, 30 days, 60 days, and 90 days of program participation. See Appendix C for the DNP project timeline.

Collection Protocol

A body-analyzer scale was used to collect data on muscle mass and a digital strain dynamometer was used to collect data on muscle strength. Data for these two measures were recorded manually in Excel spread sheets. Although Dent et al. (2018) indicated grip strength was not the best measure of muscle strength, Beaudart et al. (2019) disagreed. For convenience, grip strength was used as a measure of muscle strength. Data for physical performance were collected using the SPPB and data were recorded using the SPPB app I purchased for use on my phone. Sarcopenia was indicated by

- muscle mass < 8.87 kg/m in men and < 6.42 kg/m in women (Cruz-Jentoft et al., 2019),
- grip strength of < 30 kg in men and < 20 kg in women (Beaudart, Biver, et al., 2017), and
- < 8 combined points for physical performance on the SPPB (Guralnik et al., 2000).

Although the purpose of collecting these data was to demonstrate improved outcomes over the course of the 90 days in which the participants were engaged in the exercise program, the data also was used to confirm that participants were sarcopenic. Data for quality of life were collected using a paper version of the SarQol. After participants completed the surveys, each participant's responses were recorded in a separate Excel spread sheet.

Instruments and Measures

Various instruments and measures were used in this DNP project. Screening for sarcopenia was accomplished using the SARC-F. The instruments and measures used to collected data for muscle mass, muscle strength, physical performance, and overall quality of life are discussed in detail in this section.

SARC-F. The SARC-F is made up of five components: strength, assistance walking, rise from a chair, climb stairs, and falls (Malstrom et al., 2015). The components are measured using one of three scales: *none* (0), *some* (1), *a lot or unable* (2); *none* (0), *some* (1), *a lot, use aids, or unable* (2); *none* (0), *less than 3 falls* (1), *4 or more falls* (2). The SARC-F, which has been endorsed as an international clinical practice for diagnosing sarcopenia (Dent et al., 2018), has demonstrated good validity and reliability (Malstrom et al., 2016). The complete five-item instrument is presented in Appendix D.

Inevifit body-analyzer scale. The Inevifit body-analyzer scale was used to measure muscle mass. Although only the muscle mass measure was considered for this DNP project, the scale also measures body weight, percentages of body fat and water, body fat grade, bone mass, and basal metabolic rate (Inevifit, 2020). To ensure the scale was in the best possible working condition, the scale was purchased new from the manufacturer's website.

Dynamometer. A dynamometer was used to measure grip strength. Dynamometers may be of the hydraulic, pneumatic, mechanical, or strain varieties (Beaudart et al., 2019). Although the Jamar hydraulic dynamometers are considered the gold standard for measuring grip strength, pneumatic, mechanical, and strain dynamometers all have been shown to generate valid and reliable results. Additionally, according to Beaudart et al. (2019), for practical purposes, "cheap and easy-to-administer tool[s]" (p. 8) are essential. Therefore, in this DNP project, I chose to use a Handeful digital strain gauge dynamometer, which she purchased from the manufacturer's website. The device can measure in 0.2 pound (or 0.1 kilogram) increments up to 198 pounds and can record 19 user profiles (Handeful Store & Club, 2021). The device's grip bar is adjustable to accommodate all hand sizes.

SPPB. The SPPB was developed by the National Institute on Aging (2021) to measure lower extremity function in older persons. The SPPB, made up of the three separate measures balance, gait speed, and chair stand (Guralnik, 2020), has been shown to be a valid measure of lower extremity function in the elderly (Guralnik et al., 1994). No permission was needed to use the instrument.

To demonstrate balance, participants are asked to maintain side-by-side, semitandem, and tandem positions for 10 seconds (Guralnik et al., 2000). On a scale of 1–4, points are awarded based on participants' capacity hold the full tandem stand for 10 seconds. To demonstrate gait speed, participants are asked to walk 8 feet at their usual pace starting from a static standing position and to repeat the measure. The faster of the two measures are recorded, and on a scale of 1–4, points are awarded in quartiles based on the speed with which participants' complete the 8-foot walk. To demonstrate chair stand, participants are asked to stand up from a seated position while keeping their arms folded across their chests and to repeat the activity for a total of five times as quickly as they can. On a scale of 1–4, points are awarded in quartiles based on the speed with which participants can complete the activity. A full description of the balance, gait speed, and chair stand activities along with the scoring guide is presented in Appendix E.

SarQol. The SarQol was developed specifically to measure quality of life among elderly people (i.e., people 65 years and older) who live in community settings (Beaudart et al., 2015a). The 22-item survey represents 55 conceptual items pertaining to seven domains: physical and mental health (8 items), locomotion (9 items), body composition (3 items), functionality (14 items), activities of daily living (15 items), leisure activities (2 items), and fears (4 items; see Appendix F.) Scores can be calculated per domain at 100 points per domain or for overall quality of life based on the 22 survey items (Beaudart et al., 2018). Scoring for the instrument is based on an algorithm (Beaudart et al. 2015a) and is provided by SarQol (2021) upon request and after the user establishes an account, which I did.

At the time this DNP project was implemented, the instrument was being translated into five languages and already had been translated into 32 languages, six of which have been validated including the English version (SarQol, 2021) used in this DNP project. Although some measurement tools used in practice have not demonstrated good validity (Bruyére et al., 2016), results of instrument testing show the SarQol is both a valid and reliable instrument (Beaudart et al., 2017).

Data Analysis

All collected data were stored in electronic files for analysis. Data collected using the SARC-F were used only for screening purposes and were not included in any data analyses. All electronic data were uploaded to SPSS for analysis. Results of *t* tests were used to demonstrate change in participant scores from baseline to 30 days, from baseline to 60 days, from baseline to 90 days, from 30 days to 60 days, and from 60 days to 90 days and thus confirm that the study aims were achieved.

Chapter 4: Results

Descriptive Statistics

There were 23 individuals between the ages of 66 and 87 years old with a mean age of 78.7 years old (SD = 6.39) who participated in this DNP project. More women (*n* = 14) than men (*n* = 9) participated. Table 1 displays the descriptive statistics (i.e., SARC-F scores) for the sample and data. The modal SARC-F score of participants was 9. The mean muscle mass of participants before the intervention was 48.3 kg and after 90 days of intervention, mean muscle increased to 49.5 kg. Mean grip strength before intervention was 23.0 lbs. and after 90 days of intervention mean grip strength increased to 27.0 lbs. Mean sarcopenia quality of life before intervention was 39.1%, whereas after 90 days of intervention, sarcopenia quality of life increased to 56.3%.

Three measures of lower body extremity function were measured. Before intervention, the modal score for balance was 2 (i.e., individual can hold a semitandem stand for 10 seconds but is unable to hold a full tandem stand for more than 2 seconds) and after 90 days of intervention, the modal balance score increased to 4 (i.e., individual can hold the full tandem stand for 10 seconds). Before intervention, the modal score for gait speed was 1 (i.e., individual walks at ≤ 0.43 m/s) and after 90 days of intervention, modal gait speed increased to 3 (i.e., individual walks between 0.61 – 0.77 m/s). Finally, before intervention, the modal score for chair stand was 1 (i.e., individual can stand and sit 5 times requiring > 16.7 seconds) and after 90 days of intervention, the modal chair stand increased 3 (i.e., individual can stand and sit 5 times in 11.2 to 13.6 seconds).

Table 1

SARC-F and SarQol Scores

Variable	Baseline		30 days		60 days		90 days	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
				SARC-F				
Muscle mass	48.32	8.04	48.84	8.00	49.34	8.00	49.50	8.05
Grip strength	23.02	12.19	24.75	12.35	25.16	11.59	27.04	11.55
Balance	1.52	0.51	2.35	.71	2.91	0.51	3.65	0.57
Gait speed	1.26	0.45	2.00	0.67	2.74	0.45	3.09	0.42
Chair stand	1.22	0.42	1.96	0.56	2.78	0.42	3.09	0.42
				SarQol (%)				
Quality of life	39.1	5.9	45.2	7.4	54.0	5.2	56.3	5.4

Inferential Statistics

Table 2 displays the results of the paired *t* test analyses. Muscle mass (Aim 1) increased significantly from preintervention baseline over the first 60 days of the intervention. There were minimal, nonsignificant gains in the last 30 days of the intervention. Grip strength (Aim 2) improved over the course of the intervention. There was, however, a nonsignificant increase in grip strength between 30 days and 60 days of the intervention. This result cannot be explained at this time. Steady significant gains were made on all other measures (balance [Aim 3], gait speed [Aim 4], chair stand [Aim 5], and quality of life [Aim 6]) over the intervention period.

The resistance training and balance exercises had the greatest effect on balance, gait speed, chair stand, and quality of life over 90 days. On average, participant's balance score preintervention ($M = 1.52$, $SD = 0.51$) increased over 90 days ($M = 3.65$, $SD = 0.57$) by 2.13, which was statistically significant ($t[22] = 18.64$, $p < .001$) and represented an effect size of $d =$ 3.89. On average, participant's gait speed score preintervention ($M = 1.26$, $SD = 0.45$) increased over 90 days (*M* = 3.09, *SD* = 0.42) by 1.83, which was statistically significant ($t[22] = 17.84$, $p < .001$) and represented an effect size of $d = 3.72$. On average, participant's chair speed score preintervention (*M* = 1.12, *SD* = 0.42) increased over 90 days (*M* = 3.09, *SD* = 0.42) by 1.87, which was statistically significant ($t[22] = 16.36$, $p < .001$) and represented an effect size of $d = 3.41$. On average, participant's quality of life score preintervention (*M* = 39.1%, *SD* = 5.9%) increased over 90 days (*M* = 56.3%, *SD* = 5.4%) by 17.5%, which was statistically significant ($t[22] = 19.26$, $p < .001$) and represented an effect size of $d = 4.03$.

Table 2

Results of the Paired Samples t Tests

Variable	Time 1 *M*	Time 1 *SD*	Time 2 *M*	Time 2 *SD*	*t*(22)	*p*	Cohen's d
			Baseline to 30 days				
Muscle mass	48.32	8.04	48.84	8.00	2.93	.008	0.610
Grip strength	23.02	12.19	24.76	12.35	11.96	<.001	2.493
Balance	1.52	0.51	2.35	0.71	10.22	<.001	2.132
Gait speed	1.26	0.45	2.00	0.67	7.90	<.001	1.646
Chair stand	1.22	0.42	1.96	0.56	7.90	<.001	16.46
Quality of life	39.1	5.9	45.2	7.4	4.47	<.001	0.917
			Baseline to 60 days				
Muscle mass	48.32	8.04	49.34	8.00	6.24	<.001	1.301
Grip strength	23.02	12.19	25.16	11.59	4.97	<.001	1.029
Balance	1.52	0.51	2.91	0.51	13.37	<.001	2.788
Gait speed	1.26	0.45	2.74	0.45	13.88	<.001	2.894
Chair stand	1.22	0.42	2.78	0.42	14.81	<.001	3.411
Quality of life	39.1	5.9	54.0	5.2	13.88	<.001	2.900
			Baseline to 90 days				
Muscle mass	48.32	8.04	49.50	8.05	2.85	.009	0.593
Grip strength	23.02	12.19	27.04	11.55	8.15	<.001	1.700
Balance	1.52	0.51	3.65	0.57	18.64	<.001	3.887
Gait speed	1.26	0.45	3.09	0.42	17.84	<.001	3.719
Chair stand	1.22	0.42	3.09	0.42	16.36	<.001	34.11
Quality of life	39.1	5.9	26.3	5.4	19.26	<.001	4.026
			30 days to 60 days				
Muscle mass	48.84	8.00	49.34	8.00	4.03	.001	0.839
Grip strength	24.75	12.35	25.16	11.59	1.01	.323	0.211
Balance	2.35	0.71	2.91	0.51	5.35	<.001	1.115
Gait speed	2.00	0.67	2.74	0.45	7.90	<.001	1.646
Chair stand	1.96	0.56	2.78	0.42	10.22	<.001	2.132
Quality of life	45.2	7.4	54.0	5.2	19.26	<.001	1.412
			30 days to 90 days				
Muscle mass	48.84	8.00	49.50	8.05	1.70	.103	0.355
Grip strength	24.75	12.35	27.04	11.55	5.04	<.001	1.051
Balance	2.35	0.71	3.65	0.57	9.85	<.001	2.054
Gait speed	2.00	0.67	3.09	0.42	7.80	<.001	1.626
Chair stand	1.96	0.56	3.09	0.42	9.89	<.001	2.063
Quality of life	45.2	7.4	56.3	5.4	8.96	<.001	1.858
			60 days to 90 days				
Muscle mass	49.34	8.00	49.50	8.05	0.44	.665	0.092
Grip strength	25.16	11.59	57.04	11.55	10.87	<.001	2.267
Balance	2.91	0.51	3.65	0.57	7.90	<.001	1.646
Gait speed	2.74	0.45	3.09	0.42	3.43	.002	0.714
Chair stand	2.78	0.42	3.09	0.42	3.10	.005	0.647
Quality of life	54.0	5.2	56.3	5.4	4.44	<.001	0.965

Chapter 5: Discussion

The data showed that overall the strength training program was an effective intervention for reducing the characteristics associated with sarcopenia. Each of the six aims were achieved: significant gains were made on muscle mass from baseline to 60 days and on grip strength, balance, gait speed, chair stand, and quality of life) over the intervention period. The resistance training and balance exercises had the greatest effect on balance, gait speed, chair stand, and quality of life over 90 days.

The literature supports the use of resistance training for improving muscle mass (e.g., Bandiera de Mello et al., 2019; Talar et al., 2021; Vikberg et al., 2019; Zhang et al., 2021). It is not clear why no significant gains were indicated in the last 30 days of the intervention. However, as Beaudart, Dawson et al. (2017) suggested, lack of significant outcomes may indicate a particularly frail sample group who were unable to fully participate in the required exercises. Per the SARC-F, scores of 4 or more are considered indicative of sarcopenia; the highest possible score is 10. Because participant scores were not included as a variable in this DNP project, it is possible that the participants in this DNP project were more severely sarcopenic (indicated by scores of 8–10) as opposed to only mildly to moderately sarcopenic (indicated by scores of 4–6). However, it also is possible that participants were less sarcopenic and thus were only able to make limited improvements before reaching their capacity. It is also possible that the participants were afraid to increase the weight with which they were working or just not included to push themselves to do so.

Improved grip strength resulting from resistance training is supported in the literature (e.g., Beaudart, Dawson et al., 2017; Hassan et al., 2015; Liao, Tsauo, Wu et al., 2017). It is not clear why no significant increase in grip strength was indicated between 30 days and 60 days of the intervention. Perhaps a more sensitive instrument for measuring grip strength would have resulted in more consistent findings. Further study is required to fully understand the variables that contribute to improved grip strength in association with strength training programs.

The data showed steady significant gains for balance, gait speed, and chair stand over the intervention period. The literature supports a mix of physical performance indicators (e.g., Bandiera de Mello et al., 2019; Beckwee et al., 2019; Talar et al., 2021). In particular resistance training improved balance (Vikberg et al., 2019;), gait speed (Beaudart, Dawson et al., 2017; Liao, Tsauo, Lopez et al., 2018; Wu et al., 2017), and chair stand (e.g. Beaudart, Dawson et al., 2017; Liao, Tsauo, Wu et al., 2017).

Finally, the data showed steady significant gains for quality of life over the intervention period. Both Barthalos et al. (2016) and Olsen et al. (2019) found that resistance training improves quality of life. The findings, however, showed only a moderate improvement. More research is needed to understand the influence of resistance training on balance outcomes.

Implications for Future Study

Although the data showed that the strength training program was an effective intervention for increasing muscle mass, muscle strength, physical performance, and overall quality of life, it is unclear what demographic variables may have mediated these relationships. Study of the degree of sarcopenia and demographic variables (e.g., race, gender, specific age) that may influence the effectiveness of a strength training program could provide valuable data useful for determining the populations for whom such a program would be most valuable. Also, study of strength training programs in combination with supplemental nutritional components such as (a) protein; (b) essential amino acids; (c) β-hydroxy-β-methylbutyrate (HMB); (d) multi-nutrient intervention; or (e) other vitamin, mineral, or nutrients (Beaudart et al., 2017) is needed to more fully understand how such a program could be enhanced for maximum results.

Implications for Practice

It is understood that results from this DNP project are not generalizable to larger populations or those in other healthcare settings. However, the data did show that all measured components of sarcopenia (i.e., muscle mass, muscle strength, physical performance, and overall quality of life) improved during the course of the intervention. These findings provide a base of understanding for making informed decisions about integrating a muscle strengthening exercise intervention into existing care programs. Practitioners in skilled nursing facilities and assisted living care settings may use these findings as a starting point in the decision-making process when considering options for reducing the incidence of sarcopenia among their long-term care residents. Based on initial findings from this DNP project, strength training programs have the potential to serve as a cost-effective means for reducing the incidence of sarcopenia among long-term care residents.

Limitations

Limitations of this DNP project were recognized. A conscious choice was made to conduct a pilot study using a small convenience sample. However, data analyzed from small and nonrandomized samples may result in Type II errors (i.e., false negatives) and are not generalizable to larger populations. Another limitation was that, although appropriate by the EWGSOP guidelines, the body-analyzer scale used to measure muscle mass works using electricity to provide body fat analysis. The use of a more powerful and accurate diagnostic tool such as a dual-energy X-ray absorptiometry scan (i.e., DEXA scan) would have produced more accurate body mass data. Similarly, a hydraulic dynamometer may have provided more accurate grip strength data. Also, the intervention for this DNP project was limited to a resistance exercise protocol. The inclusion of supplemental nutritional components (Beaudart et al., 2017) could have generated more significant outcomes.

Summary

The purpose of this DNP project was to determine the efficacy of a strength training program for treating sarcopenia among older adults at Advent Health Care Center. Sarcopenia was measured by muscle mass, muscle strength (i.e., grip strength), physical performance (i.e., balance, gait speed, chair stand], and overall quality of life). Residents were screened for sarcopenia using the SARC-F. Four additional tools were used to measure the DNP project variables: muscle mass (Inevifit body-analyzer scale); grip strength (dynamometer); balance, gait speed, and chair stand (SPPB); and quality of life (SarQol). Data were collected at baseline, 30 days, 60 days, and 90 days.

Although the DNP project was limited by its small sample size and use of simple diagnostic equipment, results indicate that overall a strength training program can reduce the incidence of sarcopenia among long-term care residents in skilled nursing facilities. Practitioners in skilled nursing facilities and assisted living care settings may use the findings from this DNP project to consider whether a similar program might be appropriate for their residents. The description provided about this DNP project's design and the details provided about the exercise protocol may function as a general guide and starting point for others considering cost-effective options for reducing the incidence of sarcopenia among long-term care residents. Reduction in the incidence of sarcopenia among long-term care residents in skilled nursing facilities may, subsequently, contribute to reduced adverse effects of the disease process such as falls, hospital readmissions, morbidity, and mortality and help residents achieve an overall higher quality of life.

References

Akune, T., Muraki, S., Oka, H., Tanaka, S., Kawaguchi, H., Tokimura, F., Yoshida, H., Suzuki, T., Nakamura, K., & Yoshimura, N. (2014). Incidence of certified need of care in the long-term care insurance system and its risk factors in the elderly of Japanese population-based cohorts: The ROAD study. *Geriatric and Gerontology International, 14*(3), 695–701. https://doi.org/10.1111/ggi.12155

Antoniak, A. E., & Greig, C. A. (2017). The effect of combined resistance exercise training and Vitamin D_3 supplementation on musculoskeletal health and function in older adults: A systematic review and meta-analysis. *BMJ Open, 7*(7), 1–16. https://doi.org/10.1136/bmjopen.2016-014619

Antunes, A. C., Araújo, D. A., Veríssimo, M. T., & Amaral, T. F. (2016). Sarcopenia and hospitalisation costs in older adults: A cross-sectional study. *Nutrition & Dietetics, 74*(1), 46–50. https://doi.org/10.1111/1747-0080.12287

Bandeira de Mello, R. G., Corte, R. R. D.,Gioscia, J., & Moriguchi, E. H. (2019). Effects of physical exercise programs on sarcopenia management, dynapenia, and physical performance in the elderly: A systematic review of randomized clinical trials. *Journal of Aging Research, 2019*, Article 1959486. https://do1.org/10.1155/2019/1959486

Barthalos, I., Dorgo, S., Kopkáné Plachy, J., Szakály, Z., Ihász, F., Ráczné Németh, T., & Bognár, J. (2016). Randomized controlled resistance training based physical activity trial for central European nursing home residing older adults. *The Journal of Sports Medicine and Physical Fitness, 56*(10), 1259–1257.

Batsis, J. A., Mackenzie, T. A., Barre, L. K., Lopez-Jimenez, F., & Bartels, S. J. (2014). Sarcopenia, sarcopenic obesity and mortality in older adults: Results from the National

Health and Nutrition Survey III. *European Journal of Clinical Nutrition, 68*(9), 1001–1007. https://doi.org/10.1038//ejcn.2014.117

Beaudart, C., Biver, E., Reginster, J.-Y., Rizzoli, R., Rolland, Y., Bautmans, I., Petermans, J., Gillain, S., Buckinx, F., Dardenne, N., & Bruyére, O. (2017). Validation of the SarQoL®, a specific health-related quality of life questionnaire for sarcopenia. *Journal of Cachexia, Sarcopenia and Muscle, 8*(2), 238–44. https://doi.org/10.1002/jcsm.12149

Beaudart, C., Biver, E., Reginster, J.-Y., Rizzoli, R., Rolland, Y., Bautmans, I., Petermans, J., Gillain, S., Buckinx, F., Van Beveren, J., Jacquemain, M., Italiano, P., Dardene, N., & Bruyere. (2015a). Development of a self-administrated quality of life questionnaire for sarcopenia in elderly subjects: The SarQoL. *Age and Ageing, 44*(6), 960–966. https://doi.org/10.1093/ageing/afv133

Beaudart, C., Biver, E., Reginster, J.-Y., Rizzoli, R., Rolland, Y., Bautmans, I., Petermans, J., Gillain, S., Buckinx, F., Van Beveren, J., Jacquemain, M., Italiano, P., Dardene, N., & Bruyere. (2015b). *SarQoL/Sarcopenia and quality of life questionnaire.* SarQoL.org. http://www.sarqol.org/en/sarqol_form

Beaudart, C., Dawson, A., Shaw, S. C., Harvey, N. C., Kanis J. A., Binkley, N., Reginster, J. Y., Chapurlat, R., Chan, D. C., Bruyère, O., Rizzoli, R., Cooper, C., Dennison, E. M., & IOF-ESCEO Sarcopenia Working Group. (2017). Nutrition and physical activity in the prevention and treatment of sarcopenia: A systematic review. *Osteoporosis International, 28*(6), 1817–1833. https://doi.org/10.1007/s00198-017-3980-9

Beaudart, C., Locquet, M., Reginster, J.-Y., Delandsheere, L., & Petermans, J. (2018). Quality of life in sarcopenia measured with the SarQol: Impact of the use of different diagnosis definitions. *Aging Clinical and Experimental Research, 30*, 307–313. https://doi.org/10

.1007/s40520-017-0866-9

Beaudart, C., Rolland, Y., Cruz-Jentoft, A. J., Bauer, J. M., Sieber, C., Cooper, C., Al-Daghri, N., Araujo de Carvalho, I., Bautmans, I., Bernabei, R., Bruyère, O., Cesari, M., Cherubini, A., Dawson-Hughes, B., Kanis, J. A., Kaufman, J.-M., Landi, F., . . . Fielding, R. A. (2019). Assessment of muscle function and physical performance in daily clinical practice. A position paper endorsed by the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO). *Calcified Tissue International, 105*(1), 1–14. https://doi.org/10.1007/s00223-019-00545-w

Beckwée, D., Delaere, A., Aelbrecht, A., Baert, V., Beaudart, C., Bruyere, O., De Saint-Hubert, M., & Bautmans, I. (2019). Exercise interventions for the prevention and treatment of sarcopenia. A systematic umbrella review. *Journal of Nutrition, Health and Aging, 23*(6), 494–502. https://doi.org/10.1007/s12603-019-1196-8

Bischoff-Ferrari, H. A., Orav, J. E., Kanis, J. A., Rizzoli, R., Schlögl, M., Staehelin, H. B., Willett, W. C., & Dawson-Hughes, B. (2015). Comparative performance of current definitions of sarcopenia against the prospective incidence of falls among community-dwelling seniors age 65 and older. *Osteoporos International, 26*, 2793–2802. https://doi.org/10.1007/s00198-015-3194-y

Bone, A. E., Hepgul, N., Kon, S., & Maddocks, M. (2017). Sarcopenia and frailty in chronic respiratory disease: Lessons from gerontology. *Chronic Respiratory Disease, 14*(1) 85–99. https://doi.org/10.1177/1479972316679664

Brady, A. O., Straight, C. R., Evans, E. M. (2014). Body composition, muscle capacity, and physical function in older adults: An integrated conceptual model. *Journal of Aging and*

Physical Activity, 22(3), 441–452. https://doi.org/10.1123/JAPA.2013-0009

Bruyére, O., Beaudart, C., Reginster, J.-Y., Buckinx, F., Schoene, D., Hirani, V., Cooper, C., Kanis, J. A., Rizzoli, R., McCloskey, E., Cederholmh, T., Cruz-Jentoft, A., & Freiberger, E. (2016). Assessment of muscle mass, muscle strength and physical performance in clinical practice: An international survey. *European Geriatric Medicine, 7*(3), 243–246. https://doi .org/10.1016/j.eurger.2015.12.009

Cederholm, T., Jensen, G. L., Correia, M. I. T. D., Gonzalez, M. C., Fukushima, R., Higashiguchi, T., Baptista, G. Barazzoni, R., Blaauw, R., Coats A. J. S., Crivelli, A.N. , Evans, D.C., Gramlich, L., Fuchs-Tarlovsky, V., Keller, H., Llido, L, Malone, A., Mogensen, K. M., Morley, J. E., . . . GLIM Core Leadership Committee, GLIM Working Group. (2019). GLIM criteria for the diagnosis of malnutrition—A consensus report from the global clinical nutrition community. *Journal of Cachexia, Sarcopenia and Muscle, 10(*1), 207–217. https://doi.org/10.1002/jcsm.12383

Chang, K.-V., Hsu, T.-H. Wu, W.-T., Huang, K.-C., & Han, D.-S. (2016). Association between sarcopenia and cognitive impairment: A systematic review and meta-analysis. *Journal of the American Medical Directors Association, 17*(12), 1164. https://doi.org/10.1016/j .jamda.2016.09.013

Chodzko-Zajko, W. J., Proctor, D. N., Fiatarone Singh, M. A., Minson, C. T., Nigg, C. R., Salem G. J., Skinner, J. S. (2009). Exercise and physical activity for older adults. *Medicine & Science in Sports & Exercise, 41*(7), 1510–1530. https://doi.org/10.1249/MSS.0b013e3181a0c95c

Choi, S. (2021). Evidence-based research in nursing science: A reproducible framework. *Western Journal of Nursing Research, 43*(9) 828–833. https://doi.org/10.1177/01939

Cruz-Jentoft, A. J., Baeyens, J. P., Bauer, J., M., Boirie, Y., Cederholm, T., Landi, F., Martin, F., C., Michel, J.-P., Rolland, Y., Schneider, S., M., Topinková, E., Vandewoude, M., & Zamboni, M. (2010). Sarcopenia: European consensus on definition and diagnosis. Report of the European Working Group on Sarcopenia in Older People. *Age and Ageing, 39*(4), 412–423. https://doi-org.proxy.lib.odu.edu/10.1093/ageing/afq034

Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boire, Y., Bruyére, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, A. M., Sieber, C. C., Topinkova, E., Vandewoude, M., Visser, M., Zamboni, M., Writing Group for the European Working Groupon Sarcopenia in Older People, & Extended Group for the European Working Groupon Sarcopenia in Older People. (2019). Sarcopenia: Revised European consensus on definition and diagnosis. (2019). *Age and Ageing, 48*(1), 16–31. https://doi.org/10.1093/ageing/afy169

Cruz-Jentoft, A. J., Landi, F., Schneider, S. M., Zúñiga, C., Arai, H., Boirie, Y., Chen, L.-K., Fielding, R., A., Martin, F., C., Michel, J.-P., Sieber, C., Stout, J., R., Studenski, S. A., Vellas, B., Woo, J., Zamboni, M., & Cederholm, T. (2014). Prevalence of and interventions for sarcopenia in ageing adults: A systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). *Age and Ageing, 43*(6), 748–759. https://doi.org/10.1093/ageing/afu115

Cruz-Jentoft, A., J., & Sayer, A. A. (2019). Sarcopenia. *Lancet, 393*(10191), 2636–2646. https://doi.org/10.1016/S0140-6736(19)31138-9

De Buyser, S. L., Petrovic, M., Taes, Y. E., Toye, K. R. C., Kaufman, J.-M., Lapauw, B., & Goemaere, S. (2016). Validation of the FNIH sarcopenia criteria and SOF frailty index as predictors of long-term mortality in ambulatory older men. *Age and Ageing, 45*(5), 603–

609. https://doi.org/10.1093/ageing/afw071

Del Campo Cervantes, J. M., Macías Cervantes, M. H., & Torres, R. M. (2019). Effect of a resistance training program on sarcopenia and functionality of the older adults living in a nursing home. *Journal of Nutrition, Health and Aging, 23*(9), 829–836. https://doi.org/10.1007/s12603-019-1261-3

Delmonico, M. J., Harris, T. B., Lee, J.-S., Visser, M., Nevitt, M., Kritchevsky, S. B., Tylavsky, F. A., & Newman, A. B. (2007). Alternative definitions of sarcopenia, lower extremity performance, and functional impairment with aging in older men and women. *Journal of the American Geriatrics Society, 55*(5), 769–774. https://doi.org/10.1111/j .1532-5415.2007.01140.x

Dent, E., Morley, J. E., Cruz-Jentoft, A. J., Arai, H., Kritchevsky, S. B., Guralnik, J., Bauer, J. M., Pahor, M., Clark, B. C., Cesari, M., Ruiz, J., Sieber, C. C., Aubertin-Leheudre, M., Waters, D. L., Visvanathan, R., Landi, F., Villareal, D. T., Fielding, R., Won, C. W., Theou, O., . . . Vellas, B. (2018). International clinical practice guidelines for sarcopenia (ICFSR): Screening, diagnosis and management. *Journal of Nutrition, Health & Aging, 22*(10)*, 1148–1161*. https://doi.org/10.1007/s12603-018-1139-9

Dos Santos, L., Cyrino, E. S., Antunes, M., Santos, D. A., & Sardinha, L. B. (2017). Sarcopenia and physical independence in older adults: The independent and synergic role of muscle mass and muscle function. *Journal of Cachexia, Sarcopenia and Muscle, 8*(2), 245–250. https://doi.org/10.1002/jcsm.12160

Goodpaster, B. H., Park, S. W., Harris, T. B., Kritchevsky, S. B., Nevitt, M., Schwartz, A.V., Simonsick, E. M., Tylavsky, F. A., Visser, M., & Newman, A. B. (2006). The Loss of skeletal muscle strength, mass, and quality in older adults: The health, aging and body composition study. *Journal of Gerontology: Medical Sciences, 61A*(10), 1059–1064. https://doi.org/10.1093/gerona/61.10.1059

Guralnik, J. M. (2020, October 7). *Overview of the Short Physical Performance Batter (SPPB).* National Institute on Aging. https://www.youtube.com/watch?v=o4_TZ9oGMKA&list=PLIYnOnBLJyCrlV3jW7CJSWBN0ZRLL0HqY&index=1

Guralnik, J. M., Ferrucci, L., Pieper, C. F., Leveille, S. G., Markides, K. S., Ostir, G. V., Studenski, S., Berkman, L. F., & Wallace, R. B. (2000). Lower extremity function and subsequent disability: Consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance batter. *Journal of Gerontology, 55A*(4), 221-231. https://doi.org/10.1093/gerona/55.4.M221

Guralnik, J. M., Simonsick, E. M., Ferrucci, L., Glynn, R. J., Berkman, L. F., Blazer, D. G., Scherr, P. A., & Wallace, R. B. (1994). A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *Journal of Gerontology, 49(2)*, 85–94. https://doi.org/10.1093/geronj/49.2.m85

Handeful Store & Club. (2021). *Handeful hand strength dynamometer.* https://handeful.com/products/hand-strength-dynamometer

Hassan, B. H., Hewitt, J., Keogh, J. E. L., Bermeo, S., Duque, G., & Henwood, T. R. (2015). Impact of resistance training on sarcopenia in nursing care facilities: A pilot study. *Geriatric Nursing, 37*(2016), 116–121. https://doi.org/10.1016/j.gerinurse.2015.11.001.

Henwood, T., Hassan, B., Swinton, P., Senior, H., & Keogh, J. (2017). Consequences of sarcopenia among nursing home residents at long-term follow-up. *Geriatric Nursing, 38*(5), 406–411. https://doi.org/10.1016/j.gerinurse.2017.02.003

Inevifit. (2020). *Inevifit body fat scale with body weight, BMI & more.* https://www.inevifit.com/product/inevifit-body-fat-scale-with-body-weight-bmi-more-white/

Johansson, J., Strand, B. H., Morseth, B., Hopstock, L A., & Grimsgaard, S. (2020). Differences in sarcopenia prevalence between upper-body and lower-body based EWGSOP2 muscle strength criteria: The Tromsø study 2015–2016. *BMC Geriatrics, 20*, Article 461. https://doi.org/10.1186/s12877-020-01860-w

Kim, T. N., Park, M. S., Lee, E. J., Chung, H. S., Yoo H. J., Kang, H. J., Song, W., Baik, S. H., & Choi, K. M. (2017). Comparisons of three different methods for defining sarcopenia: An aspect of cardiometabolic risk. *Scientific Reports, 7*, Article 6491. https://doi.org/10.1038/s41598-017-06831-7

Kitson, A., Harvey, G., & McCormack, B. (1998). Enabling the implementation of evidence based practice: A conceptual framework. *Quality in Health Care, 7*(3), 149–158. https://doi.org/10.1136/qshc.7.3.149

Liao, C.-D., Tsauo, J.-Y., Wu, Y.-T., Cheng, C.-P., Chen, H.-C., Huang, Y.-C., Chen, H.-C., & Liou, T.-H. (2017). Effects of protein supplementation combined with resistance exercise on body composition and physical function in older adults: A systematic revi review and meta-analysis. *American Journal of Clinical Nutrition, 106*(4), 1078–1091. https://doi.org/10.3945/ajcn116.143594.

Liao, C.-D., Tsauo, J.-Y., Lin, L.-F., Huang, S.-W., Ku, J.-W., Chou, L.-C., & Liou, T.-H. (2017). Effects of elastic resistance exercise on body composition and physical capacity in older women sarcopenic obesity: A consort-compliant prospective randomized controlled trial. *Medicine, 96*(23), Article e7115. https://doi.org/10.1097/MD.0000000

000007115

Lopez, P., Pinto, R. S., Radaelli, R., Rech, A., Grazioli, R., Izquierdo, M., & Cadore, E. L. (2018). Benefits of resistance training in physically frail elderly: A systematic review. *Aging Clinical and Experimental Research, 30*(8), 889–899. https://doi.org/10.1007/s40520-017-0863-z.

Malstrom, T. K., Miller, D. K., Simonsick, E. M., Ferrucci, L., & Morley, J. E. (2016). SARC-F: A symptom score to predict persons with sarcopenia at risk for poor functional outcomes. *Journal of Cachexia, Sarcopenia and Muscle, 7*(1), 28–36. https://doi.org/10.1002/jcsm.120 48

Melnyk, B. M., & Fineout-Overholt, E. (2019). *Evidence-based practice in nursing & healthcare* (4th ed.). Wolters Kluwer.

Morley, J., E., Abbatecola, A. M., Argiles, J. M., Baracos, V., Bauer, J., Bhasin, S., Cederholm, T., Coats, A. J. S., Cummings, S. R., Evans, W. J., Fearon, K., Ferrucci, L., Fielding, R. A., Guralnik, J. M., Harris, T. B., Inui, A., Kalantar-Zadeh, K., Kirwan, B.-A., Mantovani, G., . . . The Society on Sarcopenia, Cachexia and Wasting Disorders Trialist Workshop. (2011). Sarcopenia with limited mobility: An international consensus. *Journal of the American Medical Directors Association, 12*(6), 403–409. https://doi.org/10.1016/j.jamda.2011.04.014

National Institute on Aging. (2021).*Training resources.* https://sppbguide.com/training-videos

Olsen, P. O., Termannsen, A.-D., Bramming, M., Tully, M. A., & Caserotti, P. (2019). Effects of resistance training on self-reported disability in older adults with functional limitations or disability: A systematic review and meta-analysis. *European Review of Aging and Physical Activity, 16*(24), 1–25. https://doi.org/10.1186/s11556-019-0230-5

Polit, D. F., & Beck, C. T. (2018). *Essentials of nursing research: Appraising evidence for nursing practice* (9th ed.) Wolters Kluwer.

Robinson, K. A., Brunnhuber, K., Ciliska, D., Bogh Juhl, C., Christensen, R., Lund, H. (2021). *Journal of Clinical Epidemiology, 129*, 151–157. https://doi.org/10.1016/j.jclinepi.2020.07.020

Rosenberg, I. H. (1997). Sarcopenia: Origins and clinical relevance. *American Society for Nutritional Sciences, 127*(5), 990S–991S. https://doi.org/10.1093/jn/127.5.990S

SarQol. (2021). *The SarQol questionnaire.* http://www.sarqol.org/en/sarqol_form

Schaap, L. A., van Schoor, N. M., Lips, P., & Visser, M. (2018). Associations of sarcopenia definitions, and their components, with the incidence of recurrent falling and fractures: The longitudinal aging study Amsterdam. *The Journals of Gerontology: 73*(9), 1199–1204. https://doi.org/10.1093/gerona/glx245

Steffl, M., Bohannon, R. W., Sontakova, L., Tufano, J. J., Shiells, K., & Holmerva, I. (2017). Relationship between sarcopenia and physical activity in older people: A systematic review and meta-analysis. *Clinical Interventions on Aging, 12*, 835–845. https://doi.org/10.2147/CIA.S132940

Stetler, C. B., Damschroder, L. J., Helfrich, C. D., & Hagedorn, H. J. (2011). A guide for applying a revised version of the PARIHS framework for implementation. *Implementation Science, 6,* Article 99. https://implementationscience.biomedcentral.com/track/pdf/10.1186/1748-5908-6-99.pdf

Talar, K., Hernández-Belmonte, A., Vetrovsky, T., Steffl, M., Kalamacka, E., & Courel-Ibáñez, J. (2021). Benefits of resistance training in early and late stages of frailty and sarcopenia: A systematic review and meta-analysis of RCTs. *Journal of Clinical Medicine, 10*, Article 1630, 1–34. https://doi.org/10.3390/jcm10081630.

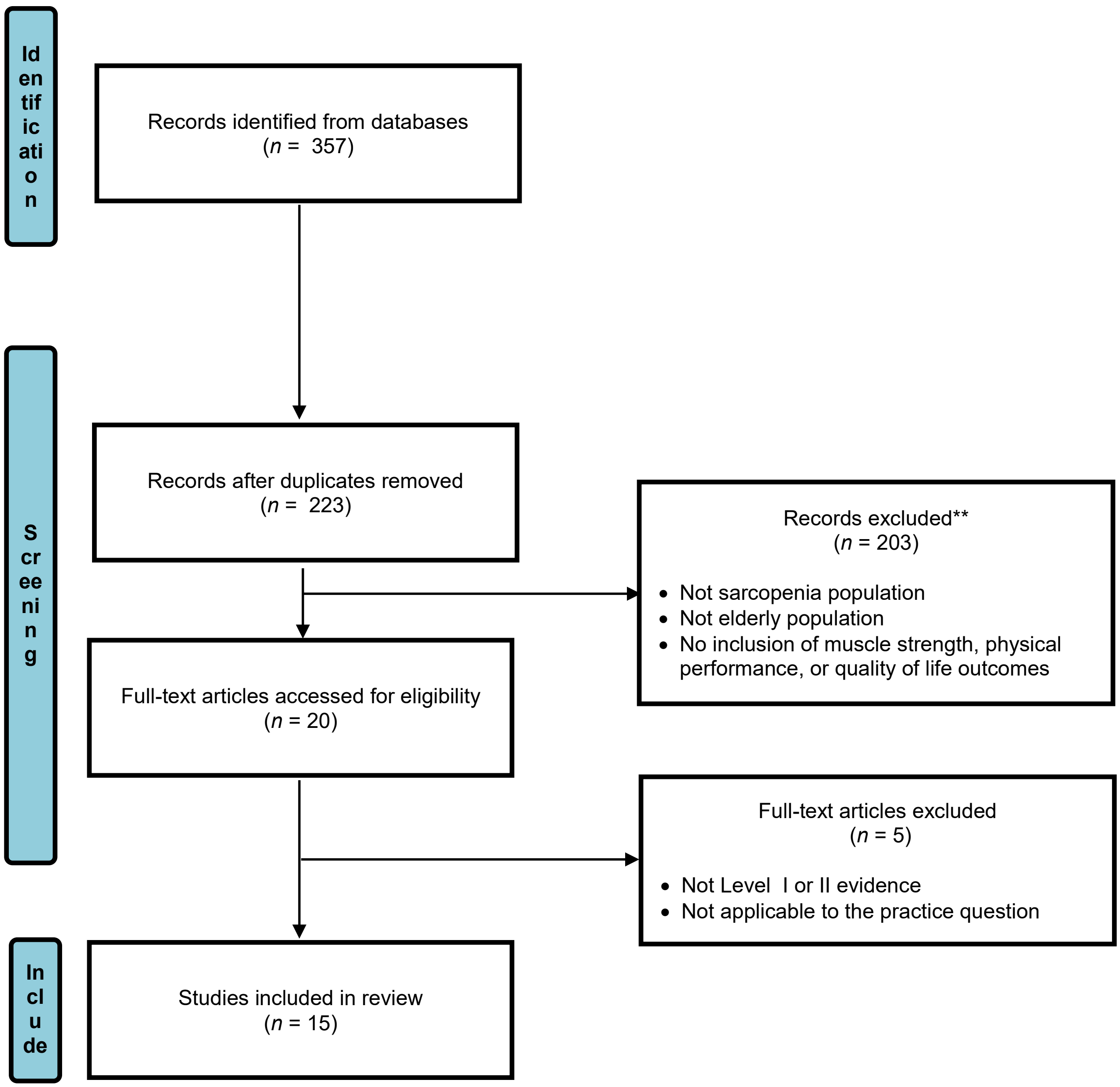
Tosato, M., Marzetti, E., Cesari, M., Savera, G., Miller, R. R., Bernabei, R., Landi, F., & Calvani, R. (2017). Measurement of muscle mass in sarcopenia: From imaging to biochemical markers. *Aging Clinical Experimental Research, 29*, 19–27. https://doi.org/10.1007/s40520-016-0717-0

Vikberg, S., Sörlen, N., Brandén, L., Johansson, J., Nordström, A., Hult, A., & Nordström, P. (2019). Effects of resistance training on functional strength and muscle mass in 70-year-old individuals with pre-sarcopenia: A randomized controlled trial. *Journal of the American Medical Directors Association, 20*(1), 28–34. https://doi.org/10.1016/j.jamda.2018.09.011

Vlietstra, L., Hendrickx, W., & Waters, D. L. (2018). Exercise interventions in healthy older adults with sarcopenia: A systematic review and meta-analysis. *Australasian Journal on Ageing, 37*(3), 169–183. https://doi.org/10.1111/ajag.12521

Zhang, Y., Zou, L., Chen, S., Bae, J. H., Kim, D. Y., Liu, X., & Song, W. (2021). Effects and moderators of exercise on sarcopenic components in sarcopenic elderly: A systematic review and meta-analysis. *Frontiers in Medicine, 8,* Article 649748, 1–18. https://doi.org/10.3389/fmed.2021.649748

Appendix A: PRISMA Flow Chart of Study Selection Process



Appendix B: Table of Evidence

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question (specific)	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
1.	Antoniak & Greig (2017)	Systematic review and meta-analysis	To evaluate the effectiveness of combined resistance exercise training and Vitamin D3 supplementation on musculoskeletal health in older adults	RCTs (N = 7)	Systematic review and meta-analysis	Evidence supports resistance exercise, supplemented with Vitamin D3, as an effective treatment of muscle loss due to sarcopenia	Muscle strength of the lower extremities was significantly improved ($p < 0.001$)	Small sample size; inclusion of a high risk study and studies with low quality outcome measures; lack of clear criteria for D^3 component	Level I
2.	Bandeira de Mello et al. (2019)	Systematic review	To examine the effects of physical exercise programs compared to no exercise interventions to improve sarcopenia components.	RCTs (N = 5)	Systematic literature review	Evidence supports physical training with resistance training as the main intervention identified, improved muscle strength, muscle quality, and muscle function compared to inactive control groups.	Muscle strength: length muscle strength and grip strength Physical performance: gait speed, chair stand, SPPB	Heterogeneity among trials, small number of RCTs, limited robust conclusions and data analysis	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
3.	Barthalos et al. (2016)	Quantitative study RCT	To evaluate resistance training based physical activity on quality of life, attitude to aging, assertiveness, physical fitness and body composition of nursing home elderly residents.	Sample/size: 45 older nursing home residents. Setting: Unified Institution of Medical and Social Care of Gyor City.	Anthropometric measures, fitness performance, quality of life, and attitudes to aging survey data measured over a 15-week period on participants randomly divided into two intervention groups and a control group. One of the intervention group Mental group) received additional weekly discussions on health and quality of life.	Resistance based physical activity shown to improve older adult's physical condition and coordination, physical mobility, daily functions, and improved attributes of quality of life.	Both intervention groups significantly improved their social participation, upper and lower body strength scores than the control group. EG: Chair stand- p=0.005; Arm strength p=0.02 MG: Chair stand- p=0.008; Arm strength p=0.038.	The study was restricted to use of indoor facility only.	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
4.	Beaudart et al. (2017)	Systematic review.	To explore the effect of combined exercise and nutrition intervention on muscle mass and muscle function in older people	37 RCTs	Systematic literature review.	Evidence indicate that resistance training has a positive impact on muscle mass, muscle function, and performance in subjects age 60 years and older with limited effect of nutrition combined interventions.	N/A	The exercise interventions and supplementation described in the RCTs varied in regards to types of exercise, doses, intensity and duration.	Level I)
5.	Beckwee et al. (2019)	Systematic Review	To evaluate the efficacy of different exercise interventions to counter sarcopenia in older adults.	14 studies	Systematic literature review	Four categories of resistance exercise for providing significant effect on muscle mass, muscle strength, and physical performance: resistance training, resistance training with nutritional supplementation, multimodal exercise, and blood flow restriction training.	N/A	The quality of individual randomized clinical trials was not analyzed. The inclusion of a small number of eligible reviews.	Level II

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
6.	Del Campo Cervantes et al. (2019)	Quantitative research. Longitudinal study	Investigate the effect of a resistance training program on the sarcopenia and functionality of the elderly nursing home resident	Sample/size: 19 older nursing home residents, ages 64-93 years Setting: Mexico	The measurement of the effects of a resistance exercise program on muscle strength over a 12-week period.	The resistance training program improved the functionality (muscle strength and physical performance). There was found to be a decrease in severe sarcopenia	There was a significant increase in muscle strength (p=0.0001), improvement in physical performance (p=0.0001), in balance (p=0.0001), chair stand (p=0.036), and gait speed (p=0.0001). There was a decrease from 47.4% to 33.3% of sarcopenia degree.	Small sample size 2) absence of a control group	Level I
7.	Hassan et al. (2016)	Quantitative study, quasi-experimental design	Investigate the impact of resistance training on sarcopenia status in older adults residing in nursing care facilities	Sample/size: 42 nursing home residents between the ages of 78 and 93 Setting: 4 nursing care facilities in Asia	Measuring the effects of twice weekly resistance and balance exercise programs on older adults enrolled to a control group and exercise group over a 6 month period	Resistance and balance exercise was found to maintain skeletal muscle mass, improve the overall grip and pinch strength, and reduce disability and sarcopenia transition among residents.	Exercise group experienced a significant increase in grip strength when compared to the control group (p = 0.02) and a within-group decrease in body mass index and increase in grip strength (p < .007).	Study's participants were not a true cross-section of all residents in aged care. Small sample size. Limited variables were collected for a pilot study.	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
8.	Liao, Tsauo, Wu et al. (2017)	Systematic review and meta-analysis	To identify the effects of protein supplementation (PS) on strength gain, and physical mobility improvements in older people undergoing resistance training (RET)	17 RCTs	Systematic literature review	Evidence showed substantially greater leg strength with combined intervention of PS and RET than with RET alone	Overall significantly greater increases in leg strength with a standard mean difference of 0.69 (95% CI: 0.39, 0.98; P, 0.00001)	Various PS protocols and exercise regimens were used in the included trials. Most of the included studies monitored participants less than 6 months.	Level I
9.	Liao, Tsauo, Lin et al. (2017)	Quantitative study. Prospective and RCT.	To identify the clinical efficacy of elastic resistance exercise training (RET) in patients with sarcopenic obesity.	46 obese women with ages 67.3 (5.2) years. Setting: A rehabilitation center of a university-based teaching hospital at Shuang Ho Hospital.	Measuring the effects of elastic resistance exercise training to participants randomized to an experimental group and control group over a period of 12 weeks.	Elastic resistance exercise was found to have positive benefits on the body composition, muscle quality, and physical function in the EG.	After 12 weeks of elastic RET intervention, the EG had significant fewer patients exhibiting sarcopenia ($p<0.05$) and experiencing physical difficulty ($p<0.001$) than the CG.	Only female patients were included. Small sample size. Diet or nutrition was not analyzed during the intervention.	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
10.	Lopez et al. (2018)	Systematic review	Examine the effects of resistance training alone or combined with multi-modal exercise intervention on muscle hypertrophy, maximal strength, power output, functional performance, and falls incidence in physically frail elderly.	16 RCTs	Systematic literature review and meta-analyses (experimental studies)	The common findings among the studies showed positive effects of resistance training performed alone or combined with different training components in muscle strength and power output, as well as functional capacity	Resistance training alone or with multimodal exercises improved muscle strength by 6.6-37%, muscle power by 8.2%, and functional capacity by 4.7-58.1%	Inclusion criteria used for subjects of the studies varied, resulting in high heterogeneity of subjects. The authors of the studies focused specifically on resistance training interventions.	Level I
11.	Olsen et al. (2019)	Systematic review	To investigate the effects of resistance training on self-reported disability in older people.	14 RCTs	Systematic literature review	Evidence provided that resistance training has a moderate positive effect on self-reported disability and function in older at risk people.	A significant moderate positive effect of resistance training was found at $p=0.001$.	The meta-regressions were performed on a low number of the studies found.	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
12.	Talar et al. (2021)	Systematic review and meta-analysis of RCTs	To examine the effects of resistance training programs lasting greater than 8 weeks on strength, physical function and body composition in older adults diagnosed with pre-sarcopenia, sarcopenia, pre-frailty or frailty.	Meta-analysis of 25 RCTs on resistance training programs.	Systematic literature review.	Evidence provided that RT was found a highly effective preventive strategy to delay and attenuate the negative effects of sarcopenia and frailty in both early and late stages.	Meta-analysis showed significant changes in favor of resistance training for hand grip (p=0.001); lower limb strength (p<0.001); gait speed (p\<0.001; functional performance (p<0.001; fat mass (p=0.001).	Most of the meta-analysis indicated moderate to high levels of heterogeneity. More evidence on longer resistance training programs is needed to confirm the long term benefits.	Level I
13.	Vlietstra et al. (2018)	Systematic review and meta-analysis	To assess the effects of exercise interventions on body composition and functional outcomes in older adults with sarcopenia.	Meta-analysis of 6 studies (RCT and quasi-experimental designs).	Systematic literature review	Most common theme: exercise interventions such as resistance-type exercises (gait training, balance training, and strength training) significantly improved strength, balance, muscle hypertrophy, and functional outcome in older adults.	Meta-analysis revealed that knee-extension strength (p\<0.01), timed-up and go (p<0.0001), appendicular muscle mass (p=0.04), and leg muscle mass (p=0.04) significantly improved in response to exercise interventions,	Small sample size of only 6 studies	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
14.	Vikberg et al. (2019)	Quantitative study Randomized controlled trial (RCT).	To examine the effects of a 10-week instructor-led resistance training program on functional strength and body composition.	70 participants consisting of both males and females with average age of 70. Setting: Northern Sweden	Measuring the effects of a 10-week instructor-led body weight-based resistance exercise program on functional strength, body composition, and muscle mass among pre-sarcopenia patients randomized to a control and training group using the Short Physical Performance Battery (SPPB) and the Timed Up and Go test (TUG).	There was an increase in muscle mass observed over the 10-month period in the intervention group with an improvement in functional strength, predominantly in the male sub-cohort. The intervention had significant effect on the sit-to-stand test that is a part of the SPPB.	Participants given the intervention in the male sub-cohort increased 0.5 points in SPPB score during follow-up (p= .02) compared to male controls. The intervention resulted in significantly greater improvements for the training group than control group in all measures of body composition (p\<.01for all).	Small sample size.	Level I

Article number	Author(s) and date	Evidence type	Purpose or objective(s)	Sample, sample size and setting	Methods or intervention(s) if /as applicable	Findings or outcomes that help answer the EBP question	Observable or quantitative measures	Limitations (cited by authors)	Evidence level, quality
15.	Zhang et al. (2021)	Systematic review and meta-analysis.	To determine the effects of exercise on muscle strength, physical performance, and body composition in older adults with sarcopenia.	Meta-analysis of 17 RCTs on the effects of exercise on sarcopenia in older adults.	Systematic literature review	The common findings suggested that exercise interventions have positive effects on muscle strength, physical performance, and skeletal muscle mass for sarcopenic elderly.	There were significant improvements in muscle strength: Grip strength ($p<0.01$) Knee extension ($p<0.01$) Improvement in physical performance: (Timed up and go $p<0.01$ Body composition: Skeletal muscle mass $p<0.01$.	No consistent assessment criteria for sarcopenia defined. The studies included used varied instruments to measure the interested outcome.	Level I

Appendix C: DNP Project Timeline

Table A

DNP Project Timeline

Task	Duration	Start date	End date
Receive IRB approval	1 day	1/24/22	
Deliver initial study invitations	1 day	2/4/22	2/6/22
Obtain consent and screen potential participants using SARC-F	1 week	2/8/22	2/15/22
Deliver follow-up invitations	1 day	2/17/22	2/18/22
Obtain consent and screen potential participants using SARC-F	1 week	2/20/22	2/27/22
Collect baseline muscle mass, muscle strength, physical performance, and quality of life data	2 days	2/28/22	3/1/22
Implement first month of exercise program	1 month	3/1/22	4/1/22
Collect 30-day muscle mass, muscle strength, physical performance, and quality of life data	2 days	4/2/22	4/4/22
Implement second month of exercise program	1 month	4/5/22	5/5/22
Collect 60-day muscle mass, muscle strength, physical performance, and quality of life data	2 days	5/6/22	5/8/22
Implement third month of exercise program	1 month	5/9/22	6/9/22
Collect 90-day muscle mass, muscle strength, physical performance, and quality of life data	2 days	6/10/22	6/12/22

Appendix D: SARC-F

Strength, Assistance with Walking, Rising from a Chair, Climbing Stairs, and Falls Questionnaire with Scoring Scale

1. How much difficulty do you have in lifting and carrying 10 pounds? (strength)

None	Some	A lot or unable
0	1	2

2. How much difficulty do you have walking across a room? (assistance in walking)

None	Some	A lot, use aids, or unable
0	1	2

3. How much difficulty do you have transferring from a chair or bed? (rise from a chair)

None	Some	A lot or unable
0	1	2

4. How much difficulty do you have climbing a flight of 10 stairs? (climbing stairs)

None	Some	A lot or unable without help
0	1	2

5. How many times have you fallen in the past year? (falls)

None	Less than 3 falls	4 or more fall
0	1	2

Appendix E: SPSS Measures

Balance

Activity: Maintain side-by-side, semitandem, and tandem positions for 10 seconds.

Scoring

Points	Participant capacity
1	Can hold a side-by side stand for 10 seconds but unable to hold a semitandem stand for 10 seconds
2	Can hold a semitandem stand for 10 seconds but unable to hold a full tandem stand for more than 2 seconds
3	Can hold the full tandem stand for 3 to 9 seconds
4	Can hold the full tandem stand for 10 seconds

Gait Speed

Activity: At usual pace, 8-ft walk timed from a standing start. Participants are scored according to quartiles of performance. Time on the faster of two walks is used to define scores.

Scoring

Points	Participant capacity
1	≥ 5.7 seconds (≤ 0.43 m/s)
2	4.1–5.6 seconds (0.44–0.60 m/s)
3	3.2 to 4.0 seconds (0.61–0.77 m/s)
4	≤ 3.1 seconds (≥ 0.78 m/s)

Chair Stand

Activity: Participants fold their arms across their chest and stand up once from a chair. If successful they were asked to stand up and sit down 5 times as quickly as possible. Quartiles of performance for the repeat chair stands are used to define scores.

Scoring

Points	Participant capacity
1	> 16.7 seconds
2	16.6–13.7 seconds
3	13.6–11.2 seconds
4	< 11.1 seconds

Overall Performance: A summary performance score is created by summation of the scores for tests of standing balance, gait speed, and chair stand 5 times.

Appendix F: SarQol

Questionnaire | Time : ±10 min

SarQoL
Sarcopenia and Quality of Life

Quality of life in sarcopenia

This questionnaire asks about sarcopenia, which is a muscle weakness that comes about with ageing. Sarcopenia can affect your daily life. This survey will enable us to find out if the state of your muscles currently affects your quality of life.

Please choose the most appropriate response for each question. The questionnaire should take you approximately 10 minutes to complete.

1. Do you currently feel you have a reduction in:

	A lot	Some	A little	None
The strength in your arms?	☐	☐	☐	☐
The strength in your legs?	☐	☐	☐	☐
Your muscle mass?	☐	☐	☐	☐
Your energy?	☐	☐	☐	☐
Your physical capabilities?	☐	☐	☐	☐
Your general flexibility?	☐	☐	☐	☐

2. Do you have pain in your muscles?

☐ Often
☐ Sometimes
☐ Rarely
☐ Never

SarQoL
Sarcopenia and Quality of Life

3. When undertaking light physical activities (walking slowly, doing the ironing, dusting, washing-up, DIY, watering the garden, etc.), do you:

	Often	Occasionally	Rarely	Never	I do not undertake these types of physical activities
Have difficulty?	☐	☐	☐	☐	☐
Get tired?	☐	☐	☐	☐	☐
Experience pain?	☐	☐	☐	☐	☐

4. When undertaking moderate physical activities (fast walking, cleaning windows, hoovering, washing the car, pulling up weeds in the garden, etc.), do you:

	Often	Occasionally	Rarely	Never	I do not undertake these types of physical activities
Have difficulty?	☐	☐	☐	☐	☐
Get tired?	☐	☐	☐	☐	☐
Experience pain?	☐	☐	☐	☐	☐

5. When undertaking intense physical activities (running, hiking, lifting heavy objects, moving furniture, digging the garden, etc.), do you:

	Often	Occasionally	Rarely	Never	I do not undertake these types of physical activities
Have difficulty?	☐	☐	☐	☐	☐
Get tired?	☐	☐	☐	☐	☐
Experience pain?	☐	☐	☐	☐	☐

6. Do you currently feel old?

- ☐ Yes, very
- ☐ Yes, somewhat
- ☐ Yes, a little
- ☐ No, not at all

SarQoL
Sarcopenia and Quality of Life

7. If yes to question 6, what gives you that impression?

(Choose as many answers as you like)

- ☐ I become unwell easily
- ☐ I take many medications
- ☐ I feel a weakness in my muscles
- ☐ I have problems with my memory
- ☐ I've had to face the death of several people close to me
- ☐ I do not have much energy, I am often tired
- ☐ My eyesight is poor
- ☐ Other:

8. Do you feel physically weak?

- ☐ Yes, completely
- ☐ Yes, somewhat
- ☐ Yes, a little
- ☐ No, not at all

9. Do you feel you are limited in:

	A lot	Some	A little	None
The length of time you can walk for?	☐	☐	☐	☐
How often you go out walking?	☐	☐	☐	☐
The distance you can walk?	☐	☐	☐	☐
The speed at which you can walk?	☐	☐	☐	☐
The length of your steps?	☐	☐	☐	☐

10. When you are walking:

	Often	Occasionally	Rarely	Never	I am unable to walk
Do you feel very tired?	☐	☐	☐	☐	☐
Do you need to sit down regularly to recover?	☐	☐	☐	☐	☐
Do you have difficulty crossing roads quickly enough?	☐	☐	☐	☐	☐
Do you have difficulties with uneven surfaces?	☐	☐	☐	☐	☐

SarQoL
Sarcopenia and Quality of Life

11. Do you have problems with your balance?

- ☐ Often
- ☐ Occasionally
- ☐ Rarely
- ☐ Never

12. How often do you fall?

- ☐ Very often
- ☐ Occasionally
- ☐ Rarely
- ☐ Never

13. Do you think that your physical appearance has changed?

- ☐ Yes, very
- ☐ Yes, somewhat
- ☐ Yes, a little
- ☐ No, not at all

14. If yes to question 13, in what way? (Choose as many answers as you like)

- ☐ Change in your weight (you've put on weight or you've lost weight)
- ☐ Appearance of wrinkles
- ☐ Loss of height
- ☐ Loss of muscle mass
- ☐ Hair loss
- ☐ Getting white or grey hair
- ☐ Other:

15. If yes to question 13, are you upset by this change?

- ☐ Yes, very
- ☐ Yes, somewhat
- ☐ Yes, a little
- ☐ No, not at all

SarQoL
Sarcopenia and Quality of Life

16. Do you feel frail?

- ☐ Very much so
- ☐ A little
- ☐ Not at all

17. Do you currently have difficulty in undertaking any of the following daily activities:

	Unable to do	Great difficulty	A little difficulty	No difficulty	Not applicable
Climbing a flight of stairs?	☐	☐	☐	☐	☐
Climbing several flights of stairs?	☐	☐	☐	☐	☐
Going up one or several steps without holding on to the banister?	☐	☐	☐	☐	☐
Squatting or kneeling?	☐	☐	☐	☐	☐
Stooping or leaning down to pick up an object off the floor?	☐	☐	☐	☐	☐
Getting up from the floor without holding on to anything?	☐	☐	☐	☐	☐
Getting out of a low chair without armrests?	☐	☐	☐	☐	☐
Moving, generally, from a sitting position to a standing position?	☐	☐	☐	☐	☐
Carrying heavy objects (large bags full of shopping, saucepan filled with water, etc.)?	☐	☐	☐	☐	☐
Opening a bottle or a jar?	☐	☐	☐	☐	☐
Using public transport?	☐	☐	☐	☐	☐
Getting in or out of a car?	☐	☐	☐	☐	☐
Doing your shopping?	☐	☐	☐	☐	☐
Doing the housework (making the bed, hoovering, doing the ironing, washing the dishes, etc.)?	☐	☐	☐	☐	☐

SarQoL
Sarcopenia and Quality of Life

18. Does your muscle weakness limit your movement?

- ☐ Yes, a lot
- ☐ Yes, somewhat
- ☐ Yes, a little
- ☐ No, not at all

19. If yes to question 18, for what reasons? (Choose as many answers as you like)

- ☐ Fear of pain
- ☐ Fear that you might not be able to
- ☐ Fear of feeling tired after these activities
- ☐ Fear of falling
- ☐ Other:

20. Does your muscle weakness limit your sex life?

- ☐ I am not sexually active
- ☐ Yes, completely
- ☐ Yes, somewhat
- ☐ Yes, a little
- ☐ No, not at all

21. How has your participation in physical activities/sport changed?

- ☐ Increased
- ☐ Decreased
- ☐ Unchanged
- ☐ I have never participated in physical activities or sports

22. How has your participation in leisure activities (going out to eat, gardening, doing DIY, shooting/fishing, senior citizens clubs, playing bridge, going for a walk, etc.) changed?

- ☐ Increased
- ☐ Decreased
- ☐ Unchanged
- ☐ I have never participated in leisure activities