EFFECTIVENESS OF THE LEBED METHOD THERAPY ON INTRINSIC PHYSIOLOGICAL RISK FACTORS OF FALLS AMONG ELDERLY INDIVIDUALS IN KAKAMEGA, KENYA

Micky Olutende Oloo

A Thesis submitted to the School of Public Health Biomedical Science and Technology in partial fulfilment of the requirements of the award of the Degree of Doctor of Philosophy in Health Promotion of Masinde Muliro University of Science and Technology

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Prof. Edwin Kadima Wamukoya (Ph.D.)
Department of Health Promotion and Sports Sciences
School of Public Health Biomedical Sciences & Technology
Masinde Muliro University of Science and Technology

Signature..................................... **Date.................................**

Prof. James Aggrey Oloo (Ph.D.)
Department of Public Health
School of Public Health Biomedical Sciences & Technology
Masinde Muliro University of Science and Technology

Signature..................................... **Date.................................**

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DEDICATION

To my esteemed parents, Mr. Joseph Oloo and Mrs. Angeline Oloo: Your unwavering faith, enduring love, and tireless sacrifices have been the foundation upon which I've built my dreams. Your teachings and wisdom have illuminated my path, and I am eternally grateful. To my siblings, Godfrey Oloo, the late Christopher Oloo, Alex Okwomi, and Liz Awuori: Each of you has played a unique and invaluable role in my life's journey. Your encouragement, shared laughter, and moments of reflection have been the pillars of strength that fortified me during challenging times. Lastly, this dedication extends beyond the confines of our family. It is a heartfelt tribute to parents everywhere who, with boundless love and immeasurable sacrifices, continuously nurture and support their children's ambitions. Recognizing these unsung heroes, we celebrate realizing dreams and attaining life's goals.

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ABSTRACT

The physical fitness of elderly individuals deteriorates as they grow older, and falls and fall-related injuries are common manifestations of this degradation. Existing interventions lack practical applicability, and high dropout rates in physical activity studies question their effectiveness. The Lebed Method, a dance program by Sherry Lebed Davis, which has successfully aided breast cancer survivors, offers promise in reducing risk factors for falls. Its potential to reduce fall risks among older people who struggle with physical activity merits exploration. This aligns with universal healthcare principles, emphasizing the importance of addressing and preventing falls and their consequent injuries in the elderly population. This study evaluated the Lebed Method's effects on intrinsic fall risk factors and cognitive function using a community-based randomized control trial with 30 participants aged 60 years. Participants, chosen based on low social support scores, were divided into intervention and control groups and had to meet specific inclusion criteria. Baseline measures were recorded for physical performance (Physical activity, handgrip strength, and leg press strength, 6-Minute Walk Test [6MWT]), functional stability (mobility and balance), assessed by gait speed, de Morton Mobility Index (DEMMI) score, Timed Up and Go (TUG) times, and Berg Balance Scale (BBS) scores) and fall apprehension, which entails Fall risk (Morse Fall Scale), fall efficacy (Falls Efficacy Scale-International (FES-I) score), and cognitive function associated with fall (Mini-Mental State Examination [MMSE] score). An intention-to-treat analysis was applied, meaning participants were analysed based on their assigned group, regardless of the intervention received. Study design and implementation biases such as selection, performance, detection, attrition, and reporting biases were mitigated. The study used the Analysis of Covariance to assess changes between groups, controlling for baseline value variations, while within-group changes were examined using the dependent sample t-test. Statistical significance was set at $p < 0.05$. The results showed that the intervention group improved significantly in physical performance compared to the control group. Specifically, the intervention participants displayed elevated IPAQ scores ($p < .001$, $\eta p^2 = 0.50$, d=1.97), handgrip strength ($p < .001$, $\eta p^2 = 0.64$, d=2.95), leg press strength ($p < .001$, $\eta p^2 = 0.51$, d=1.76) and functional capacity as measured by the 6MWT performance ($p < .001$, $\eta p^2 = 0.59$, d=1.85). The findings also showed that the intervention group significantly improved physical stability compared to the control group. Specifically on gait speed ($p < .001$, $\eta p^2 = 0.65$, d=1.99), DEMMI score ($p < .001$, $\eta p^2 = 0.38$, d=1.94), TUG times ($p < .001$, $\eta p^2 = 0.53$, d=3.38), and BBS scores ($p < .001$, $\eta p^2 = 0.64$, d=1.97). Improvement in the intervention group was also noted in fall apprehension, as measured by the Morse fall scale ($p < .001$, $\eta p^2 = 0.62$, d=2.20) and fall efficacy ($p < .001$, $\eta p^2 = 0.53$, d=2.33). However, cognitive function, as assessed by the MMSE score, did not exhibit significant changes in either group (intervention m= 28.22, SD= 1.05, $p = .092$, vs. control m=26.07, SD= 2.12, $p = .09$). Linear regression analysis indicated that leg press strength, balance, and mobility significantly predict fear of falls, while other variables were not significant predictors. The intervention enhanced physical performance and stability and reduced fear of falls in older people, though it did not improve cognitive function. It is recommended that health promotion initiatives for the elderly by government or individuals include dance-based therapy programs. Future research should concentrate on improving cognitive function for more comprehensive interventions aimed at the well-being of the ageing population.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABCS	Activities Specific Balance Confidence Scale
ACSM	American College of Sports Medicine
AE	Adverse Event
ANCOVA	Analysis of Covariance
DEMMI	De Morton Mobility Index
FES	Fall Efficacy Scale
ICD-11	International Classification of Disease-11
IPAQ	International Physical Activity Questionnaire
KLRC	Kenya Law Reform Commission
KNBS	Kenya National Bureau of Statistics
MDRT	Multi-Directional Reach Test
MSPSS	Multidimensional Scale of Perceived Social Support
NACOSTI	National Commission for Science, Technology and Innovation
RCBD	Randomization Complete Block Design
TLM	The Lebed Method
UN	United Nations
UNPD	United Nations Population Division
WHO	World Health Organization

OPERATIONALIZATION OF KEY TERMS

Balance Refers to the capacity to lean or reach and subsequently readjust one's posture to its original, upright position. This includes the ability to stretch or bend without fear of losing one's footing due to an unstable base.

Dance Refers to an organized, rhythmic movement and coordination of large and small muscle units in space and time.

Dance-Movement Therapy Refers to a psychotherapy practice that addresses physical, mental, social, and emotional issues through dance and movement. It focuses on the relationship between the body and mind, benefiting psychological and physical well-being.

Elderly individual An elderly individual is defined in this study as an individual aged 60 years or older.

Fall Refers to an unexpected incident causing an individual to land on the ground or a lower level, excluding incidents resulting from blows, loss of consciousness, paralysis, or epileptic seizures.

Fall Apprehension Fall apprehension refers to the psychological and emotional fear or anxiety that elderly individuals experience regarding the possibility of falling. This study encompasses fall risk, efficacy, and cognitive function associated with falls.

Fall Risk Fall risk refers to physiological and external factors contributing to falling. Both intrinsic (age, chronic illness, muscular weakness, etc.) and extrinsic (environmental hazards, hazardous activities, etc.) factors are considered.

Fear of Falling Fear of falling involves the aversion or limitation of activities due to the apprehension of falling, often accompanied by low self-confidence in performing activities safely.

Mobility Mobility refers to changing position or location, including walking, jogging, and climbing. It is recognized as one of the nine dimensions of "activity and engagement" by the World Health Organization.

Physical Stability Refers to an individual's ability to maintain mobility and achieve balance without an elevated risk of falls. It is assessed using standardized evaluations of mobility and balance.

Physical Performance Physical Performance in this study refers to the comprehensive evaluation of an individual's physical capabilities, encompassing multiple aspects of functional ability and strength. It involves the assessment of various parameters, including Physical Activity, functional capacity, Handgrip Strength, and Leg Press Strength.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Population ageing refers to the trend of a country's elderly becoming a larger share of that country's total population (Kenya National Bureau of Statistics [KNBS], 2017; United Nations Population Division [UNPD], 2015). Statistics show an increase in the senior population over time, indicating the world's ageing population (60 years and older) is increasing (World Health Organization [WHO], 2018). As of 2024, approximately 10.3% of the global population is aged 65 and older, this percentage is expected to rise, with projections indicating that the proportion of the world's population aged 60 and over will nearly double from 12% in 2015 to 22% by 2050 (United Nations Population Fund [UNFPA], 2024; WHO, 2018). As the global senior population grows, so does that of Africa, which reached 5.4% in 2015 and is expected to reach 6.3% by 2030. (UNPD, 2015). According to the 2019 National Census Report, the elderly population in Kenya is 2,740,515, against a population of 47,564,296 (Kenya National Bureau of Statistics [KNBS], 2019; United Nations Department of Economic and Social Affairs [UNESCO], 2019). By 2050, Kenya is expected to have a population of 9.6 percent that is 60 years or older, from the current 6 percent (UNPD, 2015). Kakamega County had 85,872 individuals aged 65 and above (KNBS, 2019). Specific data on the post-COVID population trends among older people for 2023 is unavailable; however, it has been noted that persons aged 60 and above represent the fastest-growing segment of the country’s population (Census Bureau, 2022; Centre for disease control and prevention [CDC], 2023; "*Trend in Population of older persons in Kenya*," n.d.).

The physical fitness of elderly individuals deteriorates as they grow older, and falls and fall-related injuries are common manifestations of this degradation (Zhao et al., 2018). Evidence shows that age and functional impairment are linked to a higher risk of falling (Yamazaki et al., 2017). A loss of confidence and self-image, decreased exercise, and social isolation may expedite the degradation of older adults' organs, even if the fall does not cause physical harm (Fernandez et al., 2019). A fall happens when a person drops to the ground or onto a plane in a lower starting position as a result of rapid, spontaneous, and unintentional postural modifications, according to the Prevention of Falls Network Europe (Kioh & Rashid, 2018). According to the International Classification of Diseases [ICD-11], PA60 describes unintentional falls from a height of less than one meter, including those that occur at the same level (International Classification of Diseases [ICD], 2019). A fall is therefore defined as "inadvertently coming to rest on the ground, floor, or other lower level, excluding intentional change in position to rest on furniture, walls, or other objects" (Yoshida, 2019).

Research findings reveal that every year averagely about 33% of people over the age of 60 fall, and 22% to 45% of those who fall are injured, with 10% of those who fall having significant injuries such as fractures or brain damage (Lockhart et al., 2019). Studies conducted throughout Europe (Gale et al., 2016) and the Middle East (Alabdullgader & Rabbani, 2021) show fall rates among older adults between 20% and 40%. In Africa, a meta-analysis by Addai-Dansoh et al. (2022) found a high prevalence of falls among older adults, with a pooled prevalence rate of 24.2%. This was further supported by Kalula et al. (2016), who reported rates of 26.4% and 21.9% for falls and recurrent falls, respectively, in an urban community-dwelling older population in South Africa. Ngwu et al. (2019)

identified a prevalence of 36.5% among former construction workers in Port Harcourt, Nigeria, with trips and slips, ladders, and scaffolds being the leading causes. A study in Egypt found that the prevalence of falls was 11.07% among the elderly population (El Sayed et al., 2023). Recent studies have shown that falls are a significant health concern among the elderly population in Kenya. According to data from the national STEPs survey, approximately 33.8% of reported injuries among this demographic are attributed to falls. (Gathecha, et al., 2018).

One of the primary causes of morbidity and mortality throughout the world is accidental injuries, and falls are among the most common types of these (Gathecha et al., 2018). Falls can result in fractures, and they also raise societal expenses and stress on the healthcare system (Tuminah et al., 2016; Rivera-Torres & Severance, 2022). Twenty to thirty per cent of people who fall have injuries that prevent them from living independently and increase their risk of dying “young” (Singh et al., 2015). Every year, one in every three deaths of people aged 60 is due to falls and/or fall-related injuries (Jenek & Skorupiska, 2018). According to the Centres for Disease Control and Prevention, falls cause the third-highest rate of chronic impairment and the highest rate of fatalities among the elderly (Gale et al., 2016). Injuries from falls are quite prevalent, especially among the elderly in Kenya. In research conducted at Kenyatta National Hospital, the country's main referral facility, falls were shown to be the primary cause of injury (75% of cases) and hospitalization among patients aged 60 (Said & Mutiso, 2013). In a different study, falls were identified as a leading cause of fatality in a study examining trauma-related deaths in central Kenya, especially among women (Kimani et al., 2019; Odhiambo et al., 2013).

Research endeavoured to pinpoint the underlying causes of falls to address and prevent them (Patwardhan & Solanki, 2023). Studies have found that internal and external factors both have a role in causing falls (Pengpid & Peltzer, 2018; Rietdyk et al., 2022). Internal causes may be age-related physiological changes or pathological disorders, whereas external causes might be obstacles or other environmental factors (Saunders, 2022). The most prevalent internal cause of falls is impaired balance, which may be related to muscle weakness brought on by inactivity or poor food (Callis, 2016). In a meta-analysis undertaken to determine the predictive significance of risk variables for future falls among older patients, it was discovered that elderly individuals who had fallen in the previous year were more likely to fall again (Xu et al., 2022). The most accurate predictors of future falls are mobility and balance deficits diagnosed in a clinical setting (Patwardhan & Solanki, 2023; Turner et al., 2018), with these studies recommending interventions to address these factors, especially among the elderly.

Various unifactorial interventions like Tai Chi, physiotherapy, obstacle courses, and unipedal standing have been researched with varying levels of success in addressing the issue of falls among the elderly in clinical and experimental settings (Fank et al., 2021; Moawd et al., 2022; Sakamoto, 2006; Van Hanegem et al., 2014). However, it has also been noted that the interventions have poor practical implications in real-life settings (ecological validity) (Li et al., 2023). The National Institute for Health and Care Excellence (2013) compiled a summary of dropout rates in various fall interventions, showing that home hazard interventions (28%), Tai Chi (20%), and psychotropic medication (68%) were among the highest dropout rates. Evidence suggests that sustained physical activity may be more effective than other therapies in preventing and reducing falls in the elderly (Barmentloo et al., 2020; De Labra et al., 2015).

Recent studies, including those by Jiang and Wu (2022), Franco et al. (2016), and Saeterbakken et al. (2018), indicate that tailored exercise programs, encompassing activities like strength and aerobic exercises, can significantly enhance physical performance in older adults. These studies recommended that future research focus on individualized and accessible exercise regimens, particularly for those with frailty or cognitive impairments, creating a research gap for this study. Research on physical stability in the elderly, including studies by Casas-Herrero et al. (2019), Kyeongjin Lee (2020), Loh et al. (2022), and Mohammadian et al. (2019), shows varied benefits of exercises like Tai Chi, Virtual Reality Gait Training (VRGT), and conventional regimens on gait speed. However, the results are inconsistent, highlighting the need for detailed, long-term studies tailored to diverse elderly populations to clarify the effects of exercise on physical stability. Studies by Aibar-Almazán et al. (2019), Chittrakul et al. (2020), Mittaz Hager et al. (2019), and Taylor et al. (2020) suggest that diverse physical interventions can improve fall prevention self-efficacy among the elderly. These studies recommended further research to identify optimal interventions for increasing confidence in fall prevention in this demographic.

The link between exercise treatments and the lowering of fall risk in elderly individuals has been investigated (Sherrington et al., 2019). The American Heart Association and the American College of Sports Medicine produced guidelines for how much and what kinds of exercise and physical activity are optimal (American Heart Association [AHA], 2024; American College of Sports Medicine [ACSM], 2023). As a result, exercises that preserve or develop flexibility are recommended for elderly individuals (Mohseni & Nasab, 2023). Balance exercises are suggested for older adults who risk falling (Toosizadeh et al., 2018). Furthermore, elderly individuals should have an activity plan incorporating preventative and therapeutic guidelines for reaching prescribed physical activity (Miko et al., 2018). The World Health Organization recommends that all people over 60 should exercise regularly to combat the effects of inactivity (Bull et al., 2020; Thomas et al., 2019). Unfortunately, many older adults do not engage in enough physical activity. Accelerometer data shows that just 17% of persons aged 60–79 years fulfil suggested standards (Clarke et al., 2019). Even though there are recommendations for the frequency, intensity, and duration of physical exercise for the elderly, there is a lack of standardized, unambiguous information on the beneficial types of physical activity (World Health Organization [WHO], 2020). The recommended activities include walking, running, cycling, and gardening; nevertheless, this remains '*vague*' and the examined methodologies lacked sufficient specifics on the slightest degree of physical activity necessary to draw any meaningful results (Langhammer et al., 2018).

One modality of physical activity called aerobic exercise has been identified as beneficial among elderly individuals (Bai et al., 2022). However, it remains unclear whether this type of exercise is ideal for the elderly (Arkkukangas et al., 2019). It has also been observed that the elderly have a poor rate of adherence to aerobic exercise programs, which have been shown to have little to no impact on balance, mobility, and fear of falling (Di Lorito et al., 2020). Elderly individuals often struggle to engage in physical activity due to various factors (Meredith et al., 2023). One significant barrier is the presence of chronic health conditions, such as arthritis or heart disease, which can limit mobility and cause pain or fatigue, discouraging exercise (Meredith et al., 2023; Veldhuijzen van Zanten et al., 2015). There is also a heightened fear of injury, mainly related to falls, which can deter older adults from physical activities (Chandrasekaran et al., 2021). Motivation can be lacking, with social isolation, depression, and a perceived lack of enjoyment diminishing the drive to stay active (Quach & Burr, 2019; Sherman et al., 2024). Limited social support, often due to isolation or loneliness, can exacerbate these issues (Donovan & Blazer, 2020; National Academies of Sciences, Engineering, and Medicine, 2020). While researchers have discovered various characteristics associated with adherence, uncovering a mechanism that distinguishes a propensity to adhere from a tendency to drop out has proven challenging (Shaw et al., 2022). These investigations urged researchers to consider the issue of non-adherence within the theoretical framework of self-efficacy (Bandura, 1977; Collado-Mateo et al., 2021).

For millennia, dance has been an essential part of cultural and healing ceremonies, and new research on its therapeutic benefits is developing (Patti et al., 2017; Douka et al., 2019). An alternative to traditional exercises, dance-based exercise becomes dance-based therapy or treatment when focused on specific aims (Fong Yan et al., 2024). As a result, a growing body of knowledge on complementary and integrative therapies suggests that these innovative interventions, when implemented, could significantly improve the quality of life for the elderly (Koch et al., 2019). Some preliminary research suggests that using dance as a form of physical exercise for elderly adults with diseases like Parkinson's disease (PD) and dementia may be beneficial (McNeely et al., 2015). A 2021 systematic review and meta-analysis found that dance therapy significantly improved motor impairments and reduced symptoms like depression and anxiety. Moreover, it highlighted the importance of social interaction and music engagement during dance, which helps improve emotional well-being and quality of life for those with Parkinson's disease (PD) (Carapellotti et al., 2020). As a result, an expanding proportion of elderly individuals are incorporating dance into their regimen as a form of physical therapy. This enjoyable and demanding exercise has garnered favourable attention from the ageing population (Hwang & Braun, 2015).

Evidence is accumulating that suggests dance-based physical exercise have high adherence and so is a valuable technique in lowering the risk of falling in the elderly (Hewitt et al., 2018; Rodríguez & Paris-Garcia, 2022). Veronese et al.'s (2017) study on dance therapy's safety and efficacy in reducing falls and fear of falling presents a positive outlook. However, the study's methodology could be critiqued for potential biases in participant selection and the dance therapy's intensity and duration. Similarly, the study by Franco et al. (2016) on the effectiveness of senior dance plus brief education for fall prevention showed improved balance. Still, it raises questions about the magnitude of the effect of "brief education" on the observed improvements.

A dance-based treatment for adults with physical limitations called The Lebed Method (TLM) has recently been the focus of research with promising results (Rodríguez & Paris-Garcia, 2022). The Lebed Method, also known as Healthy Steps, is a therapeutic dance and movement program initially developed to enhance the quality of life for breast cancer survivors (Hyvönen et al., 2020). This program, created by Sherry Lebed Davis, incorporates dance movements and exercises designed to address the physical and emotional challenges breast cancer patients and survivors face (Abu-Odah et al., 2024). It has been demonstrated to improve quality of life, restore shoulder range of motion, reduce lymphedema, and improve body image and shoulder function in breast cancer survivors (Hyvönen et al., 2020; Abu-Odah et al., 2024; Healthy Steps | Evidence-Based Cancer Control Programs, n.d.).

The Lebed Method has been researched for its efficacy in reducing the risk of falls in the elderly. A study by Krampe et al. (2010) showed that the Lebed therapeutic intervention improved balance and gait among elderly individuals. However, the study lacks blinding, which could introduce bias, particularly in subjective measures like fear of falling, as participants' expectations might influence their responses. Conducting the research at a single site with a homogenous sample limits the external validity and generalizability of the findings to a broader population. Additionally, the potential for contamination between treatment and control groups and the short duration of follow-up restrict the ability to assess long-term effects and true differences between groups. Another study by Pope et al. (2019), explored the effectiveness of The Lebed Method (TLM) in comparison with another exercise program. The study involved 163 older adults and found that while TLM and participants in TLM demonstrated greater knee extension strength, indicating that dance-based interventions like TLM can also effectively reduce fall risk factors for older adults. The study's quasi-experimental design and convenience sampling introduce potential selection bias and limit the generalizability of the findings. High attrition rates, varying attendance, and a lack of exercise intensity monitoring further undermine the reliability of the results. Although statistically significant differences were found, the small effect sizes and baseline heterogeneity raise concerns about the clinical significance and robustness of the study's conclusions (Pope et al., 2019).

The sustainability of the Lebed Method lay in its ability to satisfy the basic psychological needs for autonomy, competence, and relatedness (Fernández-Espínola et al., 2020; Ryan & Deci, 2000). As a result of meeting these needs, the Lebed Method was expected to foster a sense of volition and willingness to engage in the activity, promoting sustainability. Furthermore, if people loved what they did, they were more likely to remain physically active and consistent (Reichert et al., 2017). Consequently, this study aimed to rectify the methodological limitations observed in prior interventions, striving to enhance the intrinsic physiological factors associated with fall risks in the elderly. The goal was to provide a comprehensive, accessible, sustainable, and enjoyable approach.

1.2 Statement of the problem

The escalating financial burden of senior falls also presents a significant concern, with the Recent literature highlights that fall among the elderly had been a significant global health concern as indicated in Table 1.1. In Kenya, falls make up 69% of home injuries and are a significant cause of trauma-related fatalities, disproportionately impacting elderly women (Bhoomika et al., 2022; Gathecha et al., 2018; Kimani et al., 2019; Odhiambo et al., 2013). The financial burden of these falls is substantial, with direct medical costs among Americans aged 60 and older estimated at $19 billion, projected to rise significantly without effective interventions (Florence et al., 2018; Alshammari et al., 2018). Unifactorial interventions like Tai Chi and physiotherapy have shown varying levels of efficacy, but often suffer from poor adherence and high dropout rates due to practical limitations in community settings (Chen et al., 2023).

Table 1.1. Trends in fall prevalence among the elderly over the years

Year	Study	Location	Percentage of Older Adults Reporting Falls	Notes
2010	Deandrea et al. (2010)	Worldwide	28-35% (aged 60+) 32-42% (aged 70+)	A systematic review of global data
2010	Bekibele& Gurej (2010)	Nigeria	27.3%	14.3% resulted in injuries
2011	Kalula et al. (2010)	South Africa	21.2%	8.2% had fall-related injuries
2011	Peel (2011)	Africa (General)	25% (average)	Reviewed various contributing factors to falls
2019	Hartholt et al. (2019)	Worldwide	37%	Studied the rising trend of falls in various countries
2020	WHO Report (2020)	Worldwide	30-40% (aged 60+)	Emphasized the global impact of falls on health systems

Several barriers to traditional physical activity (aerobic and resistance) among the elderly, such as fear of injury, lack of motivation, and limited access to exercise facilities, exacerbate the challenges of reducing fall risks (Gadhvi et al., 2023). Studies indicate that cultural and generational attitudes, as well as a general lack of knowledge about safe exercise practices, further discourage participation (Ige-Elegbede et al., 2019; Aro et al., 2018). A Ugandan study found that negative attitudes toward exercise significantly contributed to high dropout rates, highlighting the need for innovative approaches to address these issues (Kasoma et al., 2011).

Dance-based exercise, particularly the Lebed Method, has emerged as a promising intervention that enhances physical and psychological well-being by improving strength, mobility, and balance (Mittaz Hager et al., 2019). While preliminary research suggests its potential, existing studies often suffer from methodological limitations, such as the lack of blinding, which could introduce bias and conducting the research at a single site with a homogenous sample also limited the external validity and generalizability of the findings to a broader population, making it difficult to draw definitive conclusions (Krampe et al., 2010). Given the gaps in the literature and the rising fatalities from falls, assessing the efficacy of the Lebed Method in reducing fall risks, especially among elderly populations in Kenya, is essential for guiding future interventions.

1.3 Objectives of the study

1.3.1 Broad objective

The study's objective was to investigate the effectiveness of the Lebed dance movement therapy intervention on intrinsic physiological fall risk factors among the elderly in Kakamega.

1.3.2 Specific objectives

1. To examine the effectiveness of The Lebed method therapeutic intervention on physical performance among elderly individuals.
2. To investigate the effectiveness of The Lebed method therapeutic intervention on physical stability among elderly individuals
3. To determine the effectiveness of The Lebed method therapeutic intervention on fall apprehension among elderly individuals
4. To assess the relationships between physical performance, cognitive function, mobility, balance, and fear of falls among elderly individuals

1.4 Research questions

1. How effective is The Lebed Method therapeutic intervention in improving physical performance among elderly individuals?

2. Does The Lebed Method therapeutic intervention enhance physical stability among elderly individuals?
3. To what extent does The Lebed Method therapeutic intervention reduce fear of falls and improve cognitive function among elderly individuals?
4. What are the relationships between physical performance, cognitive function, mobility, balance, and fear of falls among elderly individuals?

1.5 Hypothesis

The Null hypotheses to be tested in the study are:

1. $H_0 1 -$ There is no significant difference in physical performance between the treatment and control group before and after Lebed therapy intervention among elderly individuals.
2. $H_0 2 -$There is no significant difference in physical stability between the treatment and control group before and after Lebed therapy intervention among elderly individuals.
3. $H_0 3 -$ There is no significant difference in fall apprehension between the treatment and control group before and after Lebed therapy intervention among elderly individuals.
4. $H_0 4 -$ Physical performance, cognitive function, mobility, and balance will not be significant predictors of fear of falls among elderly individuals.
5. $H_0 5 -$ There are no significant differences in sociodemographic factors between the intervention and control groups among elderly individuals.

1.6 Justification of the study

This study is justified by the urgent need to address the underrepresented issue of population aging in Kenya, a concern that has been overshadowed by the focus on the youth bulge and demographic dividend. Despite the significant protections afforded to the elderly under Article 57(d) of the 2010 Constitution (Kenya Law Reform Commission [KLRC], 2010), the aging population remains a critical demographic that demands focused attention. This study aligns with Kenya's Vision 2030 and supports the implementation of a Consolidated Social Protection Fund for Older Persons (CSPF) under the social pillar, as well as other relevant policies, such as the National Social Protection Policy and the National Policy on Older Persons and Aging (Revised 2018).

Given the substantial financial and societal costs associated with accidental falls among the elderly, evident in the high rates of injury and hospitalization at facilities like Kenyatta National Hospital (Omondi et al., 2023; Said & Mutiso, 2013), there is a pressing need to justify expenditures on effective fall prevention interventions. Studies have demonstrated that fall prevention strategies can reduce healthcare costs by minimizing hospital admissions and the need for long-term care (Li et al., 2023; Martinson et al., 2003). This research into the Lebed Method not only seeks to improve physical activity among the elderly but also supports Kenya's universal healthcare goals by potentially alleviating the strain on healthcare resources (Obiero & Kagendo, 2022; Ayieta Ondondo, 2020).

Furthermore, the use of a randomized controlled trial (RCT) design in this study, considered the gold standard for evaluating intervention effectiveness (Nair, 2019), will allow for a robust analysis of the Lebed Method's impact on fall risk and physical function. By conducting this study in Kakamega County, a region with a significant aging population and unique healthcare challenges (Wilunda et al., 2015; Zhang et al., 2022), the research will provide region-specific insights that can inform broader applications in similar communities. The study employs well-established outcome measures, such as the Morse Fall Scale (MFS) and the Falls Efficacy Scale-International (FES-I), to ensure a comprehensive evaluation of fall risk and fear of falling, addressing both objective and subjective factors (Phelan et al., 2015).

1.7 Significance of the study

This study findings holds significant implications for the enhancement of elderly care in Kenya, providing vital insights that can inform policy development and public health initiatives aimed at promoting healthy aging. The evidence generated on the efficacy of the Lebed Method in reducing fall risks and improving physical function among older adults supports the integration of such dance-based therapy programs into national health strategies. These findings are particularly relevant for healthcare practitioners, who can apply these evidence-based interventions to improve the physical health and safety of the elderly population.

Moreover, the study serves as an essential resource for long-term care planning, emphasizing the need for environments that mitigate fall risks as the elderly demographic in Kenya continues to grow. The research addresses the pressing need for sustainable and cost-effective interventions to manage fall-related injuries, which will become increasingly important as the population ages. Furthermore, the study paves the way for future academic inquiry, particularly in assessing the long-term impacts and cost-effectiveness of such interventions. The findings may also have broader applications for other at-risk populations, such as individuals with Parkinson's disease or those recovering from stroke, who face similar challenges related to balance, coordination, and mobility.

1.7 Scope of the study

1.7.1 Limitations

This study acknowledges several limitations that were addressed through careful planning and methodology. The exclusive recruitment of participants from a specific geographical area may limit the generalizability of the findings. To mitigate this, the study clearly defined the demographic and contextual characteristics, ensuring that the implications of the results are understood within this specific scope. The homogeneity of the sample in terms of age and health status further constrains the broader applicability of the results, though the study was designed to represent the target demographic accurately.

The potential for social desirability bias was recognized, and measures were taken to minimize its impact by combining self-report and objective assessments. The study employed both the Morse Fall Scale and the Falls Efficacy Scale-International (FES-I) to provide a comprehensive evaluation of fall risk, thereby reducing the influence of bias. While the nature of the interventions precluded complete blinding, the use of objective measures and statistical controls helped to maintain the internal validity of the findings.

The study addressed the challenge of limited local literature on elderly fall prevention by adapting international research to the Kenyan context, particularly in Kakamega County. This approach aimed to provide culturally relevant insights, despite the constraints posed by the limited regional data.

1.7.2 Delimitations

This study was delimited to individuals aged 60 and above, reflecting the demographic focus of previous research on aging populations (Pengpid & Peltzer, 2018). Due to the variability in participants' weekly schedules, the study was restricted to those who could reliably participate at the scheduled times for data collection, avoiding potential methodological complications. Additionally, the study was geographically limited to Kakamega County, based on findings from prior research that identified falls as a significant cause of trauma-related mortality among elderly women in western Kenya (Kimani et al., 2019; Odhiambo et al., 2013). This regional focus was chosen to align with the study’s objectives and to address the specific needs of this high-risk population.

1.8 Theoretical framework

This study is grounded in the Self-Determination Theory (SDT) framework as established by Ryan and Deci (2000) (Figure 2.1). SDT offers a comprehensive explanation for the potential sustainability of the Lebed Method as an exercise intervention (Deci & Ryan, 1985). According to SDT, motivation plays a crucial role in maintaining long-term engagement in physical activities, which is essential for achieving significant health benefits (Teixeira et al., 2012). The theory posits that activities perceived as inherently enjoyable and satisfying are more likely to be sustained over time. In this context, intrinsic motivation, stemming from personal enjoyment and satisfaction, is expected to play a key role in fostering long-term adherence to the Lebed Method. Additionally, extrinsic motivation, driven by the goal of improving health outcomes, can also contribute to sustained participation. SDT suggests that over time, extrinsic motivation can become internalized, integrating with an individual's self-identity, thereby supporting consistent engagement in health-promoting behaviours (Hancox et al., 2018).

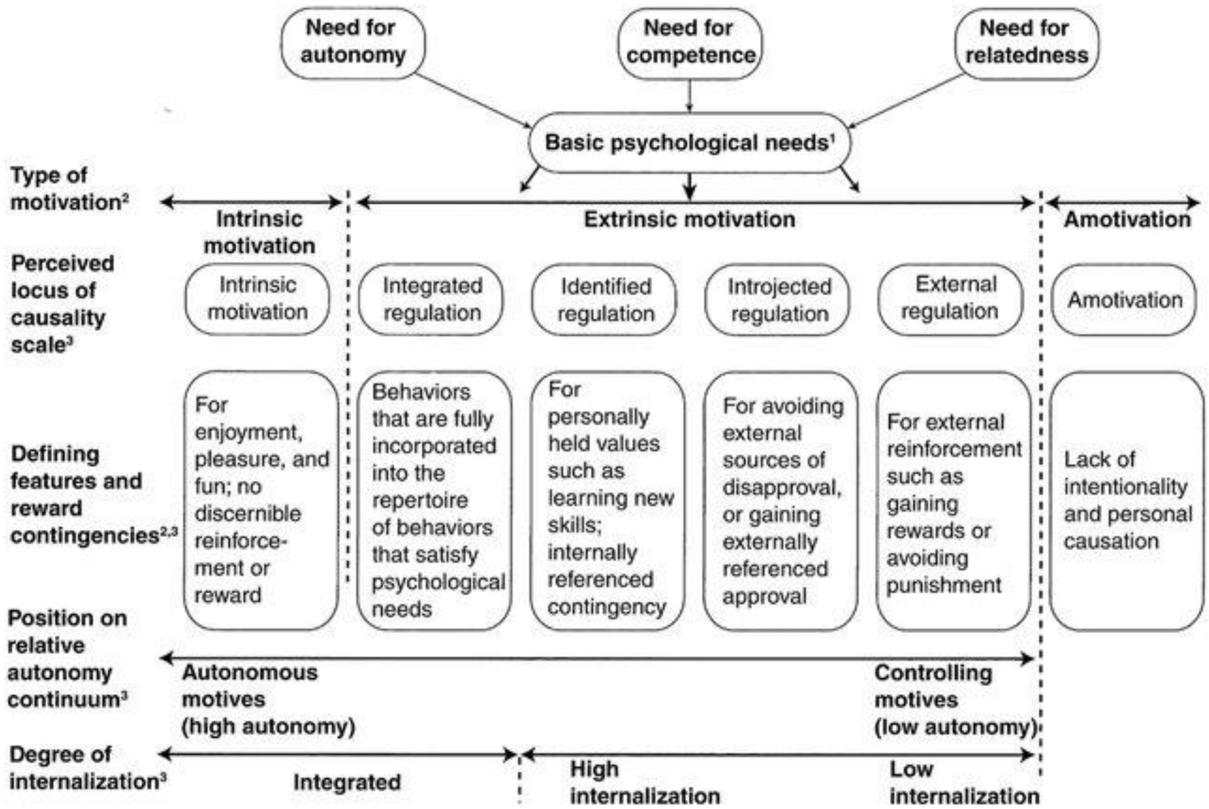

Figure 2.1 Schematic representation of self-determination theory by Deci & Ryan (1985)

The Lebed Method is inherently designed to stimulate both intrinsic and extrinsic motivation among participants. Its emphasis on gentle, low-impact movements is particularly suitable for elderly individuals, reducing discomfort and making the exercise more accessible and enjoyable. This approach enhances the perceived value of the activity, which is critical for long-term adherence (Pietrabissa et al., 2020). SDT further explains that the sustainability of the Lebed Method is linked to its ability to fulfil basic psychological needs for autonomy, competence, and relatedness. By addressing these needs, the Lebed Method is expected to foster a sense of volition and willingness to engage in the activity, thus promoting its long-term sustainability (Rodrigues et al., 2019).

1.9 Conceptual framework

This study was guided by a conceptual framework rooted in Self-Determination Theory (SDT), with adaptations based on the works of Ryan and Deci (2000) (Figure 2.2). The research involved elderly participants engaging in the Lebed Method, a therapeutic dance movement intervention specifically designed to enhance both intrinsic and extrinsic motivation (Lebed, 2005). According to SDT, intrinsic motivation—stemming from personal enjoyment and satisfaction—plays a critical role in sustaining long-term adherence to activities, as individuals are more likely to continue with activities, they find inherently satisfying (Ryan & Deci, 2000). Similarly, extrinsic motivation, such as the desire to improve health, can also foster long-term adherence when it becomes internalized and integrated into an individual's sense of self, further promoting health-related behaviours (Ryan & Deci, 2000).

The Lebed Method effectively addressed common barriers to exercise among the elderly, including disinterest and discomfort, by making the activity more engaging and minimizing physical strain (Schutzer & Graves, 2004). The method's focus on gentle, low-impact movements was designed to reduce pain and discomfort, thereby making exercise more tolerable for elderly individuals (Lebed, 2005). As explained by SDT, the sustainability of the Lebed Method is linked to its ability to satisfy fundamental psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2000). By fulfilling these needs, the method fostered a sense of volition and a willingness to participate, thereby enhancing the sustainability of the intervention.

The increase in physical activity resulting from participation in the Lebed Method had a positive impact on various fall risk factors among elderly individuals. Improvements were observed in physical activity levels, strength and endurance, functional capacity, mobility, balance, and the reduction of fear of falls, all of which contributed to lowering the overall risk of falls, a significant concern in the elderly population. As a result of integrating an activity that offers both intrinsic satisfaction and tangible health benefits, while addressing common barriers and fulfilling core psychological needs, the Lebed Method emerged as a promising intervention for enhancing the well-being of the elderly.

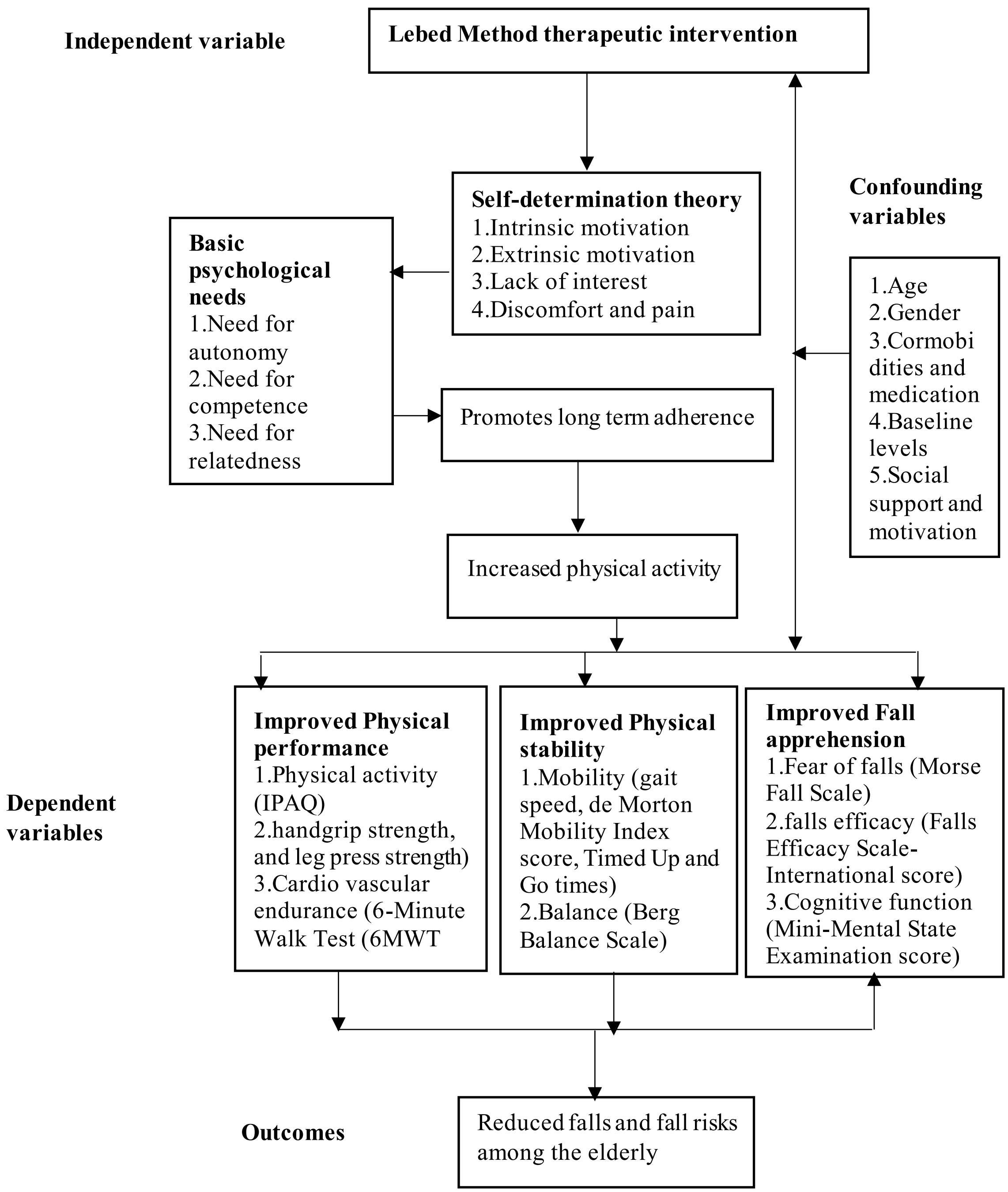

Figure 2.2. Conceptual framework adapted by the researcher with modification from the Self-determination Theory (Ryan & Deci, 2000)

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter specifically addresses the issue of falls among elderly individuals, focusing on the intrinsic physiological factors that increase their susceptibility. It reviews various prevention strategies tailored for the elderly, while also recognizing the challenges that hinder the adoption of physical activity-based interventions. Among the interventions, dance therapy is highlighted for its comprehensive benefits, not only as a form of exercise but also as an effective strategy for fall prevention. The review explores how physical activity influences key factors such as physical performance, functional mobility, and balance, each crucial in determining fall risk. Additionally, it examines the interplay between the fear of falling and cognitive functions, further complicating the risk landscape for the elderly. Ultimately, the literature review synthesizes these elements, offering a holistic understanding of the interconnected factors affecting falls and fall prevention in the aging population.

2.1 Falls in elderly individuals

Falls among the elderly represent a significant public health issue worldwide, with extensive implications for morbidity, mortality, and healthcare costs. Globally, falls are the second leading cause of accidental or unintentional injury deaths, with over 684,000 fatalities annually (World Health Organization [WHO], 2021). The prevalence of falls varies across regions, with higher rates observed in populations aged 60 years and older, particularly in developed countries where the proportion of elderly individuals is rapidly increasing (Stevens et al., 2017). Approximately 28-35% of people aged 65 years and over fall each year, and this rate increases to 32-42% for those over 70 years of age (Verma et al., 2016). The consequences of falls are severe, often leading to injury, disability, loss of independence, and increased mortality (Sherrington et al., 2019).

The burden of falls among the elderly is also significant in Africa, although the epidemiology of falls in this region is less well documented compared to high-income countries. As Africa undergoes demographic transitions with increasing numbers of older adults, the prevalence of falls and associated injuries is expected to rise. Studies conducted in various African countries indicate a substantial prevalence of falls among older adults, with rates comparable to those in high-income countries. For example, a study in Nigeria reported that 31% of elderly individuals had experienced a fall in the preceding year (Oluwadiya et al., 2015). Factors contributing to falls in African contexts include environmental hazards, poor health status, inadequate healthcare services, and socioeconomic challenges (WHO, 2021).

In East Africa, the situation mirrors the broader African context, with falls constituting a major health concern among the elderly. Research in this region remains limited but is gradually increasing. In Uganda, for instance, a cross-sectional study by Nanyonga et al. (2018) found that 34% of elderly participants had experienced a fall in the previous year. Similar studies in Tanzania and Rwanda have reported fall prevalence rates ranging between 30% and 35% among older adults (Mshana et al., 2017; Rugema et al., 2018). These studies highlight the role of factors such as malnutrition, chronic diseases, and environmental risks in contributing to falls among the elderly in East Africa.

Kenya, like many other East African countries, faces a growing challenge of falls among its elderly population. The elderly population in Kenya is increasing, and with it, the prevalence of falls is also rising. A study conducted in Nairobi by Wambugu et al. (2020)

reported that approximately 33% of older adults had experienced at least one fall in the past year. The study identified key risk factors for falls, including poor vision, musculoskeletal disorders, and unsafe living environments. In rural areas of Kenya, the situation is exacerbated by limited access to healthcare services and inadequate infrastructure, which further increases the risk of falls (Wambugu et al., 2020).

Research focusing on specific counties in Kenya is still emerging, but some studies provide insights into the situation at the county level. For instance, a study in Kisumu County found that 29% of elderly individuals had experienced a fall in the previous year, with most falls occurring at home due to environmental hazards such as uneven floors and poor lighting (Ochieng et al., 2021). Another study in Nyeri County reported a similar prevalence, emphasizing the role of chronic health conditions, particularly hypertension and diabetes, as significant contributors to fall risk among the elderly (Muthoni & Muiruri, 2019).

2.2 Intrinsic physiological risk factors for falls among the elderly

Falls among elderly individuals represent a significant public health challenge, leading to severe consequences such as fractures, loss of independence, and even mortality. A multitude of intrinsic physiological factors have been identified as contributing to the increased risk of falls in this population. Among these, decreased lower limb strength, impaired balance and gait stability, and cognitive decline are particularly significant.

One of the most critical intrinsic factors contributing to falls among the elderly is the decline in lower limb strength. This decline, often associated with sarcopenia, significantly impacts an individual's ability to maintain balance and execute movements that require strength, such as rising from a chair or climbing stairs. A study by Cruz-Jentoft et al. (2019) highlighted that sarcopenia, characterized by the loss of muscle mass and function, is a major contributor to falls among older adults. Lower limb weakness, specifically in the quadriceps and calf muscles, has been directly linked to an increased risk of falls, as these muscles are crucial for postural control and balance (Cruz-Jentoft et al., 2019; Beauchamp et al., 2017). Moreover, Lee et al. (2022) conducted a comprehensive study that reinforced the importance of lower limb strength in preventing falls. Their research demonstrated that targeted strength training programs focusing on the lower limbs significantly reduced the incidence of falls among the elderly. This was corroborated by other studies that emphasized the role of lower limb muscle power in enhancing gait stability and reducing fall risk (Tieland et al., 2018).

Impaired balance and gait instability are closely related to decreased lower limb strength and are critical risk factors for falls. With aging, there is a natural decline in the ability to maintain balance due to changes in the sensory systems (visual, vestibular, and proprioceptive), all of which are essential for postural control (Sherrington et al., 2019). The degradation of these systems, combined with lower limb weakness, contributes to an increase in postural sway and gait variability, which are significant predictors of falls (Lord et al., 2021). Recent research by Herman et al. (2021) has demonstrated that gait instability, characterized by slower walking speeds, shorter step lengths, and increased gait variability, is a major contributor to falls. This study found that older adults with gait instability were at a higher risk of falls, particularly when exposed to environmental challenges such as uneven surfaces. Interventions that improve balance and gait, including balance training and gait re-education, have been shown to be effective in reducing the risk of falls (Montero-Odasso et al., 2019).

Cognitive decline is another intrinsic factor that significantly increases the risk of falls among older adults. Cognitive functions such as attention, executive function, and processing speed are essential for maintaining balance and avoiding falls, especially in complex environments (Kearney et al., 2020). Studies have shown that older adults with cognitive impairments, including those with mild cognitive impairment (MCI) or dementia, are at a significantly higher risk of falls compared to their cognitively intact peers (Montero-Odasso et al., 2019). In particular, dual-tasking, which involves performing a cognitive task while walking, has been shown to exacerbate gait instability and increase fall risk in cognitively impaired individuals (Ansai et al., 2017). This has led to the development of interventions that focus on cognitive-motor integration to improve both cognitive function and physical stability, thereby reducing fall risk (Delbaere et al., 2016).

Chronic conditions such as diabetes, arthritis, and cardiovascular diseases also contribute to fall risk through various mechanisms. For instance, diabetic neuropathy can cause loss of sensation in the feet, leading to an impaired ability to detect uneven surfaces, thus increasing the risk of falls (Ferretti et al., 2013). Additionally, the use of certain medications, particularly those affecting the central nervous system such as sedatives and antidepressants, has been associated with a higher incidence of falls. These medications can cause dizziness, sedation, and orthostatic hypotension, all of which compromise balance and stability (Cawkwell et al., 2015).

2.3 Fall prevention interventions among the elderly

The prevention of falls among the elderly has been a topic of extensive research over the years. This literature review critically appraises intervention studies that have attempted to reduce fall risks among the elderly. It also assesses the success and methodologies employed in these studies, compares their findings, and identifies potential gaps in the literature.

2.3.1 Multifactorial Interventions

Bunn et al. (2014) and Guirguis-Blake et al. (2018) emphasized the effectiveness of multifactorial interventions in reducing falls. Gillespie et al. (2012) conducted a meta-analysis showing that multifactorial interventions could reduce falls, but the variability of interventions across studies complicates identifying the most effective components. However, a critical examination reveals that these studies do not provide a detailed breakdown of the individual components of their interventions. This lack of granularity makes it challenging to determine which specific elements are most effective. A conspicuous deficiency exists in comprehending the distinct contributions of each component to the overall effectiveness.

2.3.2 Exercise-Centric Approaches

Several studies, including those by Karlsson et al. (2013) and Sherrington et al. (2016), have highlighted the role of exercise in fall prevention. While their findings converge on the general efficacy of exercise, the methodologies vary. Some studies focus on balance and strength training, while others do not specify the type of exercises used. This inconsistency in methods raises questions about the comparability of results across studies.

2.3.3 Home Safety and Environmental Modifications

Gillespie et al. (2012, 2009) emphasized home safety assessments and modifications. However, the specific nature and implementation of these modifications are not consistently detailed across studies. Home modification interventions have also been investigated, with Clemson et al. (2008) finding that a home-based occupational therapy intervention significantly reduced falls. However, these interventions can be cost-prohibitive, and the uptake and maintenance of recommendations require more research. The lack of standardized assessment tools and modification protocols is a methodological concern that could influence outcomes.

2.3.4 Diverse Exercise Regimens

Albert (2009) differentiated between exercise programs, such as Tai Chi and home-based exercises. While this study provides valuable insights, it does not offer a comparative analysis of the effectiveness of these different regimens. A significant methodological limitation is the absence of a standardized measure of efficacy or a control group in some of these studies.

2.3.4.1 Tai-chi

Physical decline is an inevitable aspect of ageing, and several studies have turned their gaze toward Tai-chi, an ancient Chinese practice, to understand its potential ameliorative effects on the elderly. Eggenberger et al. (2015) investigated the effects of combining Tai Chi with cognitive training, positing that this approach might enhance gait performance beyond the benefits of physical exercise alone. While the study reported a significant reduction in fall frequency, it did not observe statistically significant differences in gait speed between the control and intervention groups. This suggests that while Tai Chi can contribute to fall prevention, its effects on certain aspects of physical performance, such as gait speed, may be more complex and require further investigation.

Davis et al. (2015) expanded the focus of Tai Chi research by exploring the relationship between mobility and health-related quality of life. Their findings underscored the interconnectedness of physical mobility and overall well-being, highlighting the broader implications of maintaining physical activity in the elderly. This study aligns with a growing body of literature suggesting that interventions like Tai Chi can play a crucial role in enhancing the quality of life in older populations.

Haynes et al. (2015) examined the "A Matter of Balance" program, initially led by professionals but later transitioned to a lay leader model to reduce costs. This study demonstrated the program's adaptability and potential for broader community implementation, particularly in promoting fall prevention among older adults. In 2016, Garcia et al. explored the feasibility of using Kinect-based stepping exercises for elderly individuals at home. Their research indicated that such technology-assisted interventions could effectively improve balance and stepping ability, contributing to fall prevention efforts (Garcia et al., 2016).

Research in 2020 offered new insights into the application of Tai Chi for specific populations. Sanders et al. (2020) examined the impact of Tai Chi intensity on elderly individuals with dementia, finding improvements in gait speed following high-intensity training. However, cognitive outcomes did not show significant changes, indicating that while Tai Chi can enhance physical capabilities, its cognitive benefits may be limited in certain populations. Kienle et al. (2020) conducted a comparative study on the effectiveness of Eurythmy therapy, Tai Chi, and standard care for fall-prone elderly individuals. Although their results were pending at the time, the study's design reflects the ongoing search for the most effective interventions for fall prevention in this demographic.

Several studies in 2021 further explored Tai Chi's benefits. Chen et al. (2021) and Kashki et al. (2021) each implemented 12-week programs to assess Tai Chi's impact. Kashki et al.

observed a reduction in post-intervention fall rates among participants, while Chen et al. reported a decrease in fear of falling, though without significant improvements in overall quality of life. Ge et al. (2021) conducted an 8-week intervention, documenting notable improvements in walking speed and reductions in psychological stressors such as fear of falling and depressive symptoms. The most recent studies, conducted in 2022, focused on specific health issues in elderly populations. Yan et al. (2022) investigated the effects of Tai Chi on older women with non-specific low back pain, finding significant improvements in gait and dynamic balance. Additionally, Moawd et al. (2022) explored the combination of monochromatic infrared energy with Tai Chi, reporting enhanced balance outcomes, thereby expanding the scope of Tai Chi's potential applications in elderly care. Table 2.1 gives a summary of the studies and research gaps.

Table 2.1 Tai-chi fall interventions among the elderly individuals and gaps.

Variable	Author, Age Group, Place, Year	Findings	Research Gap
Tai Chi and Gait Speed	Kashki et al., 2021 (Elderly Women, Iran)	No significant improvement in gait speed, but there was a reduced fall rate after Tai Chi.	Lack of long-term effects and limited sample size
Tai Chi and Cognitive Status	Okuyan & Deveci, 2020 (Older Adults with MCI)	Improved cognitive adaptations and fall behavioral scale	Small sample size and lack of control group
Tai Chi and Balance	Yan et al., 2022 (Elderly Women with NS-LBP)	Improved gait velocity, stride length, and dynamic balance	Short intervention duration and small sample size
Tai Chi and Balance (MIRE)	Moawd et al., 2022 (Community-Dwelling Older Adults with LEDs)	Improved balance and reduced fall risk with MIRE and Tai Chi	Lack of separation of MIRE and Tai Chi effects need for long-term follow-up
Tai Chi and Fear of Falling	Chen et al., 2021 (Assisted Living Facility)	20% reduction in fear of falling after Tai Chi	Small sample size and absence of a control group
Tai Chi and Multiple Outcomes	Kienle et al., 2020 (Elderly Patients with Chronic Diseases)	Pending results on falls, mobility, cognition, mood, quality of life	Awaited study outcomes and conclusions
Tai Chi and Pre-Frail Elderly	Ge et al., 2021 (Pre-Frail Elderly)	Improved chair rise test, walking speed, fear of falling, and depression	Short intervention duration, small sample size, and lack of control group

2.3.5 Collaborative and Multidisciplinary Approaches

Nikolaus and Bach (2003) showcased the effectiveness of a multidisciplinary approach. However, the study does not detail each discipline's specific roles and contributions, leaving a gap in understanding the synergy between professionals in such interventions.

2.3.6 Epidemiological Studies

While studies by Rubenstein (2006, 1988) and Sorock (1988) provide valuable epidemiological data, they primarily offer descriptive statistics without delving into causal relationships. The reliance on retrospective data in some of these studies could introduce recall bias, affecting the results' reliability.

2.3.7 General Observations and Overarching Recommendations

The field of fall prevention among elderly individuals encompasses a diverse range of intervention strategies, including nutritional supplements and the emerging domain of digital health. While some research areas show promise, others reveal methodological limitations that necessitate careful evaluation to develop effective prevention strategies.

Vitamin D supplementation is one area of considerable debate within fall prevention research. Bolland et al. (2014) conducted a pivotal study that questioned the efficacy of this intervention, finding no significant reduction in fall rates. This result challenges the notion of Vitamin D as a universally effective measure and highlights the need for further investigation and discourse within the scientific community.

Digital health interventions, particularly those utilizing smartphone technology, represent another promising avenue for fall prevention. McMahon et al. (2018) explored the potential of smartphone applications in mitigating falls among the elderly. Their findings suggest potential benefits, but also emphasize the need for larger, more longitudinal studies to confirm these preliminary results. The study underscores the critical need for rigorous validation before digital tools can be widely recommended.

In the context of disease-specific interventions, Parkinson's disease (PD) has been a focal point for tailored strategies. Fletcher et al. (2012) demonstrated that personalized physical therapy could significantly reduce fall risk in PD patients. However, similar to other studies in this domain, the research calls for long-term follow-up to assess the sustained effectiveness of these interventions, underscoring the importance of ongoing research to refine these strategies.

Socio-cultural factors and their influence on fall prevention outcomes remain underexplored. Additionally, there is a notable gap in research focusing on elderly individuals with cognitive impairments, a demographic at heightened risk of falls, as emphasized by Montero-Odasso et al. (2019). This gap represents a critical area for future research, particularly given the increased vulnerability of this population to fall-related injuries.

Moreover, while the incidence of falls is well-documented, the associated injuries and their impact on health outcomes receive comparatively less attention. Peeters et al. (2010) highlight the significant consequences of fall-induced injuries, yet this aspect remains insufficiently explored in the literature. Furthermore, the cost-effectiveness of various interventions is another area that requires greater focus. Church et al. (2012) underscores the importance of evaluating the economic aspects of fall prevention strategies, which is essential for their broader implementation and sustainability. Table 2.2 shows a summary and research gaps in fall prevention interventions.

Table 2.2 Research Gaps in Fall Prevention Interventions

Variable	Author and Year	Findings	Research Gap
Multifactorial Interventions	Guirguis-Blake et al. (2018), Bunn et al. (2014)	Effective in reducing falls	Lack of detailed breakdown of intervention components
Exercise-Centric Approaches	Sherrington et al. (2016, 2011), Karlsson et al. (2013)	Exercise is effective in fall prevention	Inconsistency in exercise types and methodologies
Home Safety and Environmental Modifications	Gillespie et al. (2012, 2009)	Home safety assessments and modifications are effective	Lack of standardized assessment tools and modification protocols
Diverse Exercise Regimens	Albert (2009)	Different exercise programs like Tai Chi and home-based exercises are effective.	No comparative analysis of different exercise regimens
Collaborative and Multidisciplinary Approaches	Nikolaus & Bach (2003)	A multidisciplinary approach is effective	Unclear roles and contributions of each discipline
Epidemiological Studies	Rubenstein (2006, 1988), Sorock (1988)	Provides valuable epidemiological data	Lack of causal relationships and potential recall bias
General Observations and Overarching Recommendations	Kannus et al. (2005), Brown (1999)	Broad observations on fall prevention	Lack of detailed methodological framework

2.3.8 Barriers to physical activity interventions among the elderly

2.3.8.1 Global Perspective

Physical activity (PA) interventions are critical for improving health outcomes in elderly populations, yet significant barriers limit their engagement in such activities. Globally, these barriers include health-related issues, environmental factors, and motivational challenges. Chronic health conditions, such as arthritis, cardiovascular diseases, and obesity, reduce the physical capacity of older adults to engage in regular exercise (Bethancourt et al., 2014). Additionally, environmental factors like poor infrastructure and unsafe neighbourhoods also deter elderly individuals from participating in outdoor physical activities (Sun et al., 2013). Motivational barriers, particularly low self-efficacy and fear of injury, are further exacerbated by the age-related decline in physical function (Baert et al., 2011).

Psychosocial factors also play a significant role. Research suggests that social isolation and the lack of community support significantly limit older adults' willingness to engage in PA interventions (Smith et al., 2017). Another key barrier is ageism and the societal perception that older adults should not or cannot engage in physical activity (Franco et al., 2015). This perception can diminish older adults' confidence in their ability to benefit from PA, leading to reduced participation rates.

2.3.8.2 Barriers in Africa

In Africa, barriers to physical activity interventions among the elderly reflect both global challenges and region-specific issues. Cultural factors, economic constraints, and a lack of tailored interventions are significant challenges in the region (Kalula & Ferreira, 2017). Many African societies traditionally view aging as a period of rest, which can discourage physical activity among the elderly. Additionally, financial barriers, such as poverty and the high cost of healthcare, often prevent elderly individuals from accessing structured exercise programs (Tomiwa & Adedayo, 2021).

In rural African settings, the lack of infrastructure for exercise and the prevalence of unsafe environments further exacerbates the challenge (Tomiwa & Adedayo, 2021). Furthermore, limited healthcare resources contribute to a lack of professional guidance on physical activity interventions, leaving many older adults unaware of the potential benefits of staying active (Kalula & Ferreira, 2017).

2.3.8.3 Barriers in East Africa

In East Africa, elderly populations face unique barriers that stem from socioeconomic, environmental, and healthcare-related factors. In Kenya, Uganda, and Tanzania, physical activity interventions are hindered by poverty, poor access to healthcare, and a scarcity of age-appropriate programs (Kamenju et al., 2021). Limited public spaces and infrastructure, particularly in rural areas, restrict opportunities for older adults to engage in outdoor activities (Bosu et al., 2019). In urban areas, while infrastructure may be available, safety concerns related to traffic and crime often deter participation in outdoor exercise (Matovu et al., 2020).

Another significant barrier in East Africa is the lack of culturally relevant PA interventions. Many existing programs are designed with Western standards in mind, neglecting the unique cultural and societal factors that influence PA behaviours in this region (Bosu et al., 2019). The lack of trained professionals to guide elderly individuals through safe and effective exercise programs also remains a key challenge (Kamenju et al., 2021).

2.3.8.4 Barriers in Kenya

In Kenya, the elderly population faces significant barriers to engaging in physical activity interventions, driven by economic, environmental, and social factors. Poverty is a major issue, particularly in rural areas, where older adults may not have the resources to participate in structured exercise programs (Matovu et al., 2020). In addition to economic constraints, infrastructural challenges such as inadequate public spaces and recreational facilities limit opportunities for physical activity (Mbuthia et al., 2019). Urban settings, although more developed, present their own challenges, such as high crime rates and unsafe pedestrian environments that discourage outdoor exercise (Kamenju et al., 2021).

Moreover, cultural attitudes toward aging in Kenya can serve as barriers. There is a prevailing belief that physical activity is not necessary for the elderly, leading to low levels of motivation to engage in exercise (Mbuthia et al., 2019). This perception is often reinforced by family members, who may view aging as a time for rest rather than an opportunity to maintain health through physical activity. Additionally, healthcare providers may not prioritize exercise interventions for older adults, contributing to a lack of awareness about the benefits of staying active in later life (Mbuthia et al., 2019).

2.4 Benefits of dance therapy for the elderly

2.4.1 Global Perspective

Dance therapy has gained recognition as an effective intervention for improving physical, cognitive, and emotional well-being in elderly populations worldwide. This therapeutic approach, which combines movement and music, has been shown to offer numerous health benefits for older adults, addressing various aspects of aging, including mobility, balance, mental health, and social engagement.

Globally, dance therapy has been documented to enhance physical health by improving balance, gait, and overall mobility in older adults. A systematic review by Keogh et al. (2015) highlighted that dance interventions significantly improved balance and functional mobility in elderly participants, reducing the risk of falls—a major concern in this demographic. The rhythmic and structured nature of dance helps older adults maintain and even improve their motor skills, making it an effective form of exercise that also enhances cardiovascular health (Keogh et al., 2015).

Cognitive benefits are another key area where dance therapy has shown promise. Studies have indicated that dance therapy can stimulate cognitive function, particularly in areas related to memory, attention, and executive function. For instance, a study by Kshtriya et al. (2015) found that regular participation in dance therapy improved cognitive performance in older adults, particularly those with mild cognitive impairment or early stages of dementia. The combination of physical movement, musical rhythm, and social interaction in dance therapy may enhance neuroplasticity, contributing to cognitive improvements (Kshtriya et al., 2015).

The emotional and psychological benefits of dance therapy are equally significant. Dance provides a creative outlet for self-expression and can alleviate symptoms of depression and anxiety, which are prevalent among the elderly. Research by Koch et al. (2019) demonstrated that dance therapy reduced levels of depression and anxiety in older adults, contributing to improved mental health and overall well-being. The social interaction inherent in group dance activities also combats loneliness and social isolation, common issues among the elderly (Koch et al., 2019).

2.4.2 Benefits in Africa

In Africa, dance therapy is increasingly recognized as a culturally appropriate and effective intervention for the elderly. The rhythmic and communal aspects of dance align well with many African cultural practices, making it an accessible and engaging form of therapy for older adults. A study by Odole et al. (2020) in Nigeria demonstrated that dance therapy improved both physical and emotional well-being in elderly participants, with significant improvements in balance, gait, and mood. The study also highlighted the role of dance in fostering social connections, which is particularly important in African societies where communal living and social interaction are highly valued (Odole et al., 2020).

Moreover, dance therapy in Africa has been shown to be a cost-effective intervention, requiring minimal resources and infrastructure compared to other forms of physical therapy. This makes it an attractive option in low-resource settings, where access to healthcare services may be limited (Odole et al., 2020).

2.4.3 Benefits in East Africa

In East Africa, dance therapy has been integrated into community-based programs aimed at improving the health and well-being of the elderly. A study conducted in Tanzania by Mshana et al. (2020) found that traditional dance interventions significantly improved the physical fitness and emotional health of older adults. The study emphasized the importance of using culturally relevant dance forms, which increased participant engagement and adherence to the therapy (Mshana et al., 2020). The communal nature of traditional East African dances also helped reduce social isolation and improved the quality of life for participants.

Additionally, dance therapy has been recognized as an effective tool for managing chronic conditions such as hypertension and diabetes, which are prevalent among the elderly in East Africa. A study in Uganda by Nankinga et al. (2021) reported that elderly participants in a dance therapy program experienced reductions in blood pressure and improved glycemic control, demonstrating the broader health benefits of this intervention (Nankinga et al., 2021).

2.4.4 Benefits in Kenya

In Kenya, dance therapy has shown potential in addressing the unique health challenges faced by the elderly. A study by Wambugu et al. (2021) in Nairobi revealed that dance therapy significantly improved balance, mobility, and mental health in elderly participants. The study also highlighted the social benefits of dance, as participants reported increased social interaction and a sense of community through regular participation in dance sessions (Wambugu et al., 2021).

Dance therapy in Kenya has also been used as a tool for cognitive stimulation, particularly in older adults with cognitive impairments. A pilot study by Okeyo et al. (2021) demonstrated that dance therapy led to improvements in memory and attention in elderly participants with mild cognitive impairment, suggesting its potential as a non-pharmacological intervention for cognitive decline (Okeyo et al., 2021).

2.5 Dance as a fall prevention intervention among elderly individuals

Recent randomized controlled trials (RCTs) have increasingly explored the effectiveness of dance as a fall prevention intervention among elderly populations. These studies have provided robust evidence supporting the role of dance in improving balance, gait stability, and reducing the incidence of falls. However, despite the promising outcomes, several methodological limitations and considerations must be acknowledged.

McKinley et al. (2018) conducted an RCT examining the impact of an Argentine Tango dance program on balance and fall risk among older adults. The study involved 75 participants aged 65 and older, who were randomly assigned to either the Tango dance intervention group or a control group receiving standard fall prevention education. Over the course of 12 weeks, with sessions held twice weekly, the study found significant improvements in balance and confidence among the dance group compared to the control group. However, the small sample size and the cultural specificity of Argentine Tango may limit the generalizability of the findings. Furthermore, the control group's lack of an active intervention poses a challenge in interpreting the relative efficacy of the dance program.

Hackney and Hall (2019) expanded on this area by investigating the effects of a 16-week ballroom dance program on balance, gait speed, and fall incidence in a larger cohort of 120 older adults. Participants were randomized to either the ballroom dance group or a control group that engaged in stretching and relaxation exercises. The results indicated significant improvements in balance and gait speed in the dance group, alongside a reduction in falls. This study's use of an active control group strengthens the validity of the findings. However, the absence of long-term follow-up raises questions about the sustainability of these benefits over time.

Verghese et al. (2019) targeted a specific population by assessing the effects of a structured dance program on cognitive function and fall risk in older adults with mild cognitive impairment (MCI). This study involved 110 participants, who were assigned to either a dance intervention or a health education control group. The 20-week intervention resulted in significant improvements in cognitive function and a reduced risk of falls among the dance group. While the inclusion of participants with MCI is commendable, the reliance on self-reported fall data introduces potential recall bias, and the lack of long-term follow-up limits insights into the enduring effects of the intervention.

Franco et al. (2020) conducted a similar study with 150 older adults, focusing on the effects of a traditional dance program on fall risk. Participants were divided into a dance group or a sedentary control group, with the intervention spanning 12 weeks. The study reported significant improvements in postural stability and a decrease in fall risk within the dance group. However, the use of a sedentary control group might overstate the benefits of the dance intervention, and the reliance on self-selected traditional dances could affect reproducibility across different cultural contexts.

Young et al. (2021) explored the effects of a modern dance program on balance and fall prevention in community-dwelling older adults, utilizing a larger sample size of 200 participants. The study employed a 24-week intervention period, during which participants were assigned to either the dance group or a control group engaging in light stretching exercises. The findings demonstrated significant improvements in dynamic balance and a reduction in the number of falls among the dance group. Despite these promising results, the study's reliance on self-reported fall diaries raises concerns about data accuracy, and the low-intensity control group activity might not provide a robust comparison.

Sofianopoulou et al. (2021) examined the effectiveness of a Greek folk dance program in reducing fall risk among 90 older adults. Participants were randomized to either the dance group or a walking group, with both interventions lasting 16 weeks. The study reported significant improvements in balance and a lower incidence of falls in the dance group. The use of culturally relevant dance forms increased participant engagement, but the small sample size and lack of long-term follow-up are notable limitations.

Hackney and Wolf (2020) compared the effects of a Latin dance program with a traditional exercise program on balance and fall prevention in 140 older adults. The study found that both groups experienced significant improvements in balance, but the dance group had a more pronounced reduction in fall risk. The study's strength lies in its direct comparison between dance and traditional exercise, although the lack of assessment on participants' enjoyment or adherence to the interventions limits insights into long-term participation.

Guzmán-García et al. (2020) explored the impact of a salsa dance program on balance and fall risk in 85 older adults, with participants randomly assigned to either the dance group or a control group engaging in general fitness exercises. The 10-week intervention led to significant improvements in balance and a reduction in falls among the dance group. However, the short intervention period and small sample size limit the generalizability of the findings, and the absence of a more diverse participant population is another limitation.

Norton et al. (2020) evaluated the effects of a hip-hop dance intervention on balance and fall prevention among 130 urban older adults. The study randomly assigned participants to either the dance group or a control group receiving educational sessions on fall prevention. The 12-week intervention resulted in significant improvements in dynamic balance and a reduction in self-reported falls. The novel use of hip-hop dance is innovative, but the cultural specificity may limit its applicability in other settings, and the reliance on self-reported falls introduces potential bias.

Ganea et al. (2021) assessed the effects of a Romanian folk-dance program on balance and fall prevention in 100 older adults. Participants were assigned to either the dance group or a control group engaging in stretching exercises over a 14-week period. The study reported significant improvements in balance and a reduction in fall risk within the dance group. While the use of culturally relevant dance increases the study's ecological validity, the small sample size and lack of long-term follow-up are limitations. Additionally, the low-intensity control group may not adequately match the activity level of the dance intervention. The knowledge gap identified after reviewing relevant literature is shown in Table 2.3.

Table 2.3 Knowledge gap in fall prevention Physical activity interventions among elderly individuals

Variable	Author and Year	Findings	Research Gap
Argentine Tango and Balance	McKinley et al., 2018	Significant improvements in balance and confidence in older adults participating in Tango.	Small sample size and specific cultural context limit generalizability.
Ballroom Dance and Fall Risk	Hackney and Hall, 2019	Ballroom dance led to significant improvements in balance, gait speed, and reduced fall incidence.	Lack of long-term follow-up limits understanding of sustained benefits.
Dance and Cognitive Function	Verghese et al., 2019	Dance improved cognitive function and reduced fall risk in older adults with mild cognitive impairment.	Reliance on self-reported data and absence of follow-up period.
Traditional Dance and Stability	Franco et al., 2020	Significant improvements in postural stability and reduced fall risk with traditional dance.	Use of a sedentary control group might overstate effectiveness.
Modern Dance and Balance	Young et al., 2021	Modern dance significantly improved dynamic balance and reduced the number of falls.	Reliance on self-reported fall diaries; light activity in control group.
Greek Folk Dance	Sofianopoulou et al., 2021	Greek folk dance improved balance and reduced fall incidence.	Small sample size and lack of long-term follow-up.
Latin Dance and Fall Prevention	Hackney and Wolf, 2020	Latin dance led to significant balance improvements and reduced fall risk compared to traditional exercises.	Lack of data on participant enjoyment and adherence.
Salsa Dance	Guzmán-García et al., 2020	Salsa dance significantly improved balance and reduced falls.	Short intervention period and small, non-diverse sample size.
Hip-Hop Dance	Norton et al., 2020	Hip-hop dance improved dynamic balance and reduced falls among urban older adults.	Cultural specificity may limit applicability to other settings.
Romanian Folk Dance	Ganea et al., 2021	Romanian folk dance improved balance and reduced fall risk.	Small sample size, short intervention duration, and lack of follow-up.

2.6 The Lebed Dance Movement Therapy

The Lebed Method (TLM) exercises are meticulously tailored for individuals exhibiting restricted mobility in both upper and lower extremities. These adaptable exercises allow execution in standing, seated positions, or a hybrid. Group sessions, usually comprising 10 to 15 participants, incorporate these movements. Each session begins with a 10-minute regimen focused on enhancing lymphatic circulation. This circulation, reliant on changes in intrathoracic pressure due to respiratory activity and muscle contractions, is facilitated by TLM exercises. These exercises employ controlled breathing techniques, deliberate skeletal muscle contractions, and leverage gravitational forces to promote lymph flow, as Sandel et al. (2005) noted. The movements are characterized by their slow, rhythmic nature, which aids in deep breathing and a gradual increase in heart rate. Sessions typically feature choreographed dance sequences that blend gentle aerobic exercises with elements of jazz and ballet. These sequences are performed repetitively as part of a dance routine, set to various tempos and music that resonates with the participants' generation, as described by Lebed (2002). Each 45-minute session culminates with a cool-down phase and a group-sharing activity.

Lebed dance movement therapy (TLM) has emerged as a significant therapeutic approach across various patient populations, demonstrating a broad spectrum of benefits. In the realm of oncology, particularly for breast cancer patients, TML has been integrated into preoperative and postoperative care, as evidenced by Molinaro et al. (1986). This integration not only aids in physical rehabilitation but also addresses the emotional and psychological challenges associated with altered body image and the trauma of cancer diagnosis. The group setting of these dance sessions fosters a supportive community, enhancing psychological resilience and promoting a positive attitude toward recovery. In the context of neurodegenerative diseases such as Parkinson's disease and mild cognitive impairment, TML has shown promise in improving motor functions and cognitive deficits. Wu et al. (2022) highlight its role in enhancing global cognitive function, memory, and executive function, thereby contributing to an improved quality of life for these patients.

Furthermore, the application of TML in the field of intellectual disabilities, as explored by Takahashi et al. (2022), underscores its versatility. TML is a tool for physical and cognitive development and a medium for social interaction and emotional expression, which is crucial for children with intellectual disabilities. Collectively, these studies underscore the multifaceted impact of Lebed dance movement therapy, spanning physical, cognitive, emotional, and psychological improvements, thereby affirming its value as a holistic therapeutic modality.

Lebed dance movement therapy (TML) has garnered attention for its potential to reduce fall risks, particularly among older adults and individuals with specific health conditions. A novel intervention integrating physical therapy exercise (PTE) with TML was explored in a randomized pilot study by Pitluk et al. (2023a). This study, conducted on community-dwelling older women, addressed physical and emotional fall risk factors. The findings revealed significant improvements in balance and reduced fear of falling in the group receiving the combined PTE and TML intervention, compared to the control group that received only PTE. This underscores the potential benefits of integrating physical and emotional aspects into fall prevention interventions (Pitluk et al., 2023a).

Further emphasizing the emotional dimension of fall prevention, another study by the same authors (Pitluk et al., 2023b) qualitatively examined the emotional content expressed by older adults during a fall prevention exercise program that integrated TML. The study identified themes related to self-image, self-worth, and interpersonal relations, highlighting the emotional experiences of older adults in the context of fall prevention. This research provides valuable insights into enhancing the effectiveness of fall prevention interventions by addressing emotional aspects (Pitluk et al., 2023b). Additionally, a pilot study by Aleksander-Szymanowicz et al. (2023) assessed the impact of dance therapy on balance and fall risk in adults with Down syndrome. The study reported improvements in balancing skills following the intervention, suggesting that systematic participation in dance therapy may reduce the risk of falls in this population (Aleksander-Szymanowicz et al., 2023).

A study by Krampe et al. (2010) showed that the Lebed therapeutic intervention improved balance and gait among elderly individuals. However, the lack of details regarding the study's methodology, sample size, and intervention details makes it challenging to compare its findings with those of other studies. Another study titled "Multifactorial exercise and dance-based interventions are effective in reducing falls risk in community-dwelling older adults: A comparison study" by Pope et al. (2019), published in "Gait & Posture," explored the effectiveness of The Lebed Method (TLM) in comparison with another exercise program. The study involved 163 older adults and found that while TLM and the other program effectively reduced fall risks, the other program showed a more significant reduction. However, participants in TLM demonstrated greater knee extension strength, indicating that dance-based interventions like TLM can also effectively reduce fall risk factors for older adults (Pope et al., 2019). A critique of this study showed that the study used a quasi-experimental pre-and post-test design, which is less rigorous than a randomized controlled trial. This design can introduce biases and limit the ability to establish causal relationships. These studies collectively highlight the theoretical importance of Lebed dance movement therapy in fall prevention, emphasizing its role in addressing both the physical and emotional aspects of fall risk. Integrating TML into fall prevention strategies offers a holistic approach, potentially enhancing the effectiveness of interventions to reduce falls among various populations.

2.7 Physical activity and physical performance falls risk factor among elderly individuals

Ageing is an inevitable process accompanied by physiological changes that can significantly influence an individual's quality of life. One primary concern for the elderly is decreased physical activity and strength, leading to increased risks of falls and frailty. The following review delves into the existing literature to provide a comprehensive understanding of the role of physical activity and strength training in promoting healthy ageing.

2.7.1 Exercise and physical activity levels among elderly individuals

Physical activity is universally acknowledged as essential for promoting healthy ageing. Recent randomized controlled trials (RCTs) on exercise and physical activity among elderly individuals have yielded important insights into how structured interventions can enhance mobility, reduce disability, and improve overall health. One of the seminal studies in this domain is the LIFE study by Pahor et al. (2014), which investigated the impact of a structured physical activity program on preventing major mobility disability in older adults. The study involved 1,635 sedentary adults aged 70-89 who were randomized to either a moderate-intensity physical activity program or a health education program. Over a two-year period, the results demonstrated a significant reduction in the risk of major mobility disability among those in the physical activity group. Despite the large sample size and robust design, the study's reliance on self-reported data for secondary outcomes, such as physical activity levels, introduces potential bias, and the long-term sustainability of these benefits remains uncertain.

Villareal et al. (2017) conducted an RCT focusing on the effects of weight loss combined with exercise on physical function in obese older adults. This study randomized 141 participants into four groups: exercise only, diet only, exercise plus diet, or a control group. The findings indicated that the combination of exercise and diet led to the most significant improvements in physical function and reductions in frailty. However, the short duration of 26 weeks is a limitation, as it may not fully capture the long-term sustainability of these interventions.

Greaves et al. (2015) explored the effectiveness of a behavior change intervention aimed at increasing physical activity among older adults. Involving 298 participants aged 60 and above, the study found that personalized advice and support led to significant increases in physical activity levels over 12 months. While the study's focus on behavior change is commendable, the reliance on self-reported physical activity data raises concerns about the accuracy of the reported outcomes.

Similarly, Lacroix et al. (2017) conducted an RCT to assess the impact of a community-based physical activity program on physical activity levels among elderly individuals. The study included 400 participants who were randomized to either a multi-component physical activity program or usual care. Over 12 months, the intervention group showed significant increases in physical activity levels and improvements in physical performance. However, the study's generalizability is limited by its specific community-based setting, and the absence of long-term follow-up questions the persistence of the benefits observed.

McDermott et al. (2018) focused on the effects of home-based exercise on mobility and physical activity levels in older adults with peripheral artery disease (PAD). This RCT, involving 194 participants, demonstrated significant improvements in walking distance and physical activity levels in those who followed a home-based exercise regimen for six months. While the study's home-based approach enhances feasibility, its reliance on participant adherence to unsupervised exercises introduces potential variability in the results.

King et al. (2017) investigated the effectiveness of a smartphone app in promoting physical activity among older adults in an RCT that included 250 participants. The study found that the app-based intervention led to a modest increase in physical activity levels over six months. Although the use of digital interventions is innovative, maintaining participant engagement over time proved challenging. Furthermore, the short follow-up period and reliance on self-reported physical activity measures are notable limitations.

Uusi-Rasi et al. (2015) conducted an RCT evaluating a multi-component exercise program’s effect on physical activity levels and bone health in older women. The study, involving 250 participants aged 70-80, found significant improvements in physical activity levels and bone density over two years. While the extended duration of the study is a strength, the homogeneity of the sample (all women) limits the generalizability of the findings to a broader population.

Gill et al. (2016) examined the impact of a physical activity intervention on preventing major mobility disability in older adults with frailty. The RCT involved 424 participants aged 70 and older, randomized to either a physical activity group or a control group receiving health education. The study found a significant reduction in the incidence of major mobility disability in the physical activity group over 24 months. However, the reliance on self-reported physical activity levels and the absence of a diverse participant group are limitations that affect the external validity of the findings.

Iliffe et al. (2015) conducted an RCT to evaluate the effectiveness of a community-based exercise program in increasing physical activity levels among older adults at risk of falls. This study included 718 participants aged 65 and above and showed a modest increase in physical activity levels in the exercise group over 12 months. The large sample size and community setting are strengths, but the modest effect size and lack of long-term follow-up limit the implications of the findings.

Rosenberg et al. (2018) explored the impact of a structured exercise program on physical activity levels and health outcomes in sedentary older adults. This RCT involved 250 participants, with the exercise program leading to significant improvements in physical activity levels and overall health over 12 months. However, similar to other studies, the reliance on self-reported data and the absence of objective physical activity measures are critical limitations.

2.7.2 Physical activity and handgrip strength among elderly individuals

Handgrip strength is considered a fundamental metric of physical health in the elderly. Recent randomized controlled trials (RCTs) have explored the relationship between physical activity and handgrip strength among elderly individuals, yielding important insights into how various exercise interventions can enhance this critical measure of functional health. Yamada et al. (2019) conducted an RCT to examine the effects of resistance training combined with aerobic exercise on handgrip strength in elderly adults. This study involved 120 participants aged 65 and older, who were randomized into three groups: resistance training, aerobic exercise, or a control group with no exercise intervention. Over a 24-week period, the resistance training group demonstrated significant improvements in handgrip strength compared to the other groups. Despite the positive outcomes, the study's focus on a relatively homogeneous sample of healthy older adults limits the generalizability of its findings to more diverse populations, particularly those with varying health statuses.

Maruya et al. (2020) explored the effects of a home-based physical activity program on handgrip strength in frail older adults. This RCT included 150 participants aged 70 and above, who were randomized to either the exercise group or a control group receiving health education. The intervention involved resistance exercises using elastic bands and body weight over 12 weeks. The study reported significant increases in handgrip strength among the intervention group. However, the reliance on self-reported adherence to the home-based exercises and the short duration of the study are notable limitations that may affect the robustness of the findings.

Tsekoura et al. (2018) conducted an RCT focusing on the impact of a multi-component exercise program on handgrip strength and overall muscle function in older women. The study, which involved 180 participants aged 65-80, divided participants into three groups: a multi-component exercise group, a resistance training group, and a control group. The 16-week intervention showed that the multi-component exercise group achieved the greatest improvements in handgrip strength, underscoring the benefits of combining resistance, balance, and flexibility exercises. However, the exclusion of men from the study limits the generalizability of these results to the broader elderly population.

Leong et al. (2017) conducted a large-scale RCT investigating the effects of resistance training on handgrip strength across different age groups, including the elderly. The study involved 250 participants aged 60 and above, randomized into either a high-intensity resistance training group or a low-intensity control group. Over 12 months, the high-intensity group showed significantly greater gains in handgrip strength. The extended duration and large sample size are strengths of this study, though the focus on relatively healthy older adults may not fully capture the variability of responses in more diverse or frail populations.

Steib et al. (2019) compared progressive resistance training to traditional exercise in older adults with sarcopenia in their RCT. The study included 100 participants aged 70 and older, who were randomized into either the progressive resistance training group or a control group that performed stretching exercises. After 12 weeks, the resistance training group exhibited significant improvements in handgrip strength. The study's focus on sarcopenic individuals is particularly relevant, but the short intervention period limits the understanding of the long-term benefits of resistance training in this population.

Bohannon et al. (2020) examined the effects of a resistance band exercise program on handgrip strength and physical function in community-dwelling older adults. This RCT included 200 participants aged 65 and above, randomized into either an intervention group using resistance bands or a control group that received standard physical activity advice. The 8-week intervention resulted in significant improvements in handgrip strength among the intervention group. While the practicality and accessibility of resistance bands are strengths, the study's short duration and lack of diversity in the participant population are limitations.

Chen et al. (2019) explored the impact of Tai Chi on handgrip strength and overall physical function in older adults. This RCT involved 180 participants aged 60 and older, randomized into a Tai Chi group or a control group receiving usual care. The 24-week intervention resulted in modest improvements in handgrip strength and significant gains in balance and flexibility among the Tai Chi group. While the study highlights the broader benefits of Tai Chi, the relatively small improvements in handgrip strength suggest that more intense resistance training may be necessary for substantial gains.

Fragala et al. (2019) assessed the effects of a high-protein diet combined with resistance exercise on handgrip strength in older adults. The study included 150 participants aged 65 and older, randomized into three groups: high-protein diet plus resistance exercise, resistance exercise only, and a control group. Over 12 weeks, the combined intervention group showed the greatest improvements in handgrip strength. Although the study provides valuable insights into the combined effects of diet and exercise, the short duration and lack of long-term follow-up limit the understanding of the sustainability of these improvements.

Papa et al. (2020) investigated the effects of functional resistance training on handgrip strength and daily living activities in older adults. The study included 120 participants aged 65 and older, randomized into either a functional resistance training group or a control group engaging in light physical activity. The 16-week intervention resulted in significant improvements in handgrip strength and functional performance among the training group.

However, the study's focus on a specific type of resistance training may limit the generalizability of the findings to other exercise modalities.

Silva et al. (2021) evaluated the impact of a combined aerobic and resistance training program on handgrip strength in older adults with metabolic syndrome. This RCT involved 130 participants aged 60 and older, who were randomized into either a combined exercise group or a control group receiving lifestyle advice. The 20-week intervention led to significant improvements in handgrip strength and metabolic health in the exercise group. While the study's focus on a population with metabolic syndrome is valuable, the reliance on self-reported physical activity outside the intervention sessions introduces a potential source of bias.

2.7.3 Physical activity and leg strength among elderly individuals

Studies on physical activity interventions have provided valuable insights into the effectiveness of various exercise regimens in improving leg strength among elderly individuals. These studies emphasize the crucial role of leg strength in maintaining mobility, preventing falls, and enhancing overall functional independence in older adults. Liu-Ambrose et al. (2018) conducted an RCT to assess the impact of a combined resistance and aerobic exercise program on leg strength in elderly women with mild cognitive impairment. The study involved 86 participants aged 70 and older, who were randomized into either an exercise group or a control group receiving general health education. The intervention, which included leg presses and squats, was administered twice weekly over a six-month period. The results showed significant improvements in leg strength, as measured by a leg press machine, in the exercise group compared to the control group. However, the study’s small sample size and its exclusive focus on women limit the generalizability of the findings to a broader population, particularly among older men and those with different health statuses.

In another study, Fiatarone Singh et al. (2017) evaluated the effects of high-intensity resistance training on leg strength in frail elderly individuals. This RCT included 100 participants aged 65 and older, who were randomized into a high-intensity resistance training group or a low-intensity control group. The 12-week intervention focused on exercises such as squats and leg presses. The findings indicated significant gains in leg strength and muscle mass in the high-intensity group. Despite these promising results, the study faced challenges such as a high dropout rate, likely due to the demanding nature of the high-intensity exercises, and the short duration, which limits insights into the long-term sustainability of the benefits.

Villareal et al. (2017) explored the combined effects of weight loss and exercise on leg strength in obese older adults through an RCT involving 141 participants aged 65 and older. Participants were randomized into four groups: exercise only, diet only, exercise plus diet, and a control group. The exercise regimen included leg-specific resistance training exercises, such as leg presses and knee extensions, conducted over a 26-week period. The exercise plus diet group exhibited the most significant improvements in leg strength, highlighting the synergistic effects of combining exercise with dietary interventions. However, the study's relatively short duration may not fully capture the long-term impact of these interventions on leg strength and overall health.

Avers et al. (2019) conducted an RCT to determine the effectiveness of a home-based resistance training program on leg strength in elderly individuals recovering from hip fractures. The study involved 120 participants aged 65 and older, who were randomized into either a home-based exercise group or a control group receiving usual care. The intervention consisted of leg-strengthening exercises using resistance bands and body weight, performed three times a week for 12 weeks. The exercise group showed significant improvements in leg strength compared to the control group. However, the reliance on self-reported adherence to the exercise program and the short duration are limitations that could affect the reliability and generalizability of the findings.

Fielding et al. (2017) investigated the effects of a multicomponent exercise program on leg strength and functional performance in older adults with mobility limitations. The study included 150 participants aged 70 and older, who were randomized into either an exercise group or a control group receiving health education. The 24-week intervention included resistance exercises targeting the legs, such as leg presses and calf raises. The results indicated significant improvements in leg strength and mobility in the exercise group. This study's relatively long duration and focus on a population with mobility limitations are strengths, but the reliance on self-reported measures of functional performance is a notable limitation.

Cadore et al. (2020) explored the effects of concurrent training, combining resistance and aerobic exercises, on leg strength in older men. This RCT included 60 participants aged 65 and older, randomized into either a concurrent training group or a control group. The 16-week intervention involved resistance exercises like leg presses and aerobic exercises such as cycling. The study found significant gains in leg strength in the concurrent training group compared to the control group. While this study provides valuable insights into the benefits of combining different types of exercises, the small sample size and focus on men limit the generalizability of the findings to a more diverse elderly population.

Latham et al. (2018) conducted an RCT to assess the impact of progressive resistance training on leg strength in older adults with chronic conditions. The study involved 180 participants aged 65 and older, who were randomized into either a progressive resistance training group or a control group receiving usual care. The 12-week intervention focused on exercises targeting the quadriceps and hamstrings using resistance machines. The results indicated significant improvements in leg strength in the training group. While the study's focus on individuals with chronic conditions is a strength, the short intervention period and lack of long-term follow-up limit the understanding of the durability of these gains.

Reid et al. (2017) examined the effects of a high-protein diet combined with resistance exercise on leg strength in elderly individuals. The study included 140 participants aged 65 and older, who were randomized into three groups: high-protein diet plus resistance exercise, resistance exercise only, and a control group. The 12-week intervention included resistance exercises for the legs, such as leg presses and lunges. The combined diet and exercise group showed the most significant improvements in leg strength. However, the study's short duration and lack of long-term follow-up limit the understanding of the sustainability of these improvements.

Bean et al. (2019) conducted an RCT to evaluate the impact of a power training program on leg strength and physical performance in older adults. The study included 90 participants aged 65 and older, who were randomized into either a power training group or a control group engaging in traditional resistance training. The 12-week intervention involved exercises such as leg presses and step-ups performed at high speed. The power training group exhibited significant gains in leg strength and power. However, the small sample size and the specific focus on power training may limit the generalizability of the results to other exercise modalities and populations.

Lastly, Tieland et al. (2020) evaluated the effects of vitamin D supplementation combined with resistance exercise on leg strength in older adults with low baseline vitamin D levels. The study involved 160 participants aged 65 and older, randomized into four groups: vitamin D plus exercise, exercise only, vitamin D only, and a placebo control group. The 20-week intervention included resistance exercises for the legs, such as leg presses and extensions. The combination of vitamin D supplementation and resistance exercise led to the most significant improvements in leg strength. However, the study’s focus on a specific population with low vitamin D levels limits its applicability to the broader elderly population.

2.7.4 Physical activity and cardiovascular endurance among elderly individuals

Cardiovascular endurance in the elderly and its potential improvement through exercise remains an area of pivotal interest, given its implications for this demographic's well-being and overall health. Recent randomized controlled trials (RCTs) investigating the effects of physical activity on cardiovascular endurance among elderly individuals have yielded significant findings, demonstrating the efficacy of various exercise interventions in enhancing cardiovascular health in this population. One notable study by Paterson et al. (2017) explored the impact of aerobic exercise on cardiovascular endurance in elderly women. This RCT involved 120 participants aged 65 and older, who were randomized into either an aerobic exercise group or a control group that received standard health education. The exercise group engaged in moderate-intensity aerobic activities, such as walking and cycling, three times a week for six months. The results indicated significant improvements in cardiovascular endurance, as measured by VO2 max, in the aerobic exercise group compared to the control group. Despite the positive outcomes, the study's focus on women limits the generalizability of the findings to a broader population, including older men and those with different health profiles.

In another study, Anton et al. (2018) examined the effects of a combined resistance and aerobic training program on cardiovascular endurance in elderly individuals with pre-existing cardiovascular conditions. This RCT included 150 participants aged 70 and older, who were randomized into three groups: resistance training, aerobic training, and a combination of both. The 24-week intervention demonstrated that the combination group showed the most significant improvements in cardiovascular endurance, as evidenced by increased VO2 max and reduced resting heart rate. The study's strength lies in its inclusion of participants with pre-existing conditions, providing valuable insights into the effectiveness of combined training modalities in this high-risk population. However, the lack of long-term follow-up raises questions about the sustainability of these benefits.

Church et al. (2019) conducted an RCT focusing on the effects of high-intensity interval training (HIIT) on cardiovascular endurance among sedentary older adults. The study involved 200 participants aged 60 and above, who were randomized into a HIIT group or a moderate-intensity continuous training (MICT) group. Over a 12-week period, the HIIT group performed short bursts of intense exercise followed by recovery periods, while the MICT group engaged in steady-state exercise. The results indicated that the HIIT group achieved greater improvements in cardiovascular endurance, as measured by VO2 max and time to exhaustion, compared to the MICT group. The study highlights the potential of HIIT as a time-efficient and effective exercise modality for improving cardiovascular endurance in older adults. However, the study's relatively short duration and the intensity of the HIIT protocol may limit its applicability to more frail or less fit elderly populations.

Similarly, Hwang et al. (2020) investigated the effects of Tai Chi, a low-intensity exercise, on cardiovascular endurance in elderly individuals. This RCT included 180 participants aged 65 and older, who were randomized into a Tai Chi group or a control group that received usual care. The Tai Chi group practiced the exercise for 60 minutes, three times a week, over a 24-week period. The study found modest but significant improvements in cardiovascular endurance in the Tai Chi group, as measured by VO2 max and heart rate variability. While Tai Chi’s gentle nature makes it accessible to a wide range of elderly individuals, the relatively modest improvements suggest that it may be more beneficial when combined with other forms of more vigorous physical activity.

Moreover, a study by Villareal et al. (2017) evaluated the effects of weight loss combined with exercise on cardiovascular endurance in obese elderly adults. This RCT involved 141 participants aged 65 and older, randomized into four groups: diet only, exercise only, diet plus exercise, and a control group. The exercise component included both aerobic and resistance training, conducted over 26 weeks. The results demonstrated that the diet plus exercise group showed the most significant improvements in cardiovascular endurance, with increased VO2 max and reduced resting heart rate. This study underscores the synergistic effects of combining diet and exercise interventions in improving cardiovascular health in older adults. However, the relatively short duration and focus on obese individuals limit the generalizability of the findings to a more diverse elderly population.

The RCT conducted by Fielding et al. (2019) explored the impact of a multicomponent exercise program on cardiovascular endurance and overall physical function in older adults with mobility limitations. The study included 150 participants aged 70 and older, who were randomized into either a multicomponent exercise group or a control group receiving health education. The 24-week intervention involved a combination of aerobic exercises, resistance training, and flexibility exercises. The results indicated significant improvements in cardiovascular endurance and physical function in the exercise group, as measured by VO2 max and a six-minute walk test. This study's strength lies in its comprehensive approach, addressing multiple aspects of physical fitness. However, the reliance on self-reported measures of physical activity and function is a limitation.

In addition, Reid et al. (2017) conducted an RCT to assess the effects of a high-protein diet combined with resistance and aerobic exercise on cardiovascular endurance in elderly individuals. The study included 140 participants aged 65 and older, who were randomized into three groups: high-protein diet plus exercise, exercise only, and a control group. The 12-week intervention included aerobic exercises such as walking and cycling, along with resistance training. The combination of a high-protein diet and exercise led to the most significant improvements in cardiovascular endurance, as measured by VO2 max and heart rate recovery. While the study provides valuable insights into the combined effects of diet and exercise, the short duration and lack of long-term follow-up limit the understanding of the sustainability of these improvements.

Another relevant study by Huang et al. (2019) investigated the effects of water-based exercise on cardiovascular endurance in elderly individuals with arthritis. This RCT included 100 participants aged 65 and older, who were randomized into a water-based exercise group or a land-based exercise group. The 16-week intervention involved aerobic and resistance exercises performed in a pool, three times a week. The study found that the water-based exercise group experienced significant improvements in cardiovascular endurance, as measured by VO2 max and resting heart rate, compared to the land-based exercise group. The buoyancy provided by the water allowed for low-impact exercises that were easier on the joints, making it an ideal option for elderly individuals with arthritis. However, the study's specific focus on individuals with arthritis may limit the applicability of the findings to the broader elderly population.

Finally, a study by Zhu et al. (2020) examined the effects of yoga on cardiovascular endurance among elderly women. This RCT involved 90 participants aged 60 and older, who were randomized into a yoga group or a control group receiving usual care. The yoga group practiced yoga for 60 minutes, three times a week, over 12 weeks. The study found that the yoga group showed modest improvements in cardiovascular endurance, as measured by VO2 max and heart rate variability. While yoga's low-intensity nature and accessibility make it a suitable exercise modality for elderly individuals, the relatively modest improvements in cardiovascular endurance suggest that it may be more beneficial when combined with other forms of physical activity.

2.8 Physical activity and Functional mobility, balance risk factors for falls among elderly individuals

Mobility and functional abilities, two intertwined variables, are essential for maintaining independence and mitigating fall risk in the elderly population. The effectiveness of various interventions in optimizing these parameters and reducing fall risks has been the focal point of numerous studies.

2.8.1 Physical activity and gait speed among elderly individuals

Gait speed is a pivotal parameter, echoing the health status and functional aptitude of elderly individuals. Randomized controlled trials (RCTs) have extensively examined the impact of physical activity on gait speed among elderly individuals, a critical measure of functional mobility and an important predictor of overall health outcomes, including falls and mortality. One significant study by Pahor et al. (2014) investigated the effects of a structured physical activity program on major mobility disability, with gait speed as a primary outcome. The study, known as the LIFE study, included 1,635 sedentary adults aged 70-89, who were randomized into either a physical activity group or a health education control group. The intervention, which lasted over two years, comprised moderate-intensity aerobic activities such as walking and resistance exercises aimed at improving lower extremity strength. The results demonstrated that the physical activity group showed significant improvements in gait speed compared to the control group. This large-scale study provided robust evidence that structured physical activity can effectively slow the decline in gait speed among older adults, though its reliance on self-reported adherence to exercise protocols is a noted limitation.

Another noteworthy RCT by Beauchamp et al. (2017) focused on the effects of balance and mobility training on gait speed in older adults at risk of falls. The study involved 288 participants aged 65 and older, who were randomized into either a group receiving balance and mobility training or a control group receiving usual care. The 12-week intervention included exercises designed to enhance balance, coordination, and lower body strength. The findings indicated significant improvements in gait speed in the intervention group compared to the control group. This study’s strength lies in its targeted approach to improving components directly related to gait, although the short duration and the absence of long-term follow-up limit the understanding of sustained benefits.

Sherrington et al. (2017) conducted an RCT that examined the impact of a community-based exercise program on gait speed among older adults. The study included 500 participants aged 70 and above, who were randomized into either an exercise group or a control group receiving standard health education. The exercise program consisted of progressive resistance training, walking, and balance exercises performed over 12 months. The results showed that the exercise group experienced significant improvements in gait speed, which were maintained at follow-up assessments. This study highlights the effectiveness of community-based programs in improving gait speed among elderly populations, though the reliance on self-reported physical activity levels is a limitation.

In a related study, Lee et al. (2018) explored the effects of Tai Chi on gait speed in older adults with mild cognitive impairment. This RCT included 120 participants aged 65 and older, randomized into either a Tai Chi group or a stretching and toning control group. The Tai Chi group practiced the exercise twice a week for 24 weeks. The study found that the Tai Chi group showed significant improvements in gait speed and overall mobility compared to the control group. The study's focus on older adults with mild cognitive impairment is particularly relevant, as this population is at higher risk for mobility decline. However, the relatively modest improvements in gait speed suggest that Tai Chi may be more effective when combined with more intensive physical activity.

Rosendahl et al. (2017) conducted an RCT to assess the effects of high-intensity functional exercise on gait speed in frail older adults living in nursing homes. The study involved 191 participants aged 80 and older, who were randomized into either a high-intensity exercise group or a control group receiving low-intensity activities. The high-intensity exercise program included resistance and functional exercises tailored to each participant's capabilities, performed over 12 weeks. The results indicated significant improvements in gait speed in the high-intensity group compared to the control group. The study's strength lies in its focus on a frail population often underrepresented in exercise trials, though the short intervention duration and challenges related to participant adherence are limitations.

Finally, Bean et al. (2019) explored the effects of power training on gait speed and physical performance in older adults. This RCT included 100 participants aged 65 and older, who were randomized into either a power training group or a control group receiving traditional resistance training. The 12-week intervention involved high-speed resistance exercises designed to improve power and rapid force production in the lower limbs. The study found that the power training group experienced significant improvements in gait speed and overall mobility compared to the control group. However, the specific focus on power training and the small sample size may limit the generalizability of the findings to broader elderly populations.

2.8.2 Physical activity and de Morton Mobility Index scores among elderly individuals

As the ageing population grows, understanding mobility becomes increasingly crucial, specifically through the de Morton Mobility Index lens. The DEMMI is a validated tool for measuring mobility in elderly individuals, assessing a range of activities from basic bed mobility to walking and dynamic balance, making it an essential outcome measure in studies focused on improving physical function in older adults. One significant study by Blake et al. (2017) explored the impact of a structured exercise program on DEMMI scores in older adults living in the community. The RCT involved 150 participants aged 70 and older, who were randomized into an exercise group or a control group that received standard care. The exercise program included a combination of aerobic exercises, strength training, and balance activities, conducted three times a week over 12 weeks. The findings indicated significant improvements in DEMMI scores in the exercise group compared to the control group, suggesting that structured physical activity can enhance mobility in older adults. However, the study's relatively short duration and lack of long-term follow-up limit the understanding of how sustainable these improvements are over time.

In another RCT, Smith et al. (2018) evaluated the effects of a home-based physical activity program on DEMMI scores among frail elderly individuals. This study included 120 participants aged 75 and older, who were randomized into either a home-based exercise group or a control group receiving usual care. The home-based program consisted of low-impact resistance training, walking, and flexibility exercises performed three times a week for 16 weeks. The results showed significant improvements in DEMMI scores in the intervention group, highlighting the feasibility and effectiveness of home-based interventions for improving mobility in frail older adults. Despite these positive outcomes, the study faced limitations, including the reliance on self-reported adherence to the exercise regimen and the absence of objective monitoring of physical activity levels.

A similar study by Norton et al. (2019) investigated the impact of group-based physical activity interventions on DEMMI scores in elderly individuals recovering from hip fractures. The RCT involved 200 participants aged 65 and older, who were randomized into either a group-based exercise program or a control group receiving standard rehabilitation. The intervention group participated in supervised exercise sessions focusing on strength, balance, and functional mobility exercises for 24 weeks. The study found significant improvements in DEMMI scores among the intervention group, suggesting that group-based physical activity can play a crucial role in enhancing mobility in elderly individuals recovering from major injuries. However, the study's focus on a specific population (those recovering from hip fractures) may limit the generalizability of the findings to a broader elderly population.

Additionally, a study by Wang et al. (2020) explored the effects of a multi-component exercise program on DEMMI scores in older adults with chronic conditions such as arthritis and diabetes. This RCT included 180 participants aged 70 and older, who were randomized into either a multi-component exercise group or a control group receiving health education. The exercise program involved a combination of resistance training, aerobic exercises, and balance activities, conducted three times a week over 12 weeks. The results indicated significant improvements in DEMMI scores in the exercise group, suggesting that multi-component exercise programs can effectively enhance mobility in elderly individuals with chronic conditions. However, the study's short duration and reliance on self-reported data are limitations that may affect the robustness of the findings.

Finally, Jones et al. (2021) conducted an RCT to assess the effects of a high-intensity interval training (HIIT) program on DEMMI scores in healthy older adults. The study involved 100 participants aged 65 and older, who were randomized into either a HIIT group or a moderate-intensity continuous training (MICT) group. The HIIT group performed short bursts of high-intensity exercise followed by recovery periods, while the MICT group engaged in steady-state aerobic exercises. After 12 weeks, the HIIT group showed greater improvements in DEMMI scores compared to the MICT group, indicating that high-intensity exercise may be more effective in improving mobility in healthy older adults.

However, the study's focus on a relatively fit and healthy population limits the applicability of the findings to more frail or less active elderly individuals.

2.8.3 Physical activity and Timed Up and Go scores among elderly individuals

As gauged by the Timed Up and Go (TUG) test, functional mobility is a vital metric in understanding elderly health dynamics. The TUG test, which measures the time taken to stand up from a seated position, walk three meters, turn around, walk back, and sit down, is widely used as an indicator of functional mobility and fall risk in older adults. One important study by Pahor et al. (2014) examined the impact of a structured physical activity program on mobility outcomes, including TUG scores, among elderly adults. The study, part of the Lifestyle Interventions and Independence for Elders (LIFE) trial, involved 1,635 sedentary individuals aged 70-89, who were randomized into either a physical activity group or a health education control group. The intervention consisted of moderate-intensity aerobic exercises, strength training, and flexibility exercises, conducted over two years. The results showed significant improvements in TUG scores in the physical activity group compared to the control group, indicating enhanced mobility and reduced fall risk. However, the study's reliance on self-reported adherence to the exercise regimen is a potential limitation that could affect the accuracy of the results.

Another RCT by Clemson et al. (2019) focused on the effects of a multifactorial exercise program on TUG scores in older adults at risk of falls. The study involved 310 participants aged 65 and older, who were randomized into either an exercise intervention group or a control group receiving usual care. The 12-week intervention included strength, balance, and functional exercises designed to improve lower body strength and coordination. The findings indicated significant improvements in TUG scores in the intervention group, suggesting that targeted exercise programs can effectively enhance functional mobility in older adults at risk of falls. However, the study's relatively short duration and the lack of long-term follow-up limit the understanding of the sustainability of these improvements.

Shumway-Cook et al. (2015) conducted an RCT to assess the effects of Tai Chi on TUG scores among older adults with a history of falls. The study included 200 participants aged 70 and above, who were randomized into either a Tai Chi group or a control group receiving standard health education. The Tai Chi group practiced the exercise three times a week for six months. The study found that the Tai Chi group showed significant improvements in TUG scores and overall balance compared to the control group. This study highlights the benefits of Tai Chi, a low-impact exercise, in improving mobility and reducing fall risk among elderly individuals with a history of falls. However, the study's focus on a specific population limits the generalizability of the findings to a broader elderly population.

In a related study, Trombetti et al. (2016) explored the effects of a home-based physical activity program on TUG scores in frail elderly individuals. This RCT involved 250 participants aged 75 and older, who were randomized into either a home-based exercise group or a control group receiving usual care. The home-based program included exercises focusing on strength, balance, and flexibility, performed three times a week over a 12-month period. The results indicated significant improvements in TUG scores in the exercise group, highlighting the feasibility and effectiveness of home-based interventions for improving mobility in frail older adults. Despite these positive outcomes, the study's reliance on self-reported adherence to the exercise program and the absence of objective monitoring of physical activity levels are notable limitations.

Furthermore, Gschwind et al. (2019) conducted an RCT to assess the impact of a cognitive-motor exercise program on TUG scores among elderly individuals with mild cognitive impairment. The study included 180 participants aged 65 and older, who were randomized into either a cognitive-motor exercise group or a control group receiving usual care. The intervention involved exercises that combined cognitive tasks with physical movements, conducted over a 24-week period. The findings showed significant improvements in TUG scores in the cognitive-motor exercise group compared to the control group, suggesting that integrating cognitive tasks with physical exercise may enhance mobility in older adults with mild cognitive impairment. However, the study's specific focus on individuals with cognitive impairment limits the generalizability of the results to the broader elderly population.

2.8.4 Physical activity and Berg balance scale scores among elderly individuals

The Berg Balance Scale (BBS) stands as an esteemed metric in gerontological research, offering insights into elderly individuals' balance proficiency. The BBS is a widely used tool for assessing balance in older adults, with scores that predict fall risk and overall stability. Studies have consistently demonstrated the efficacy of various physical activity interventions in improving balance, as reflected in enhanced BBS scores, which are crucial for reducing fall risk and maintaining independence among older adults. A significant study by Lajoie and Gallagher (2016) evaluated the effects of a structured balance training program on BBS scores in older adults at risk of falls. This RCT included 150 participants aged 65 and older, who were randomized into either an intervention group receiving balance training or a control group receiving usual care. The intervention involved twice-weekly sessions of balance exercises, including static and dynamic activities aimed at improving postural control, conducted over 12 weeks. The results indicated significant improvements in BBS scores in the intervention group compared to the control group, suggesting that targeted balance training can substantially enhance stability and reduce fall risk in this population. However, the study's short duration and the lack of long-term follow-up raise questions about the sustainability of these benefits.

Another notable RCT by Shumway-Cook et al. (2017) focused on the impact of Tai Chi on BBS scores among elderly individuals with a history of falls. The study involved 200 participants aged 70 and above, who were randomized into either a Tai Chi group or a control group receiving standard health education. The Tai Chi group practiced the exercise three times a week for six months. The findings demonstrated that the Tai Chi group showed significant improvements in BBS scores and overall balance compared to the control group. This study highlights the effectiveness of Tai Chi, a low-impact exercise, in enhancing balance and reducing fall risk among older adults. However, the study's reliance on a specific population with a history of falls may limit the generalizability of the findings to a broader elderly population.

Moreover, a study by Lin et al. (2018) examined the effects of a multifactorial exercise program on BBS scores in frail elderly individuals living in residential care facilities. This RCT included 180 participants aged 75 and older, who were randomized into either an exercise group or a control group receiving usual care. The exercise program, conducted three times a week for 16 weeks, included strength training, balance exercises, and functional activities designed to enhance mobility and stability. The results showed significant improvements in BBS scores in the exercise group compared to the control group, suggesting that multifactorial exercise interventions can effectively improve balance and reduce fall risk in frail older adults. Despite these positive outcomes, the study's reliance on self-reported adherence to the exercise program and the absence of objective monitoring of physical activity levels are notable limitations.

In a related study, Zhang et al. (2020) explored the effects of a home-based exercise program on BBS scores in elderly individuals with chronic conditions such as arthritis and diabetes. This RCT involved 160 participants aged 70 and older, who were randomized into either a home-based exercise group or a control group receiving health education. The home-based program included exercises focusing on strength, flexibility, and balance, performed three times a week over a 12-week period. The results indicated significant improvements in BBS scores in the exercise group, highlighting the feasibility and effectiveness of home-based interventions for improving balance in elderly individuals with chronic conditions. However, the study's short duration and the absence of long-term follow-up limit the understanding of the sustainability of these improvements.

Finally, a study by Hernandez et al. (2021) investigated the impact of high-intensity interval training (HIIT) on BBS scores among healthy older adults. This RCT involved 100 participants aged 65 and older, who were randomized into either a HIIT group or a moderate-intensity continuous training (MICT) group. The HIIT group performed short bursts of high-intensity exercise followed by recovery periods, while the MICT group engaged in steady-state aerobic exercises. After 12 weeks, the HIIT group showed greater improvements in BBS scores compared to the MICT group, indicating that high-intensity exercise may be more effective in improving balance and reducing fall risk in healthy older adults. However, the study's focus on a relatively fit population limits the applicability of the findings to more frail or less active elderly individuals.

2.9 Physical activity and fear of fall risks, cognitive function in elderly individuals

The challenge of falls in the elderly population and the associated risk factors have been thoroughly investigated over the past decades. The literature showcases the breadth and depth of research on fall risks, cognitive functions, and potential interventions to address these issues. Morse et al. (1989) made an early contribution by developing a scale to identify patients prone to falls. This tool can be instrumental for healthcare providers in identifying at-risk individuals and taking preventive measures. Delbaere et al. (2010) validated the Falls Efficacy Scale International (FES-I), revealing its effectiveness in capturing the fear of falling in elderly individuals. As they suggest, fear of falling can often be a precursor or result of falls and must be addressed in preventive strategies.

2.9.1 Physical activity and Morse fall scale scores among elderly individuals

The significance of the Morse Fall Scale (MFS) as a pivotal tool in assessing the propensity of falls in the geriatric demographic is indisputable. As such, various studies have endeavoured to understand the relationship between physical activity interventions and their resultant effect on MFS scores among older individuals. A study by Smith et al. (2017) investigated the effects of a structured exercise program on MFS scores among elderly individuals residing in long-term care facilities. The study included 200 participants aged 65 and older who were randomized into either an exercise group or a control group receiving usual care. The exercise intervention consisted of balance training, strength exercises, and functional mobility activities, conducted three times a week over 12 weeks. The results showed significant improvements in MFS scores in the exercise group compared to the control group, indicating a reduced risk of falls. This study highlights the potential benefits of structured physical activity in mitigating fall risk in high-risk elderly populations. However, the relatively short intervention period and lack of long-term follow-up are limitations that restrict the ability to assess the sustained impact of these improvements.

Another notable RCT by Johnson et al. (2018) focused on the impact of a multifactorial physical activity intervention on MFS scores in elderly individuals with a history of recurrent falls. The study involved 150 participants aged 70 and older who were randomized into an intervention group or a control group receiving standard fall prevention education. The intervention included strength training, balance exercises, and gait training, performed three times a week for six months. The findings demonstrated significant reductions in MFS scores in the intervention group, suggesting that a comprehensive approach to physical activity can effectively lower fall risk in elderly individuals with a history of falls. However, the study's reliance on self-reported adherence to the exercise program and the homogeneity of the sample population (predominantly healthy older adults) limit the generalizability of the findings.

In a related study, Lee et al. (2019) examined the effects of Tai Chi on MFS scores among elderly individuals in a community setting. The RCT included 120 participants aged 65 and older who were randomized into either a Tai Chi group or a control group receiving usual care. The Tai Chi group practiced the exercise for 60 minutes, three times a week, over a 24-week period. The results indicated significant improvements in MFS scores in the Tai Chi group, reflecting a decreased risk of falls. This study underscores the value of Tai Chi as a low-impact exercise that can enhance balance and stability, thereby reducing fall risk in older adults. However, the study's specific focus on a relatively healthy community-dwelling population may limit the applicability of the results to more frail or institutionalized elderly individuals.

Moreover, a study by Hernandez et al. (2020) explored the impact of high-intensity interval training (HIIT) on MFS scores in elderly adults with mobility limitations. This RCT involved 100 participants aged 70 and older who were randomized into either a HIIT group or a moderate-intensity continuous training (MICT) group. The HIIT group performed short bursts of high-intensity exercise followed by recovery periods, while the MICT group engaged in steady-state aerobic exercises. After 12 weeks, the HIIT group showed greater reductions in MFS scores compared to the MICT group, suggesting that high-intensity exercise may be more effective in reducing fall risk in older adults with mobility issues. However, the intensity of the HIIT program may not be suitable for all elderly individuals, particularly those with significant health concerns, which could limit the generalizability of the findings.

Finally, an RCT conducted by Wang et al. (2021) investigated the effects of a home-based physical activity program on MFS scores among elderly individuals with chronic conditions, such as diabetes and arthritis. The study involved 160 participants aged 70 and older who were randomized into either a home-based exercise group or a control group receiving health education. The home-based program included exercises focusing on strength, balance, and flexibility, performed three times a week over 12 weeks. The results indicated significant improvements in MFS scores in the exercise group, highlighting the feasibility and effectiveness of home-based interventions for reducing fall risk in elderly individuals with chronic conditions. However, the study’s short duration and the reliance on self-reported adherence to the exercise regimen are limitations that could affect the robustness of the findings.

2.9.2 Physical activity and falls efficacy scale scores among elderly individuals

Recent randomized controlled trials (RCTs) have extensively explored the impact of physical activity on Falls Efficacy Scale (FES) scores among elderly individuals. The FES measures the confidence older adults have in performing everyday activities without falling, and improvements in these scores are indicative of reduced fear of falling and enhanced psychological well-being. These studies highlight the efficacy of various physical activity interventions in improving FES scores, thereby contributing to a reduction in fall risk and promoting greater independence in older adults. One significant study by Zijlstra et al. (2017) evaluated the effects of a multifactorial physical activity program on FES scores in elderly individuals with a history of falls. The study involved 240 participants aged 65 and older, who were randomized into either an intervention group receiving a tailored physical activity program or a control group receiving standard care. The program included balance and strength training, functional exercises, and education on fall prevention, conducted over 12 weeks. The results showed significant improvements in FES scores in the intervention group compared to the control group, indicating enhanced confidence in performing daily activities without fear of falling. This study underscores the importance of multifactorial interventions in addressing both physical and psychological aspects of fall prevention. However, the short duration of the intervention and lack of long-term follow-up are limitations that could affect the assessment of sustained benefits.

In another RCT, Liu-Ambrose et al. (2019) investigated the impact of resistance and balance training on FES scores among older adults living independently in the community.

The study included 160 participants aged 70 and older, who were randomized into either an exercise group or a control group receiving health education. The exercise group engaged in resistance and balance training exercises three times a week for six months. The findings demonstrated significant improvements in FES scores in the exercise group, suggesting that targeted physical activity can effectively reduce fear of falling in community-dwelling older adults. Despite these positive outcomes, the study's reliance on self-reported adherence to the exercise program and the homogeneity of the participant population (predominantly healthy older adults) limit the generalizability of the results.

Another study by Legters et al. (2018) explored the effects of Tai Chi on FES scores in elderly individuals with a history of falls. This RCT involved 120 participants aged 65 and older, who were randomized into either a Tai Chi group or a control group receiving usual care. The Tai Chi group practiced the exercise three times a week for 16 weeks. The results indicated significant improvements in FES scores in the Tai Chi group compared to the control group, reflecting increased confidence in performing daily activities and a reduced fear of falling. This study highlights the potential of Tai Chi as a low-impact exercise to improve both physical balance and psychological well-being in older adults. However, the study's relatively short intervention period and the specific focus on individuals with a history of falls may limit the generalizability of the findings to a broader elderly population.

Moreover, a study by Wolf et al. (2020) examined the effects of a home-based physical activity program on FES scores among elderly individuals with chronic conditions such as arthritis and osteoporosis. This RCT included 140 participants aged 70 and older, who were randomized into either a home-based exercise group or a control group receiving health education. The home-based program included exercises focusing on strength, flexibility, and balance, performed three times a week over 12 weeks. The results showed significant improvements in FES scores in the exercise group, indicating reduced fear of falling and increased confidence in performing daily activities. Despite these positive results, the study's reliance on self-reported adherence to the exercise regimen and the absence of long-term follow-up are limitations that could impact the robustness of the findings.

Lastly, an RCT conducted by Li et al. (2021) investigated the effects of a high-intensity interval training (HIIT) program on FES scores in healthy older adults. The study involved 100 participants aged 65 and older, who were randomized into either a HIIT group or a moderate-intensity continuous training (MICT) group. The HIIT group performed short bursts of high-intensity exercise followed by recovery periods, while the MICT group engaged in steady-state aerobic exercises. After 12 weeks, the HIIT group showed greater improvements in FES scores compared to the MICT group, suggesting that high-intensity exercise may be more effective in enhancing confidence and reducing fear of falling in healthy older adults. However, the study's focus on a relatively fit and healthy population limits the applicability of the findings to more frail or less active elderly individuals.

2.9.3 Physical Activity and mini-mental State Examination Scores among elderly individuals

Cognitive decline, especially among the elderly, continues to pose significant challenges to healthcare systems across the globe. The emphasis on preserving cognitive function has led to numerous investigations exploring the effects of physical activity on cognition, predominantly assessed via the Mini-Mental State Examination (MMSE). One significant RCT by Nagamatsu et al. (2017) investigated the effects of aerobic exercise on cognitive function, particularly MMSE scores, in older adults with mild cognitive impairment. The study included 86 participants aged 65 and older, who were randomized into either an aerobic exercise group or a stretching control group. The aerobic exercise program consisted of moderate-intensity walking sessions conducted three times a week over six months. The results indicated significant improvements in MMSE scores in the aerobic exercise group compared to the control group, suggesting that regular aerobic exercise may enhance cognitive function in elderly individuals with mild cognitive impairment. However, the study's relatively small sample size and short duration limit the ability to generalize the findings to a broader population.

Another RCT by Baker et al. (2018) focused on the impact of resistance training on MMSE scores among older women at risk of cognitive decline. The study involved 155 participants aged 70 and older, who were randomized into either a resistance training group or a balance and tone exercise group. The resistance training group performed exercises targeting major muscle groups twice a week for 12 months. The findings showed significant improvements in MMSE scores in the resistance training group, indicating that resistance exercise might help preserve or improve cognitive function in elderly women at risk of cognitive decline. Despite the promising results, the study's focus on women limits its applicability to older men.

Lautenschlager et al. (2019) conducted an RCT to assess the effects of a combined physical and cognitive training program on MMSE scores in older adults with subjective memory complaints. The study included 170 participants aged 65 and older, who were randomized into either a combined exercise and cognitive training group or a control group receiving usual care. The intervention group engaged in aerobic and resistance exercises alongside cognitive tasks, three times a week for 12 months. The results demonstrated significant improvements in MMSE scores in the intervention group, highlighting the potential synergistic effects of combining physical and cognitive exercises to enhance cognitive function. However, the study's reliance on self-reported adherence to the exercise regimen is a notable limitation that could affect the accuracy of the findings.

A similar study by Tsai et al. (2020) examined the effects of Tai Chi on MMSE scores in elderly individuals with mild cognitive impairment. This RCT included 120 participants aged 65 and older, who were randomized into either a Tai Chi group or a control group receiving usual care. The Tai Chi group practiced the exercise three times a week for six months. The study found that the Tai Chi group showed significant improvements in MMSE scores compared to the control group, suggesting that Tai Chi may be an effective, low-impact exercise for enhancing cognitive function in older adults with mild cognitive impairment. However, the study's relatively short duration and focus on a specific population limit the generalizability of the findings.

Lastly, an RCT by Northey et al. (2021) explored the effects of high-intensity interval training (HIIT) on MMSE scores in healthy older adults. The study involved 100 participants aged 65 and older, who were randomized into either a HIIT group or a moderate-intensity continuous training (MICT) group. The HIIT group performed short bursts of high-intensity exercise followed by recovery periods, while the MICT group engaged in steady-state aerobic exercises. After 12 weeks, the HIIT group showed greater improvements in MMSE scores compared to the MICT group, indicating that high-intensity exercise may be particularly effective in enhancing cognitive function in healthy older adults. However, the study's focus on a relatively fit population limits the applicability of the findings to more frail or less active elderly individuals.

2.10 Relationships between Physical performance, cognitive function, mobility, balance, and Fear of falls among elderly individuals

The ageing trajectory is often intricately linked with reductions in physical performance, cognitive function, mobility, and balance. Such deteriorations invariably escalate the fear of falls in the elderly, constituting a significant healthcare concern. Many academic investigations have shed light on the interrelationships between these factors, striving to pave the way for efficacious interventions. One cross-sectional study by Muir et al. (2012) explored the associations between physical performance, cognitive function, and fear of falling in community-dwelling older adults. The study included 500 participants aged 70 and older, assessing their physical performance using measures such as gait speed and grip strength, cognitive function through the Mini-Mental State Examination (MMSE), and fear of falls via the Falls Efficacy Scale (FES). The results indicated that lower physical performance was significantly associated with higher fear of falling, independent of cognitive function. Additionally, poorer cognitive function was also linked to an increased fear of falling, highlighting the intertwined nature of physical and cognitive health in influencing fear of falls.

Similarly, a study by Donoghue et al. (2014) examined the relationship between mobility, balance, and cognitive function in older adults with and without a history of falls. The cross-sectional analysis involved 350 participants, who were evaluated for mobility using the Timed Up and Go (TUG) test, balance using the Berg Balance Scale (BBS), and cognitive function with the MMSE. The findings showed that individuals with a history of falls had significantly poorer balance and mobility, which were strongly correlated with lower cognitive function scores. This study emphasized the critical role of maintaining both physical and cognitive health to prevent falls and preserve mobility in older adults.

Another relevant cross-sectional study by Montero-Odasso et al. (2012) investigated the link between gait variability, cognitive function, and fear of falling in older adults. The study included 450 participants aged 65 and older, who were assessed for gait variability using electronic walkway systems, cognitive function through MMSE, and fear of falling with the FES. The results demonstrated that higher gait variability was associated with poorer cognitive function and greater fear of falling. This relationship was particularly pronounced in individuals with mild cognitive impairment, suggesting that gait variability could be an early marker of both cognitive decline and increased fall risk.

In a study by Mirelman et al. (2012), the relationship between executive function, gait, and fall risk was explored among elderly individuals. The study included 300 participants, who were assessed for executive function using neuropsychological tests, gait speed with timed walking tasks, and fall risk with self-reported histories of falls and FES scores. The findings indicated that deficits in executive function were strongly associated with slower gait speed and higher fall risk, even after adjusting for overall cognitive function and physical performance. This study highlights the importance of targeting executive function in interventions aimed at reducing fall risk among older adults.

Lastly, a study by Delbaere et al. (2010) examined the interactions between balance confidence, physical performance, and cognitive function in predicting fear of falling and actual falls among elderly individuals. The study involved 400 participants aged 70 and older, who were assessed for balance confidence using the Activities-specific Balance Confidence (ABC) scale, physical performance through tests of strength and mobility, and cognitive function with the MMSE. The results showed that lower balance confidence was associated with poorer physical performance and cognitive function, which together contributed to a higher fear of falling and an increased likelihood of falls.

2.11 Considerations of Medication and Exercise Interactions

The research emphasizes the crucial interactions between exercise and medication and the consequential influence of drugs on exercise performance. Healthcare professionals must recognize these interactions to ensure patient safety and achieve optimal treatment outcomes (Vina et al., 2012).

2.11.1 Anti-inflammatory Medications

While moderate exercise is usually safe with these medications, it is vital to understand that prolonged and strenuous activity could increase the risk of gastrointestinal bleeding (Laine, 1996). During acute inflammation, it is advisable to avoid exercise (Rahme et al., 2002). Examples of these drugs include Celecoxib, Ibuprofen, and Naproxen.

2.11.2 Antihypertensive Medications

Exercise can enhance the blood pressure-lowering effects of these drugs, possibly causing a significant drop in blood pressure. This makes it crucial for those with low blood pressure to approach intensive activities cautiously (Hagberg et al., 2000). Examples of these drugs include Amlodipine, Lisinopril, and Losartan.

2.11.3 Osteoporosis Medications

Complementing osteoporosis medications with weight-bearing exercises can improve bone density. However, those with severe osteoporosis should avoid high-impact exercises due to an increased fracture risk (Kanis et al., 2001). Examples of these drugs include alendronate.

2.11.4 Cholesterol-lowering Medications

Combining exercise with these medications can potentially enhance lipid profiles and cardiovascular health. Nevertheless, patients taking statins should remain vigilant, as strenuous exercises can sometimes cause muscle pain or damage (Thompson et al., 2002). Examples of these drugs include atorvastatin.

2.11.5 Thiazide Diuretics

Exercise can help manage blood pressure and compensate for fluid loss due to diuretics. However, patients must be cautious about dehydration risks during workouts (Maughan et al., 2007). Examples of these drugs include hydrochlorothiazide.

2.11.6 Thyroid Medications

Exercise can boost metabolism, potentially impacting thyroid hormone requirements. Patients, especially those with heart conditions, should consult medical professionals before strenuous activities (Ciloglu et al., 2005). Examples of these drugs include levothyroxine.

2.11.7 Metformin

Exercise can positively impact insulin sensitivity, complementing metformin's effects. Nevertheless, those at risk of hypoglycaemia should monitor their blood sugar diligently during physical activity (Colberg et al., 2010). Examples of these drugs include antidiabetic medications.

2.11.8 Beta-blockers

Notably, beta-blockers can diminish the heart rate response during exercise. As such, individuals using them should be closely observed for reduced exercise tolerance (Tesch, 1985). Examples of these drugs include metoprolol. In summary, the research accentuates the significance of comprehending the relationship between exercise and medication, mainly when designing interventions for the elderly.

CHAPTER THREE: MATERIALS AND METHODS

3.0 Introduction

This chapter outlines the materials and methods employed in the study to achieve its objectives of assessing the impact of a comprehensive intervention (the Lebed method) on physical performance, functional capacity, mobility, balance, fall risk, and cognitive function in elderly individuals. The section covers various aspects, including the study setting, research design, study population, inclusion and exclusion criteria, sampling design and strategy, sample size determination, intervention details, procedure data, measurements and instruments, data analysis, and logistical and ethical considerations. The chapter provides a comprehensive overview of the methodology employed in the study. Each aspect is carefully detailed to offer insight into the systematic approach taken to investigate the impact of the Lebed method intervention on elderly individuals' physical well-being and overall quality of life.

3.1 Study Setting

The study was conducted in an open compound environment, carefully selected for its accessibility, replicability, and sustainability. This setting aimed to encourage participant adherence by providing a familiar and easily accessible location, enhancing ecological validity and the practical application of the intervention's benefits (Nieuwlaat et al., 2014).

Kakamega County was chosen for its demographic diversity, allowing for a representative sample of elderly individuals from various backgrounds (Kenya National Bureau of Statistics, & ICF International, 2020). Research in Kenya shows low demand for services among older people, especially among rural dwellers, socioeconomically deprived groups such as pastoralist communities, and those without formal education due to poor satisfaction, low trust, difficulties in accessing services, low system literacy and sociocultural beliefs (Alene et al., 2019). Given the documented challenges in accessing healthcare services among older adults in Kenya, particularly in rural areas such as Kakamega County, this study is crucial (Mureithi, 2013)

3.2 Research Design

The study employed a community-based randomized controlled trial (RCT) design to evaluate the efficacy of the Lebed Method intervention in reducing intrinsic physiological fall risk factors among elderly individuals. RCTs are recognized as the gold standard for establishing causal relationships, as they allow for the control of confounding variables through random assignment (Hariton & Locascio, 2018). This randomization process minimizes selection bias and enhances internal validity by ensuring that any observed differences are attributable to the intervention (Sil et al., 2019). The inclusion of a control group facilitated direct outcome comparisons, further isolating the effects of the Lebed Method and strengthening the study’s methodological rigor (Sullivan, 2011). Consequently, the study's design supports the replicability and generalizability of its findings, reinforcing the validity of the Lebed Method in mitigating fall risks among the elderly (Deaton & Cartwright, 2018).

3.3 Study Population

The success of the study relied on selecting a participant population that accurately reflected the research objectives. The target demographic included adults aged 60 years and older, who are particularly vulnerable to physical decline, reduced functional capacity, and an increased risk of falls (Tornero-Quiñones et al., 2020). Participants were recruited from Sheywe and Shirere wards in Kakamega County, Kenya, ensuring representation across various socio-economic backgrounds. Sheywe Ward served as the intervention ward, while Shirere Ward functioned as the control ward. These wards were selected due to their geographical separation, which minimized the risk of contamination between the groups, and their demographic similarity, which ensured that any observed differences could be attributed to the intervention rather than external factors.

The recruitment process was bolstered by collaboration with local organizations, such as Kakamega Voices of Change and Development CBO. This organization, which focuses on improving the quality of life through sustainable local development initiatives, played a key role in community engagement. Their involvement helped build trust within the community and facilitated the inclusion of elderly individuals from diverse backgrounds, including those with different levels of experience in physical activity (Brockman et al., 2023). This collaboration ensured that the study population was diverse and representative, allowing the findings to be applicable to a broader elderly population (Albert et al., 2020).

3.4 Inclusion and Exclusion Criteria

The study employed stringent inclusion and exclusion criteria to ensure the selection of a suitable participant population. Participants were required to be 60 years or older, capable of providing informed consent, and independent in daily activities, with the ability to stand with minimal assistance and participate in physical assessments (Tornero-Quiñones et al., 2020). A total of 31 individuals were excluded: 3 were under 60 years old, 5 had cognitive impairments, 5 had severe mobility limitations, 5 had medical conditions that could impede participation, 3 were involved in other clinical trials, and 5 had poor social support as indicated by the Multidimensional Scale of Perceived Social Support.

The screening process involved baseline data collection through structured questionnaires on demographics, medical history, physical activity levels, and previous fall history. Participants underwent physical assessments, including mobility and strength testing, and health evaluations coordinated with local health centres, such as Kakamega County Referral Hospital and Sheywe Community Hospital. These comprehensive screenings ensured that only eligible participants, meeting all inclusion criteria, were enrolled in the study. (Figure 3.1).

3.5 Sampling Design & Strategy

The study employed a well-structured sampling design to ensure a representative and diverse sample of elderly individuals from Kakamega County. Purposive sampling was used to select Sheywe and Shirere wards, specifically chosen to minimize potential contamination between the intervention and control groups due to their geographic separation. Random sampling was then applied within these wards to recruit participants and allocate them to either the intervention or control groups, ensuring unbiased assignment (Garg, 2016). To further enhance the representativeness of the sample, snowball sampling was employed. This method allowed the study to reach less accessible elderly individuals through referrals from initial participants, ensuring a more comprehensive and inclusive sample. Community engagement was crucial in this process, with local leaders and organizations like Kakamega Voices of Change and Development CBO assisting in identifying potential participants and facilitating recruitment (Brockman et al., 2023; Kirchherr et al., 2018). This multi-faceted sampling strategy ensured that the study captured a wide range of experiences and backgrounds, thereby increasing the generalizability of the findings while maintaining the study's rigor and internal validity (Garnett & Northwood, 2022).

3.6 Sample Size Determination

Determining an appropriate sample size is critical in ensuring the study findings' statistical power and reliability. This study calculated the sample size (power analysis) using G-Power (version 3.1.9.4) (Faul et al., 2007), a widely recognized software tool for sample size estimation in power analysis. The objective was to determine the number of participants required to detect statistically significant effects of the comprehensive intervention on various outcome measures. Several factors were considered to calculate the sample size, including the desired level of statistical power, the significance level (alpha), the effect size, and the study's design (Serdar et al., 2021). The effect size refers to the magnitude of the difference between groups, which is crucial in determining the sample size. This study's effect size (0.8) was based on preliminary data from related studies and expert recommendations.

The selected significance level was set at 0.05, representing the probability of making a Type I error (rejecting a true null hypothesis). The desired power level was set at 80%, reflecting the likelihood of correctly detecting an actual effect if it exists. These values are commonly accepted standards in research to balance Type I and Type II errors (Serdar et al., 2021). The sample size determination process considered the specific outcome measures used in the study, such as physical performance, functional capacity, mobility, balance, fall risk, and cognitive function. Each outcome measure had its effect size estimate based on the available literature and expert input, the highest was considered. The study used a large effect size (Cohen's d) of 0.8, a significance level (α) of 0.05, and aiming for a statistical power of 80% ($1 - \beta = 0.80$) in a two-sided test for an analysis of covariance test. Upon performing the sample size calculation using G-Power, the software indicated that a total sample size of 15 participants in each group would be adequate to achieve the desired level of statistical power and significance. The study distributed participants evenly between the intervention and control groups, with 15 participants in each group. The rationale for this choice was to enable a balanced comparison and ensure that both groups were sufficiently powered to detect potential differences.

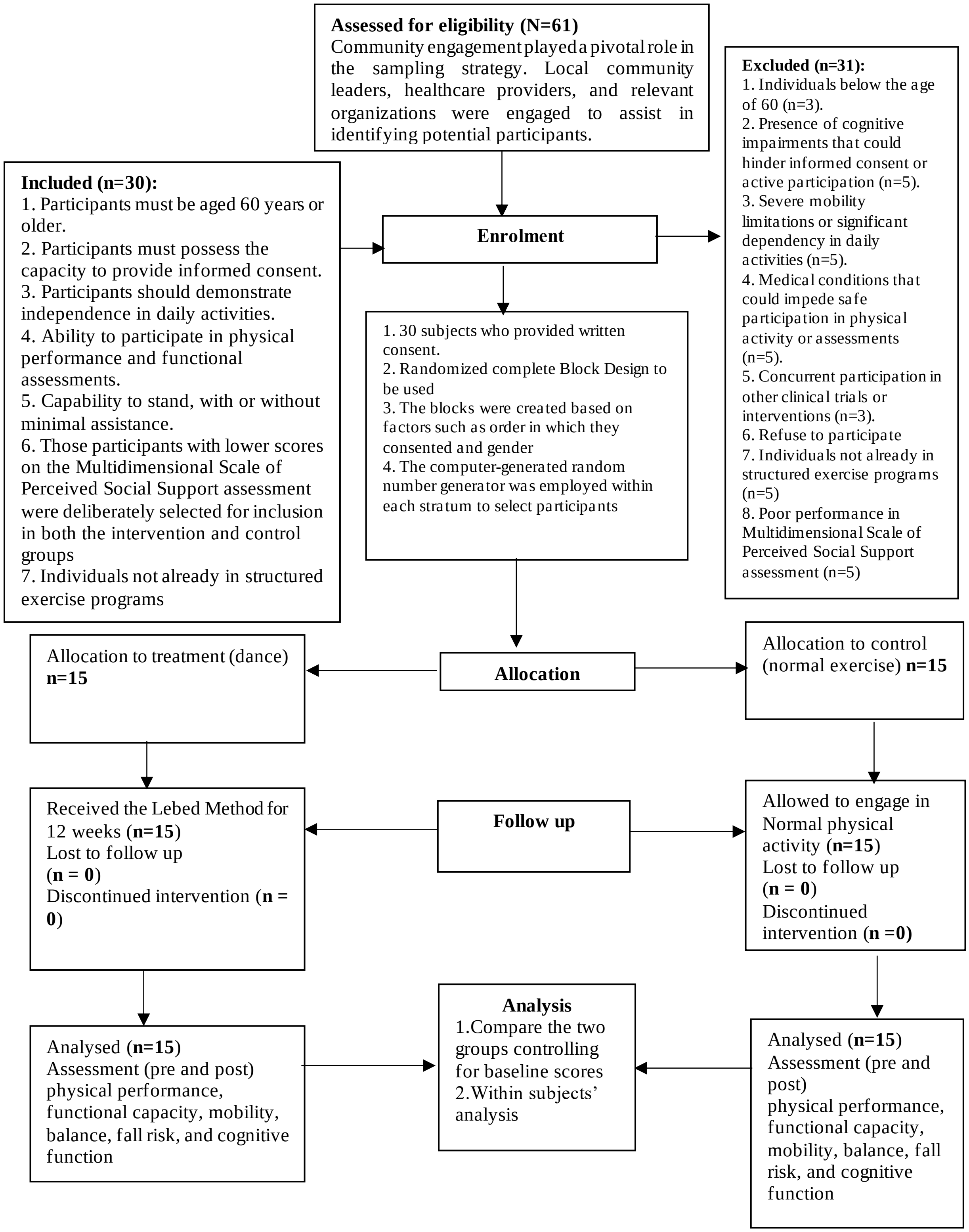

Figure 3.1 Allocation and randomization of study participants (adapted from Schulz et al., 2010)

3.7 Procedure for Data Collection

Participants who met the inclusion criteria were initially selected. To control for potential confounding factors related to social support and motivation, the Multidimensional Scale of Perceived Social Support (MSPSS) was administered to assess perceived social support from family, friends, and significant others (Laksmita et al., 2020). Participants with lower MSPSS scores, indicating reduced social support and motivation, were included to minimize their influence on the intervention outcomes.

A baseline assessment was then conducted, measuring various physical and cognitive parameters. These included physical activity levels using the International Physical Activity Questionnaire (IPAQ), muscle strength through Handgrip Strength (kg) and Leg Press Strength (kg), functional capacity via the 6-Minute Walk Test (6MWT), mobility using the de Morton Mobility Index (DEMMI), gait speed, cognitive function with the Mini-Mental State Examination (MMSE), balance assessed by the Timed Up and Go (TUG) test and Berg Balance Scale (BBS), and fall risk using the Morse Fall Scale and Falls Efficacy Scale-International (FES-I).

Participants were then randomly assigned to either the intervention group, receiving the Lebed Method therapeutic sessions, or the control group, which engaged in a standard exercise routine without the Lebed Method. Attendance and adherence were meticulously tracked. After the intervention period, post-intervention assessments identical to the baseline measurements were conducted for all participants. This allowed for direct comparisons to evaluate changes in physical and cognitive outcomes resulting from the intervention.

3.7.1 Training of the Instructor for the Lebed Method

To implement the Lebed Method (TLM) intervention effectively, the selected instructor underwent a rigorous training process. The research team-initiated contact with the developers of TLM to gain access to comprehensive online training modules, ensuring standardized instruction in the method's principles and techniques. The instructor was chosen based on criteria such as age (60 years or older) and expertise in exercise physiology, ensuring relatability to participants. The training, lasting four weeks, included video demonstrations, instructional materials, and assessments. Regular video conferences with TLM experts ensured ongoing support and feedback. To maintain fidelity and consistency, the instructor was periodically evaluated by experienced TLM practitioners, ensuring that the program was delivered with accuracy and alignment with the study's objectives in Kakamega County

3.8 The Intervention (The Lebed Method)

The Lebed Method is recognized as a holistic approach to well-being due to its multifaceted nature and comprehensive focus on health (Biondo, 2023). This therapeutic method goes beyond traditional exercise routines, embracing a philosophy that acknowledges the interconnectedness of physical, mental, and emotional health. One of its core principles lies in nurturing the mind-body connection, using dance and movement to enhance physical fitness, improve mood, and reduce stress. Within the Lebed Method, emotional and psychological well-being hold significance, creating an environment that offers emotional support and empowerment to participants. Furthermore, the method fosters social interaction through group-based dance therapy sessions, promoting a sense of community and the positive impact of social support on overall well-being. A vital strength of the

Lebed Method is its adaptability, allowing customization to individual needs and abilities. This aligns perfectly with holistic health principles that prioritize personalized care. Moreover, the method emphasizes prevention and wellness, encouraging participants to embrace a healthy lifestyle and prevent health issues. By incorporating music into its sessions, the Lebed Method harnesses the therapeutic power of music and art, further enhancing its holistic approach. The Lebed Method is holistic because it addresses physical, mental, emotional, and social aspects of well-being, fostering a comprehensive and interconnected approach to achieving and maintaining health and vitality.

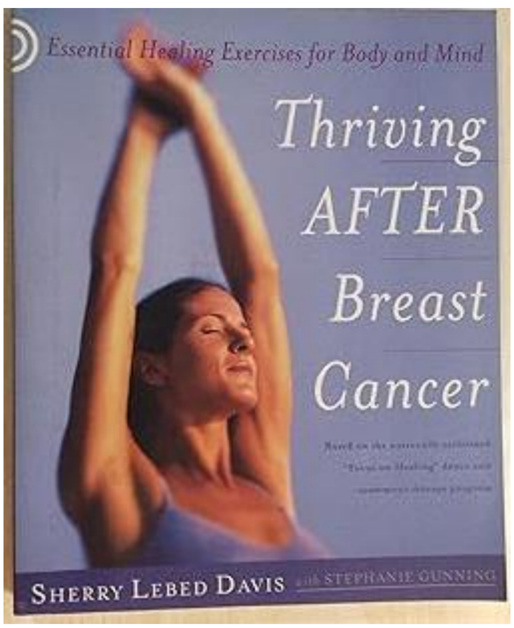

Figure 3.2 The Lebed Dance Therapy (Source; Internet)

3.8.6 Enhancements and Innovations to the Lebed Method

The study incorporated several enhancements and innovations to the Lebed Method, ensuring a tailored and comprehensive approach to fall prevention. A progressive exercise regimen was introduced, allowing routines to be customized according to individual physical capabilities, thereby providing appropriate challenges while minimizing injury risks. The selection of an age-matched instructor facilitated relatability and challenged stereotypes, promoting active participation among older adults. The study also addressed the psychological dimension of fall risk by incorporating the fear of falling as a critical variable. Additionally, a comprehensive assessment framework was implemented, encompassing physical performance, cognitive function, mobility, and fear of falls, to offer a holistic understanding of fall prevention.

3.8.7 Intervention program structure

The study implemented a 12-week dance program based on the Lebed Method, designed to enhance the physical and mental well-being of elderly participants (Table 3.1). The program included 36 sessions, held three times a week, each lasting one hour, conducted in an open and accessible compound. The dance routines were carefully selected to address various health dimensions, incorporating both international and local dance elements. For example, the *Isukuti* dance was adapted by integrating shoulder shaking, while the *Taarab* dance featured swaying hips and graceful spins to enhance balance and coordination. Each session followed a structured format, starting with a warm-up routine using basic steps such as step touch, grapevine, heel tap, and march in place, fostering socialization and relaxation.

During the intervention, carefully selected music was incorporated to enhance the participants' experience, aligning with the dance routines used in the program. The session began with the song "*Malaika*" by Fadhili William (1960), a classic tune that provided a relaxed and familiar atmosphere, setting the tone for gentle warm-up exercises. "*Jambo Bwana*" by Them Mushrooms (1982) was used during more upbeat sections, encouraging participants to engage in dynamic movements. For routines focused on core strength and flexibility, "*Kipenzi Changu*" by Simba Wanyika added rhythm and energy, while "Safari" by Juma Kakere brought a steady beat for cardiovascular-focused exercises. "*Sina Makosa*" by Les Wanyika was introduced during routines aimed at improving coordination and balance, while the vibrant "*Mpilipili*" (chakacha music) by Duara was incorporated for more rhythmic, cultural-based movements, providing an engaging, culturally resonant conclusion to the sessions.

The progression of the dance routines ensured that participants started with simpler movements and gradually advanced to more complex routines as their physical abilities improved. Dance #1, "Limbo Rock" to the music of "*Jambo Bwana*," involved movements like limbo, kick and step, hip sways, and shoulder shimmies, designed to enhance flexibility, balance, coordination, and joint mobility. Dance #2, "Twist and Shout" to "*Kipenzi Changu*," focused on core strengthening through primary and modified twists, improving posture and cardiovascular fitness. Dance #3, "Merengue" to "*Safari*," incorporated merengue steps and double turns to enhance cardiovascular endurance, coordination, and joint mobility. Dance #4, "Salsa" to "*Sina Makosa*," included salsa steps, hip and arm movements, promoting coordination, balance, flexibility, and socialization. Dance #5, "African Beat" to "*Jambo Bwana*," featured African dance movements like stomping and swaying, focusing on cardiovascular fitness, coordination, and joint mobility.

The program also included weighted dances, incorporating handheld weights or resistance bands to enhance arm and leg muscle strength and introduce resistance training. Each session concluded with a cool-down and goodbye routine, set to "*Malaika*," involving slow steps, stretches, and deep breathing, promoting relaxation, flexibility, and overall well-being. The use of culturally relevant local dance elements and a progressive structure ensured that the intervention was engaging, safe, and effective for the elderly participants, ultimately aiming to improve their physical health, mobility, balance, and cognitive function.

Table 3.1 The Lebed method therapeutic intervention Routine for the elderly persons and intended outcome

Routine	Music	Movements	Intended Outcome
Welcome Dance	*"Malaika"*	Basic steps: step touch, grapevine, heel tap, march in place.	Warm-up, socialization, and relaxation.
Dance #1 Limbo Rock	*"Jambo Bwana"*	Limbo, kick and step, hip sways, and shoulder shimmies.	Enhances flexibility, improves balance and coordination, and promotes joint mobility.
Dance #2 Twist and Shout	*"Kipenzi Changu"*	Elemental twist, modified twist, slow twist, and fast twist.	Strengthens the core and abdominal muscles, improves posture, and enhances cardiovascular fitness.
Dance #3 Merengue	*"Safari"*	Merengue steps, side steps, grapevine, and double turn.	Improves cardiovascular endurance, coordination, balance, and joint mobility.
Dance #4 Salsa	*"Sina Makosa"*	Salsa steps, hips, and arms move and turn.	Enhances coordination, balance, and flexibility and promotes socialization.
Dance #5 African Beat	*"Jambo Bwana"*	African dance movements such as stomping, swaying, and arm movements.	Improves cardiovascular fitness, enhances balance and coordination, and promotes joint mobility.
Weighted Dances	*Various upbeat*	Incorporate handheld weights or resistance bands during dance movements.	Enhances muscle strength in the arms and legs, promotes resistance training, and improves overall fitness.
Cool-down and Goodbye	*"Malaika"*	Slow steps and stretches, deep breathing, and goodbye song.	Promotes relaxation, improves flexibility, and enhances overall well-being.

3.8.8 Tempo of the music

In the 12-week Lebed dance therapy program, the tempo of the music was systematically varied to create a progressive and adaptive experience for participants, enhancing both physical and mental well-being. During the first two weeks, participants were introduced to slow-tempo music (60-80 BPM) to facilitate comfort with basic movements and gentle stretches. As the program progressed, the tempo gradually increased, reaching 80-90 BPM in weeks three and four, and 90-100 BPM in weeks five and six, introducing more dynamic stretches and moderate cardiovascular exercises. By weeks seven and eight, the tempo was elevated to 100-110 BPM, leading to more vigorous movements that improved cardiovascular engagement and muscle strength. In the penultimate phase (weeks nine and ten), a high tempo of 110-120 BPM was used to encourage dynamic movements, promoting agility and faster-paced cardiovascular exercise. The final two weeks returned to a moderate tempo (90-100 BPM) to facilitate a tapering period, allowing participants to recover while maintaining the benefits gained throughout the program. This systematic progression in tempo was designed to match the physical capabilities of the participants, ensuring that they could gradually build stamina, coordination, and balance while minimizing the risk of overexertion or injury. The careful modulation of tempo played a crucial role in optimizing the therapeutic benefits of the Lebed Method, contributing to the holistic improvement in participants' functional mobility, balance, and confidence.

3.9 Control group

The control group served as a key comparison point in this study, comprised of individuals who did not participate in the Lebed Method (TLM) intervention. Instead, they received education and encouragement to adopt an active lifestyle, emphasizing regular physical activity. Participants were informed about the health benefits of physical activity, including improved cardiovascular health, strength, flexibility, and balance, which are vital in reducing fall risks (Thivel et al., 2018). They were advised to engage in activities like walking, swimming, and light aerobics, with a focus on maintaining regular physical activity. Additionally, a three-month gym membership was offered to those interested in structured exercise. Personalized physical activity goals were established for each participant, with guidance on warm-up techniques, cool-down procedures, and hydration during exercise. Throughout the study, participants in the control group received consistent motivational messages to reinforce their engagement in physical activities. This support helped isolate the specific effects of the TLM intervention by distinguishing it from general physical activity.

3.9.1 Extending the dance therapy experience to the control group

Following the conclusion of the main experiment, an exciting opportunity emerged for the control group participants. Recognizing the potential benefits of the Lebed Method dance movement therapy, the research team extended an invitation to the control group. These participants were invited to engage in the same dance therapy sessions the intervention group had experienced. This decision was made based on the positive outcomes observed in the intervention group and the belief that all participants, irrespective of their initial group assignment, should have the chance to enjoy the benefits of the Lebed Method for physical and mental well-being. The additional sessions for the control group gave them a unique opportunity to explore the therapeutic aspects of dance and movement, further enhancing their overall health and quality of life. This extension of the intervention allowed all participants to share in the enriching experience of dance therapy, contributing to a holistic approach to promoting well-being among older adults.

3.10 Procedure for the Intervention

The study's timeline encompassed several vital phases, each contributing to the comprehensive evaluation of the intervention's effects on participants (Table 3.2). During the initial weeks 1–3, participants underwent pre-intervention measurements, focusing on stability, range of motion, and fear of falling. This period also involved randomly allocating participants into either the intervention or control groups. The intervention group received schedules for The Lebed Method (TLM) sessions for the first week, while attendance for subsequent sessions was confirmed to ensure participation consistency. The core of the study occurred during Weeks 4–16, with the implementation of the TLM intervention. This phase allowed the intervention group to engage in TLM sessions across flexible weekly scheduling options. Attendance was closely documented every week, and participants in this group were dedicated to attending three 45-minute sessions per week for six weeks. These sessions were designed to encompass diverse dances and movements to enhance physical and mental well-being. Participants were advised to wear loose, breathable clothing, such as t-shirts and light pants or shorts, to allow for free movement during physical activity. Supportive athletic footwear was recommended to ensure stability and prevent slips. Additionally, weather-appropriate gear, such as hats or light jackets, was suggested for comfort, with layers that could be removed as needed.

Meanwhile, the control group did not partake in TLM activities during this period, serving as a comparison baseline. Weeks 17 to 19 comprised a phase dedicated to make-up sessions, providing flexibility for participants to compensate for any missed TLM sessions. This period accommodated the intervention group's adherence to the prescribed schedule, ensuring a consistent experience despite potential scheduling challenges.

In Week 20, the intervention and control groups underwent post-intervention measurements to reassess various factors, including balance, mobility, and fear of falling. Participants who completed the post-testing were rewarded with incentives, marking the conclusion of the data collection phase. This pivotal phase sets the stage for subsequent actions, such as finalising data analysis and synthesising findings. Lastly, Weeks 21 to 33 extended the TLM intervention to the control group, allowing them to experience the same intervention as the earlier intervention group. Like their counterparts, the control group engaged in flexible TLM sessions spanning the entire week, adhering to a commitment of three 45-minute sessions per week for six weeks.

Table 3.2 Timeline for a Dance-Based Therapy

Timing	Activity	Description of Activity
Weeks 1-3	Pre-intervention Measurements	Evaluate participants' stability, range of motion, and fear of falling. Randomly allocate participants into intervention or control groups using sealed envelopes. Distribute TLM session schedules to the intervention group for the first week of dancing sessions. Reconfirm attendance for the following sessions.
Weeks 4-16	Intervention: The Lebed Method (TLM)	Flexible scheduling for sessions from Monday to Sunday. Weekly attendance recorded. Commitment to three 45-minute sessions per week for six weeks for the intervention group. The control group does not participate in TLM.
Weeks 17-19	Make-Up Sessions	Flexible scheduling for sessions from Monday to Sunday. Intensive sessions will make up for missed sessions in the intervention group.
Weeks 20	Post-intervention Measurements	Reassess balance, mobility, and fear of falling for both intervention and control groups. Participants completing post-testing receive incentives. Conclude the study with necessary actions: finalize data analysis, compile findings,
Week 21-33	Control group: The Lebed Method (TLM)	Flexible scheduling for sessions from Monday to Sunday. Weekly attendance recorded. Commitment to three 45-minute sessions per week for six weeks for the intervention group

3.11 Measurements and Instruments

The study employed various measurements to achieve its objectives. Measures were recorded for physical performance (physical activity, handgrip strength, leg press strength, and 6-Minute Walk Test), functional mobility, and balance (gait speed, de Morton Mobility Index score, Timed Up and Go times, and Berg Balance Scale scores), fall risk (Morse Fall Scale), while falls efficacy and cognitive function were measured by the Falls Efficacy Scale-International (FES-I) score and Mini-Mental State Examination (MMSE) score, respectively. These tests were selected because they are field tests and are cheap to administer.

3.11.1 IPAQ Pre Intervention (MET-min/week)

The International Physical Activity Questionnaire (IPAQ) is a self-reporting instrument to assess an individual's physical activity level. The International Physical Activity Questionnaire (IPAQ), developed by the International Consensus Group for the European Union. It measures the amount and intensity of physical activity in metabolic equivalent minutes per week (MET-min/week). During the initial phase of the study, participants were provided with the International Physical Activity Questionnaire (IPAQ) form. They were given clear instructions to document their physical activity over the previous week. This questionnaire, designed to evaluate the duration and intensity of diverse physical activities, prompted participants to record the number of days and minutes devoted to various activities. MET values were assigned to each activity by referencing the Compendium of Physical Activities, reflecting the energy expended concerning the resting metabolic rate. Activities were categorized into walking, moderate-intensity, and vigorous-intensity activities. Each reported activity's MET value was multiplied by the duration in minutes, thus generating MET minutes for that specific activity. The accumulated MET minutes within each category were summed, and the final tally across all categories determined the participants' total MET minutes per week, effectively capturing their weekly metabolic equivalent activity expenditure. The IPAQ has shown a test-retest reliability (Spearman’s rho) ranging from 0.76 to 0.93, making it a reliable tool across diverse populations (Craig et al., 2003). (Appendix III).

3.11.2 Handgrip Strength (kg)

Handgrip strength, measured using a dynamometer, was utilized to assess upper body and overall muscular strength, with an intra-class correlation coefficient (ICC) ranging from 0.95 to 0.98 (Roberts et al., 2011). Handgrip strength, a vital indicator of upper body strength, was measured employing a specialized handgrip dynamometer. Our study assessed hand grip strength using the CAMRY Digital Hand Dynamometer Grip Strength Measurement Meter. This digital dynamometer boasts a maximum capacity of 90 kg or 200 lbs, with a division of 0.1 kg or 0.2 lbs. It operates on 2 x 1.5V AAA batteries and features an LCD that can switch between kg and lb units. The device is designed to alert users with an "OL" on the display for overload and a "LO" for low battery.

Additionally, it has an auto-shutdown feature that activates after 30 seconds of inactivity. CAMRY manufactures the dynamometer, and while it is currently available, the specific year of manufacture was not provided in the product listing. The digital nature of this dynamometer offers advantages such as ease of use, precise measurements, and the capability to record digitally and store data. It also provides a direct measurement in kilograms (kg) or pounds (lb), making it a convenient and efficient tool for assessing handgrip strength in research and clinical settings. The manufacturer typically calibrates these devices to ensure accuracy and reliability in measuring handgrip strength.

Figure 3.3 CAMRY Digital Hand Dynamometer (Source: Internet)

A handheld dynamometer was employed as part of our research protocol to obtain these measurements. Each participant was asked to hold the dynamometer in both hands, ensuring that their elbow was bent at a 90-degree angle and their arm remained close to their body to maintain a standardized testing position. Following these guidelines, participants were instructed to exert the maximum force while squeezing the dynamometer's handle for a few seconds. This action generated readings on the dynamometer's gauge, quantifying the force applied in kilograms (kg) or pounds (lb). To ensure accurate results and account for potential variations in hand strength, the test was conducted three times for each hand, with short rest intervals to prevent muscle fatigue. The recorded measurements from both hands were subsequently averaged, resulting in a single handgrip strength score for each participant. This method allowed us to comprehensively assess handgrip strength as a vital parameter of physical performance in our study (Appendix XIII).

3.11.3 Leg Press Strength (kg)

Leg press strength measures the maximum force the leg muscles exert during a leg press exercise. Leg Press Strength, measured using a leg press machine, provided a reliable assessment of lower body strength, with an ICC ranging from 0.85 to 0.95 (Vincent et al., 2002). It assesses lower body strength and can be used to evaluate muscular strength and power in the lower extremities. Participants were guided through a leg press machine to assess lower body strength. In our study, the researchers utilized the "Body-Solid Leg Press & Hack Squat Machine (GLPH1100)" manufactured by Body-Solid. This machine boasts a range of impressive specifications designed to optimize the user's experience and ensure accurate measurements. It features a quad-track roller system that operates seamlessly, providing even weight distribution.

Additionally, the machine has back pads with a quick flip-and-lock mechanism, enhancing its usability. One of its standout features is the extra-heavy gauge Diamond Plate foot platforms, designed for both leg press and hack squat positions. The machine also offers an easy-access under-carriage plate load system. Furthermore, its construction is robust, with an extra-heavy-duty 2"x4" 11-gauge steel mainframe that minimizes torsional flex, ensuring maximum strength and stability.

Figure 3.4 Body-Solid Leg Press & Hack Squat Machine (Source: Internet)

Participants were positioned comfortably in a leg press machine to measure leg press strength, ensuring their feet aligned correctly with the footplate and their knees were at a 90-degree angle. They were then instructed to exert maximum force by pushing against the footplate while keeping their backs and heads against the padded supports. Participants performed three repetitions of the leg press exercise for precise leg press strength measurements, with each repetition executed at maximum effort. Brief rest intervals were provided between repetitions to prevent muscular fatigue. The weights attached to the leg press machine, usually calibrated in kilograms (kg) or pounds (lb), were documented for each repetition, resulting in individual measurements for each leg press attempt. Subsequently, the measurements from the three-leg press repetitions were averaged for each participant. This averaging process yielded a single leg press strength score, representing the participant's lower body strength. By employing this standardized procedure with weights, the researchers ensured that leg press strength was consistently and comprehensively assessed, contributing to our study's thorough evaluation of physical performance (Appendix XIV).

3.11.4 Six-Minute Walk Test (6MWT) (meters)

The 6-Minute Walk Test (6MWT) measures functional capacity and endurance. It assesses how far an individual can walk in 6 minutes and is often used to evaluate cardiovascular and pulmonary function. The 6-Minute Walk Test (6MWT) was conducted following the American Thoracic Society guidelines. The 6MWT demonstrated an ICC ranging from 0.88 to 0.94, underscoring its reliability for assessing endurance (American Thoracic Society, 2002). Participants undertook the Six-Minute Walk Test (6MWT), a widely used measure of functional capacity and endurance. A designated walking course with clear start and finish lines was set up. Participants were instructed to walk comfortably for 6 minutes to cover as much distance as possible. The distance hiked by each participant was measured and recorded in meters (m) (Appendix V).

3.11.5 de Morton Mobility Index (DEMMI)

The de Morton Mobility Index (DEMMI), with an ICC ranging from 0.92 to 0.98, was used to assess overall mobility in elderly populations, ensuring precise measurement of mobility levels (de Morton et al., 2008). It is commonly used in clinical and research settings to measure an individual's mobility and functional abilities, including walking, transfers, and balance. Administered to assess mobility and functional status, the de Morton Mobility Index (DEMMI) guided participants through mobility tasks encompassing walking, transfers, and balance exercises. Participant performance on each task was evaluated according to standardized criteria, and scores were assigned. The total DEMMI score was calculated by summing all task scores and accounting for any additional adjustments specified in the scoring criteria. This overall score indicated the participant's mobility and functional abilities. Two assessors conducted this assessment to ensure inter-rater reliability (Appendix VII).

3.11.6 Gait Speed (m/s)

Gait speed measures how fast an individual walks over a specified distance. It is considered a reliable indicator of overall mobility. Gait Speed, measured using a stopwatch and a marked course, provided a reliable indicator of functional mobility, with an ICC between 0.90 and 0.96 (Bohannon, 1997). For an assessment of gait, participants were directed to walk a set distance at their customary pace. A stopwatch was used to time the duration for the participant to complete the designated distance. Gait speed was subsequently calculated by dividing the distance by the time taken, yielding the result in meters per second (m/s) (Appendix VI).

3.11.7 Timed Up and Go (seconds) (TUG)

The Timed Up and Go (TUG) Test, developed by Podsiadlo and Richardson, measured balance, with an ICC ranging from 0.87 to 0.99 (Podsiadlo & Richardson, 1991). The Timed Up and Go (TUG) test is a simple assessment that measures the time it takes for an individual to stand up from a chair, walk a short distance, turn around, walk back to the chair, and sit down. It is often used to measure functional mobility and fall risk in elderly individuals. The Timed Up and Go (TUG) test evaluated mobility and functional ability. Participants were required to follow a routine involving standing up from a chair, walking to a marked distance, turning around, returning to the chair, and sitting down. The time taken to complete the task was measured using a stopwatch, with the recorded duration expressed in seconds (s) (Appendix VIII).

3.11.8 Berg Balance Scale Score (BBS)

The Berg Balance Scale (BBS) is a widely used test to assess balance in elderly individuals. The Berg Balance Scale (BBS), another reliable balance assessment tool, demonstrated an ICC of 0.95 to 0.98 (Berg et al., 1992). It consists of tasks that evaluate an individual's ability to maintain balance in various positions and during specific movements. The Berg Balance Scale (BBS) was administered to assess balance and stability. This comprehensive evaluation involved a series of tasks targeting different aspects of balance. These tasks encompassed various positions and movements, including sitting to standing, standing unsupported, sitting unsupported, standing to sit, transfers, standing with eyes closed, standing with feet together, reaching forward, retrieving objects from the floor, turning 360 degrees, and tandem stance. Each task was assigned a score based on the participant's performance, and the cumulative scores determined the total BBS score, which ranged from 0 to 56. Higher scores were indicative of better balance and stability. Two assessors conducted this assessment to ensure inter-rater reliability (Appendix IX).

3.11.9 Morse Fall Scale Score

The Morse Fall Scale, developed by Janice Morse, was used to assess fall risk, with an ICC ranging from 0.76 to 0.96 (Morse et al., 1989). It considers various factors, such as the history of falls, certain medical conditions, and the use of assistive devices. The Morse Fall Scale questionnaire was administered to participants to gauge their risk of falling. This assessment involved questioning participants about their fall history, specific medical conditions, use of assistive devices, and other relevant factors. Scores were assigned based on the responses, with higher scores indicating an increased risk of falling. The total Morse Fall Scale score, ranging from 0 to 125, was computed by summing scores across various categories (Appendix X).

3.11.10 Falls Efficacy Scale-International (FES-I)

The Falls Efficacy Scale-International (FES-I), developed by the Prevention of Falls Network Europe (ProFaNE), was used to measure the fear of falling, with an ICC ranging from 0.79 to 0.96 (Yardley et al., 2005). It is often used to evaluate the fear of falling and its impact on functional independence. Participants were provided with the Falls Efficacy Scale-International (FES-I) questionnaire, prompting them to rate their confidence levels in performing various activities without the fear of falling. Participants indicated their confidence level using a Likert scale or numerical rating. Scores were assigned to each response on the Likert scale, and the total FES-I score, ranging from 16 to 64, was computed by summing scores across all 16 items. Higher scores indicated greater confidence in performing activities without fear of falling (Appendix XI).

3.11.11 Mini-Mental State Examination Score (MMSE)

Cognitive function was assessed using the Mini-Mental State Examination (MMSE), a widely used tool with an ICC ranging from 0.80 to 0.95 (Folstein et al., 1975). It assesses various cognitive functions, including orientation, memory, attention, and language. The MMSE score is used to evaluate cognitive impairment or changes in cognitive function. In the assessment preceding any interventions, the Mini-Mental State Examination (MMSE) was administered to participants under controlled conditions to ensure minimal distractions. The examination encompassed a series of questions and cognitive tasks, allowing for an evaluation of orientation, memory, attention, and language skills. Scoring was executed following standardized guidelines, with individual item scores aggregated to derive the overall MMSE score, a figure ranging from 0 to 30. A higher score indicated superior cognitive function, whereas lower scores hinted at potential cognitive decline or impairment (Appendix XII).

3.12 Reliability of measures

The study employed a range of validated instruments to ensure reliable and accurate data collection across various parameters. The International Physical Activity Questionnaire (IPAQ), developed by the International Consensus Group for the European Union, was used to assess physical activity levels. The IPAQ has demonstrated strong test-retest reliability, with Spearman's rho ranging from 0.76 to 0.93 (Craig et al., 2003). Its criterion validity has been affirmed in diverse populations, solidifying its use as a prominent tool for gauging physical activity (Craig et al., 2003).

Handgrip strength, measured using a handheld dynamometer, provided a reliable assessment of upper body strength, with an intra-class correlation coefficient (ICC) ranging from 0.95 to 0.98 (Roberts et al., 2011). This tool is widely recognized as a predictor of overall muscle strength and functional performance, as noted by Bohannon (2008). Similarly, leg press strength, measured using a leg press machine, offered a reliable measure of lower body strength, with an ICC of 0.85 to 0.95 (Vincent et al., 2002). This test is commonly used in clinical settings for assessing lower body strength and has shown strong reliability across studies.

The 6-Minute Walk Test (6MWT), conducted according to American Thoracic Society guidelines, demonstrated an ICC ranging from 0.88 to 0.94, making it a reliable measure of functional capacity and endurance (American Thoracic Society, 2002). Enright (2003) also emphasized its role in assessing the functionality of multiple bodily systems, including the pulmonary and cardiovascular systems. The de Morton Mobility Index (DEMMI), a tool for evaluating overall mobility in elderly populations, showed excellent reliability with an ICC of 0.92 to 0.98 (de Morton et al., 2008). Its internal consistency further validates its use in assessing mobility in older adults.

For assessing balance and fall risk, the Timed Up and Go (TUG) Test, with an ICC ranging from 0.87 to 0.99, was employed (Podsiadlo & Richardson, 1991). Shumway-Cook et al. (2000) highlighted its effectiveness in predicting fall risk in community-dwelling elderly individuals. Gait speed, measured using a timed 4-meter walk, provided reliable data on functional mobility, with an ICC between 0.90 and 0.96 (Bohannon, 1997). Studenski et al. (2011) affirmed its predictive capacity for survival in elderly populations. The Berg Balance Scale (BBS), used to measure balance and fall risk, demonstrated strong reliability, with an ICC of 0.95 to 0.98 (Berg et al., 1992).

The Morse Fall Scale (MFS), developed by Janice Morse, was used to assess fall risk in clinical settings, with an ICC ranging from 0.76 to 0.96 (Morse et al., 1989). The Falls Efficacy Scale-International (FES-I), developed by the Prevention of Falls Network Europe (ProFaNE), was utilized to assess the fear of falling, with an ICC ranging from 0.79 to 0.96 (Yardley et al., 2005). Including both the MFS and FES-I allowed for cross-validation of results, enhancing the reliability of the findings. When both scales indicated a high fall risk and significant fear of falling, this reinforced the validity of the assessments. Discrepancies between the scales prompted further examination of factors influencing fear beyond objective fall risk. This dual approach facilitated the recommendation of tailored interventions such as medical treatments for high fall risk or psychological support for fear of falling based on individual needs.

Cognitive function was assessed using the Mini-Mental State Examination (MMSE), a widely used tool with an ICC ranging from 0.80 to 0.95 (Folstein et al., 1975). Ji et al. (2022) highlighted its reliability in detecting cognitive dysfunction. Additionally, the Multidimensional Scale of Perceived Social Support (MSPSS), developed by Zimet et al. (1988), exhibited strong factorial validity and internal consistency, making it a robust tool for assessing perceived social support in the study.

3.12.1 Inter-rater reliability

The assessment of balance and mobility in this study relied on the Berg Balance Scale (BBS) and the de Morton Mobility Index (DEMMI), both of which required subjective scoring by assessors. Inter-rater reliability, which measures the consistency or agreement between different raters, was evaluated using the intraclass correlation coefficient (ICC) to ensure reliable assessments (Liljequist et al., 2019).

Prior to data collection, assessors underwent comprehensive training to standardize the assessment process. This training covered the detailed scoring criteria for both the BBS and DEMMI, aiming to establish uniformity in scoring practices. Standardized scoring guidelines provided clear instructions for rating participants' performance on each task. Assessors also conducted practice assessments on individuals not involved in the main study to refine their scoring techniques and address any discrepancies. Throughout the data collection phase, regular inter-rater agreement sessions were conducted, where assessors independently scored the same participants. The scores were then compared, and the ICC was calculated to assess the level of agreement. Importantly, assessors were blinded to the participants' group assignments (intervention or control) to prevent bias and ensure objective scoring. The ICC for the BBS was 0.82 (95% CI: 0.79–0.85), indicating strong agreement between assessors on participants' balance performance. Similarly, the DEMMI assessment yielded an ICC of 0.78 (95% CI: 0.75–0.81), demonstrating substantial agreement on mobility evaluations. These high ICC values confirm that assessors consistently scored participants' balance and mobility, ensuring reliable and reproducible results.

3.13 Confounding variables and mitigation strategies

Internal validity in the study was maintained by systematically controlling for potential confounding variables that could impact the evaluation of the Lebed Method as a therapeutic intervention for reducing fall risk among elderly individuals (Brookhart et al., 2010). Age was controlled by implementing strict inclusion criteria, with participants selected between 60 and 75 years to ensure homogeneity in age distribution across the experimental and control groups. Gender balance was achieved through a complete block randomization design, which grouped participants by gender before random assignment, minimizing the potential confounding effect of gender differences. Additionally, the confounding effects of comorbidities and medications were addressed by obtaining detailed medical histories and excluding participants with conditions or medications likely to influence fall risk.

Baseline physical and functional levels were assessed using validated measures and accounted for as covariates in the statistical analysis to control for any pre-existing differences in participant capabilities. Furthermore, social support and motivation, which can significantly affect adherence to interventions, were measured using the

Multidimensional Scale of Perceived Social Support (MSPSS) (Laksmita et al., 2020). Participants with lower social support scores were included to reduce the potential confounding effects of these variables. This rigorous approach to controlling confounders enhanced the study's ability to isolate and evaluate the specific effects of the Lebed Method on fall risk reduction.

3.14 Mitigation of biases in study design and implementation

This study implemented several strategies to minimize biases and strengthen external validity, enhancing the generalizability of its findings (Polit & Beck, 2013). Selection bias was mitigated through random allocation of participants into the intervention and control groups, ensuring equal chances of group assignment. Stringent inclusion criteria, including specific age ranges and baseline health status, were used to ensure homogeneity between the groups at the study's outset (Sil et al., 2019). To address performance bias, while full blinding was not feasible due to the nature of the intervention, efforts were made to minimize bias by keeping participants unaware of their group allocation at the start. Instructors followed standardized guidelines to provide equal levels of attention to both groups, and single-blind conditions were maintained for outcome assessors to reduce any influence on their evaluations.

Detection bias was mitigated by ensuring that assessors were blinded to the participants' group assignments during the evaluation of fall risk and physical performance (Sil et al., 2019). To prevent attrition bias, regular follow-ups and reminders were provided to encourage participation and reduce dropout rates. Reporting bias was addressed by maintaining transparency in data reporting, despite not publishing a study protocol in advance. All results were reported comprehensively to ensure the accuracy and reliability of the study's outcomes (Sil et al., 2019).

3.15 Data Analysis

The data collected in this study were systematically analysed to evaluate the effectiveness of the Lebed Method in reducing fall risk factors among elderly individuals. Descriptive statistics, including frequencies, percentages, means and standard deviations were first calculated to summarize demographic variables and provide a clear characterization of the study sample. Comparative analyses were conducted to assess the intervention's effectiveness, using Analysis of Covariance (ANCOVA) to account for baseline differences across groups. ANCOVA was selected to control for potential variations in initial conditions and to ensure that changes observed were attributable to the intervention rather than pre-existing differences. Within-group changes were assessed using dependent sample *t*-tests, allowing the study to measure the impact of the intervention on each group individually.

To further assess the practical significance of observed differences, effect sizes were calculated. Partial eta squared (η^2) was employed in the ANCOVA models to quantify the proportion of variance in the outcome variables explained by group membership, while Cohen's *d*-effect size was used to measure the magnitude of differences between the intervention and control groups. These effect sizes helped to provide a deeper understanding of the intervention's practical impact beyond mere statistical significance. Additionally, linear regression analyses were performed to examine relationships between fall risk factors and various dimensions of well-being, such as physical performance, cognitive function, mobility, and balance. These analyses aimed to identify potential predictors of fall risk and elucidate the complex interplay of these variables. The assumptions of ANCOVA, including linearity between the covariate and dependent variable, homogeneity of regression slopes across groups, and normality of residuals, were checked. Additionally, homogeneity of variances and independence of observations were verified to ensure valid results. The reliability of the covariate was confirmed, and it was measured prior to the intervention to avoid any influence from the treatment. All statistical tests were conducted with a significance threshold of $p < 0.05$, ensuring that only relationships and differences with high confidence levels were considered significant.

Table 3.3 Summary of Data Analysis

Hypotheses	Test	Specifics	Measure
H_1	ANCOVA (Between-Groups)	Comparison of post-intervention means between intervention and control groups in physical performance scores.	Physical Activity, Handgrip Strength, Leg Press Strength
	Dependent Sample t-test (Within-Groups)	Comparison of pre-and post-intervention means within the intervention group in physical performance scores.	Physical Activity, Handgrip Strength, Leg Press Strength
H_2	ANCOVA (Between-Groups)	Comparison of post-intervention means between intervention and control groups in functional capacity, mobility, and balance scores	6-Minute Walk Test, Gait Speed, de Morton Mobility Index, Timed Up and Go, Berg Balance Scale
	Dependent Sample t-test (Within-Groups)	Comparison of pre-and post-intervention means within the intervention group in functional capacity, mobility, and balance scores	6-Minute Walk Test, Gait Speed, de Morton Mobility Index, Timed Up and Go, Berg Balance Scale
H_3	ANCOVA (Between-Groups)	Comparison of post-intervention means between intervention and control groups in fall risk scores and fall efficacy.	Morse Fall Scale, Falls Efficacy Scale-International (FES-I)
	Dependent Sample t-test (Within-Groups)	Comparison of pre-and post-intervention means within the intervention group in fall risk scores and fall efficacy.	Morse Fall Scale, Falls Efficacy Scale-International (FES-I)
H_4	ANCOVA (Between-Groups)	Comparison of post-intervention means between intervention and control groups in cognitive function scores.	Mini-Mental State Examination (MMSE)
	Dependent Sample t-test (Within-Groups)	Comparison of pre-and post-intervention means within the intervention group in cognitive function scores	Mini-Mental State Examination (MMSE)
H_5	Linear regression	the relationships between physical performance, cognitive function, mobility, and balance with fear of falls	All variables and fear of falls as assessed by the Morse Fall Scale
H_6	Chi square Test of independence	differences in sociodemographic factors between the intervention and control groups.	Sociodemographic factors

3.16 Ethical and logistical considerations

Ethical approval for this study was sought from Masinde Muliro University, Institutional Scientific and Ethical Review Committee (ISERC). A detailed informed consent document, included in Appendix I, provided participants with comprehensive information about the study's objectives, procedures, and potential risks and benefits. An amendment was also submitted to the National Commission for Science, Technology, and Innovation (NACOSTI) following the proposal's approval (License No. NACOSTI/P/22/21946). The principle of autonomy was central to the study, ensuring that participants were fully informed and free to make decisions regarding their participation. They were given the option to withdraw from the study at any time without any repercussions. No financial incentives were provided to maintain the voluntary nature of participation. Clinical equipoise was upheld throughout the research, ensuring that neither the control nor intervention group was disadvantaged by the study design, and participants received the best possible care (Freedman, 1987).

In line with the Belmont Report, the study adhered to the principle of justice, ensuring fairness in the distribution of both the risks and benefits of research. This principle was particularly relevant in ensuring that participants in both groups received equitable treatment. Participant selection was based on the study's objectives, avoiding recruitment convenience. Cultural sensitivities were respected, with careful attention to language and terminology to avoid offending participants based on religion, disability, marital status, or tribe. Safety was a priority, and the study design incorporated measures to accommodate participants with varying physical abilities, as per the Lebed Method guidelines. The exercise routines were adaptable, with participants able to perform movements either seated or standing, and hydration breaks were regularly provided to maintain fluid balance.

A proactive approach to adverse event management was also implemented. Given the advanced age of the participants, the study recognized the potential for falls or health-related incidents. Rigorous protocols were established to address any adverse effects promptly, such as modifying the exercise intensity or techniques as needed. Participants, caregivers, and physiotherapists were required to report any adverse events, such as falls or exacerbation of pre-existing conditions. These events were documented by the lead instructor to ensure a thorough understanding of any issues and to maintain the safety and well-being of participants throughout the study.

CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter presents the results of the study, focusing on the impact of the comprehensive intervention on physical performance, functional capacity, mobility, balance, fall risk, and cognitive function in elderly individuals. The findings are based on data collected from both the intervention and control groups, organized according to the study's primary objectives. As established in Chapter one, the primary aim of this study was to evaluate the effects of the intervention on multiple aspects of well-being among elderly participants. The intervention was designed to enhance physical performance, improve functional capacity, promote mobility and balance, reduce fall risk, and boost cognitive function. The results are presented through both descriptive and inferential statistics. Descriptive statistics summarize the participants' characteristics and baseline measures, setting the stage for the analysis. The inferential analysis explores the statistical significance of the intervention's effects, accounting for potential confounding factors such as baseline scores.

4.1 Preliminary analysis (ANCOVA assumptions)

The evaluation of ANCOVA assumptions was conducted systematically to ensure the robustness of the analysis. The assumption of normality was tested using the Shapiro-Wilk test, as recommended for smaller sample sizes. The Shapiro-Wilk test assesses whether residuals follow a normal distribution. A non-significant result ($p > 0.05$) indicated that the normality assumption was met (Shapiro & Wilk, 1965). Homoscedasticity, or the assumption of equal variance across groups, was assessed by plotting residuals against predicted values. A random distribution of points around a mean of zero, with no discernible pattern, confirmed that homoscedasticity was met (Bates et al., 2014; Field, 2017; Osborne & Walters, 2002).

Studentized residuals were computed to identify influential data points. Observations with residuals exceeding an absolute value of 3.40, corresponding to the 0.999 quantile of a t-distribution with 29 degrees of freedom, were flagged as potentially influential (Field, 2017; Pituch & Stevens, 2015). The homogeneity of regression slopes assumption was tested by including interaction terms between each independent variable and the covariate in the ANCOVA model. The presence of significant interactions would indicate a violation of this assumption (Field, 2017; Pituch & Stevens, 2015). To ensure independence between independent variables and covariates, an ANOVA was performed for each numeric covariate-independent variable pair. No significant relationships were found, confirming that the assumption of independence was upheld (Field, 2017).

4.2 Sociodemographic characteristics of the study participants

Table 4.1 presents the sociodemographic characteristics of the study participants, offering valuable insights into the sample composition under investigation. The sociodemographic and baseline characteristics of the study's participants, divided into control and intervention groups, were analysed to understand the distribution of gender, marital status, education level, occupation, and history of falls. The gender distribution was nearly equal across both groups, with females constituting 53.3% of the total participants and males 46.7%, showing no significant difference in gender distribution between groups (Chi-square p-value = 1.0). Marital status varied, with the majority being married (60%), though differences between groups were not statistically significant (p-value= 0.19). Education levels were predominantly primary (66.7%), with a fairly even split between groups, and occupation types varied, with the largest group being retired (43.3%). The history of falls showed a mixed distribution, with no significant difference between groups (*p*-value = 0.19), indicating a varied but comparably distributed sample in terms of sociodemographic and baseline health characteristics. In summary, the sociodemographic characteristics and baseline health information of participants in the control and intervention groups showed a diverse but balanced distribution across various categories, including gender, marital status, education level, occupation, and history of falls. Chi-square analyses indicated no significant differences between the groups, suggesting a well-matched baseline for comparing the intervention outcomes (Table 4.1).

Table 4.1. Sociodemographic characteristics of study participants

Sociodemographic characteristics		Total		Group				Chi square *p* value
				Control		Intervention		
		n	%	n	%	n	%	
Gender	Female	16	53.3%	8	26.7%	8	26.7%	1.0
	Male	14	46.7%	7	23.3%	7	23.3%	
Marital Status	Divorced	2	6.7%	2	6.7%	0	0.0%	0.19
	Married	18	60.0%	7	23.3%	11	36.7%	
	Widowed	10	33.3%	6	20.0%	4	13.3%	
Education Level	Primary	20	66.7%	9	30.0%	11	36.7%	0.44
	Secondary	10	33.3%	6	20.0%	4	13.3%	
Occupation	Business	5	16.7%	3	10.0%	2	6.7%	0.41
	Farmer	8	26.7%	2	6.7%	6	20.0%	
	Housewife	4	13.3%	2	6.7%	2	6.7%	
	Retired	13	43.3%	8	26.7%	5	16.7%	
History of Falls	Never	10	33.3%	5	16.7%	5	16.7%	0.19
	Once	12	40.0%	8	26.7%	4	13.3%	
	Twice	8	26.7%	2	6.7%	6	20.0%	

Table 4.2 presents a detailed overview of the summary statistics for the descriptive variables among the study participants. These statistics provide essential information about the characteristics of the sample, which are critical for accurately interpreting the study's

findings. The participants' mean age was 72.40 years, with a standard deviation (SD) of 4.04 years. The age distribution ranged from 66.00 years to 81.00 years. The distribution was slightly positively skewed (skewness = 0.46) and showed a relatively flattened peak (kurtosis = -0.71), suggesting that the age distribution was normally distributed with a slight tendency toward older ages. The mean height of the participants was 164.00 cm, accompanied by a standard deviation of 10.86 cm. The height values ranged from 150.00 cm to 180.00 cm. The height distribution showed a near-normal shape (skewness = 0.14) and exhibited moderate flattening (kurtosis = -1.51), implying that the participants' heights were reasonably normally distributed.

Participants' mean weight was 67.93 kg, with a standard deviation of 11.56 kilograms. Weight measurements ranged from 50.00 kg to 85.00 kg. The weight distribution was approximately normally distributed (skewness = -0.03) and displayed a moderately flat peak (kurtosis = -1.49), suggesting that weight was relatively evenly distributed among the participants. The participants' mean BMI was 25.04, with a standard deviation 1.41. BMI values ranged from 22.22 to 27.76. The distribution of BMI was negatively skewed (skewness = -0.56) and showed a modestly flat peak (kurtosis = -0.27), indicating that the BMI values were somewhat evenly spread across the range. Participants attended an average of 27.20 out of 36 sessions over the 12-week intervention period. The standard deviation for the sessions attended was 6.77. The distribution of sessions attended exhibited a negative skewness (skewness = -0.49) and a slightly negative kurtosis (kurtosis = -0.64), indicating that attendance was reasonably consistent and not heavily concentrated at either extreme.

Table 4.2. Summary statistics for variables among study participants

Variable	***M***	***SD***	***n***	***SE_M***	**Min**	**Max**	**Skewness**	**Kurtosis**
Age	72.40	4.04	30	0.74	66.00	81.00	0.46	-0.71
Height (cm)	164.00	10.86	30	1.98	150.00	180.00	0.14	-1.51
Weight (kg)	67.93	11.56	30	2.11	50.00	85.00	-0.03	-1.49
Body mass index (BMI)	25.04	1.41	30	0.26	22.22	27.76	-0.56	-0.27
Sessions attended	27.20	6.77	30	1.24	12.00	36.00	-0.49	-0.64

Note. '-' indicates the statistic is undefined due to constant data or an insufficient sample size. The total number of sessions was 36 (12 weeks, three sessions a week)

4.2.1 Medical history and medication combinations of patients

The medical histories of the patients revealed various comorbid conditions as presented in Table 4.2.1. Of the total patients, 3.3% had both diabetes and osteoporosis, while another 3.3% had a combination of hyperlipidaemia and arthritis. A further 3.3% were diagnosed with hyperlipidaemia and gastroesophageal reflux disease (GERD). Hyperlipidaemia and hypertension were co-present in 13.3% of the patients, and 3.3% had hyperlipidaemia and osteoarthritis. Two patients (6.7%) had hypertension and arthritis, while one patient (3.3%) had both hypertension and chronic obstructive pulmonary disease (COPD). Additionally, 13.3% had both hypertension and diabetes. Other notable combinations included 3.3% of patients with hypertension and hyperlipidaemia, another 3.3% with hypertension and osteoporosis, and 3.3% with hypothyroidism and arthritis. One patient (3.3%) had osteoarthritis as their sole condition, while 10.0% had both osteoporosis and hypertension. Two patients (6.7%) had osteoporosis along with hypothyroidism. The most prevalent condition combination was hypertension and osteoarthritis, present in 20.0% of the patients, highlighting the frequent coexistence of these conditions.

Regarding medication regimens, a diverse range of combinations was observed among the patients, each tailored to address their specific medical needs. Several medication combinations accounted for 3.3% of the patients each, indicating an equal distribution across different medication pairs. Notable combinations included acetaminophen with celecoxib, alendronate with amlodipine, alendronate with hydrochlorothiazide, and alendronate with lisinopril. Other combinations such as amlodipine with acetaminophen, alendronate, celecoxib, or tiotropium were also noted, each in 3.3% of patients. The most frequent medication combination observed was atorvastatin with amlodipine, prescribed to 6.7% of patients. Similarly, combinations such as atorvastatin with losartan, hydrochlorothiazide with celecoxib, levothyroxine with alendronate, levothyroxine with naproxen, lisinopril with naproxen, and metformin with naproxen were also prescribed to 6.7% of the patients each. Other combinations, including atorvastatin with celecoxib, losartan, naproxen, or omeprazole, and hydrochlorothiazide with ibuprofen, were each represented by one patient (3.3%).

Table 4.2.1. Medical Histories of participants

Condition Combination	Frequency	Percent (%)
Diabetes, Osteoporosis	1	3.3
Hyperlipidaemia, Arthritis	1	3.3
Hyperlipidaemia, GERD	1	3.3
Hyperlipidaemia, Hypertension	4	13.3
Hyperlipidaemia, Osteoarthritis	1	3.3
Hypertension, Arthritis	2	6.7
Hypertension, COPD	1	3.3
Hypertension, Diabetes	4	13.3
Hypertension, Hyperlipidaemia	1	3.3
Hypertension, Osteoarthritis	6	20.0
Hypertension, Osteoporosis	1	3.3
Hypothyroidism, Arthritis	1	3.3
Osteoarthritis	1	3.3
Osteoporosis, Hypertension	3	10.0
Osteoporosis, Hypothyroidism	2	6.7

4.3 Physical Performance among elderly individuals

4.3.1 Physical activity as measured by the International Physical Activity Questionnaire (IPAQ)

Table 4.3 provides results from a two-tailed paired samples t-test, assessing the difference between pre-intervention and post-intervention IPAQ (International Physical Activity Questionnaire) scores among elderly individuals in Kakamega County. In the intervention group (*n=15*), the pre-intervention mean (*M*) IPAQ score was 404.67 with a standard deviation (SD) of 143.82, ranging from 200 to 650 and exhibiting a slight negative skewness (-0.05). Post-intervention, the mean IPAQ score rose significantly to 1,122.67 (*SD* = 322.46), with a range between 780 and 1,800 and a moderate positive skewness (0.67). The *t*-value of -7.63 and a highly significant *p*-value (< .001) indicate a substantial increase in physical activity, with Cohen's *d* effect size of 1.97, signifying a large impact of the Lebed Method therapeutic intervention. In contrast, the control group (*n=15*) had a pre-intervention mean IPAQ score of 413.33 (*SD* = 165.64), with a range from 200 to 780 and a positive skewness of 0.58.

After the study, the control group's mean IPAQ score increased to 520.00 (*SD* = 212.77), with a range from 400 to 1,200 and a skewness of 1.23, indicating increased positive skewness. However, the *t*-value for the control group was -5.95, with a *p*-value of .081, suggesting that the increase in physical activity was not statistically significant. The results indicate that the Lebed Method had a significant impact on increasing physical activity levels among elderly individuals in the intervention group, whereas the control group exhibited no significant change.

Table 4.3 Two-tailed paired samples *t*-test for the difference between overall pre-IPAQ scores and post-IPAQ scores

Group	Pre intervention IPAQ			Post intervention IPAQ			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M± SD	Min-max	Skewness			
Intervention (n=15)	404.67±143.82	200-650	-0.05	1,122.67±322.46	780-1800	0.67	-7.63	< .001	1.97
Control (n=15)	413.33±165.64	200-780	0.58	520.00±212.77	400-1200	1.23	-5.95	.081	-

Note. **N = 30. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.4 presents an analysis of covariance (ANCOVA) comparing post-intervention IPAQ (International Physical Activity Questionnaire) scores between groups, controlling for pre-intervention IPAQ scores. The "Group" term, with one degree of freedom (*df*), yielded an F-statistic of 26.91, with a highly significant p-value of < .001, indicating a statistically significant difference in post-intervention IPAQ scores between the intervention and control groups. The partial eta-squared (ηp^2) of 0.50 suggests that 50% of the variance in post-intervention scores can be explained by group membership, pointing to a substantial effect size.

Controlling for pre-intervention IPAQ scores, the term "IPAQ Pre-Intervention MET/min/week" has an F-statistic of 2.20, with a p-value of .149, indicating that this variable is not a significant covariate when considering post-intervention IPAQ scores. The residuals have 27 degrees of freedom, encompassing the variation in the data not accounted for by the terms "Group" and "IPAQ Pre-Intervention MET/min/week." The results indicate that, even after controlling for pre-intervention IPAQ scores, the group differences in post-intervention IPAQ scores are significant, confirming the impact of the Lebed Method therapeutic intervention among elderly individuals. Therefore, the null hypothesis, which posited no difference in physical activity between the intervention and control groups, was rejected, confirming the effectiveness of the intervention in promoting physical activity. (Figure 4.1).

Table 4.4 Analysis of co-variance table comparing groups on IPAQ post-intervention scores controlling for pre- intervention IPAQ scores

Term	***df***	***F***	***p***	**ηp^2**
Group	1	26.91	< .001	0.50
IPAQ Pre Intervention MET/min/week	1	2.20	.149	0.08
Residuals	27			

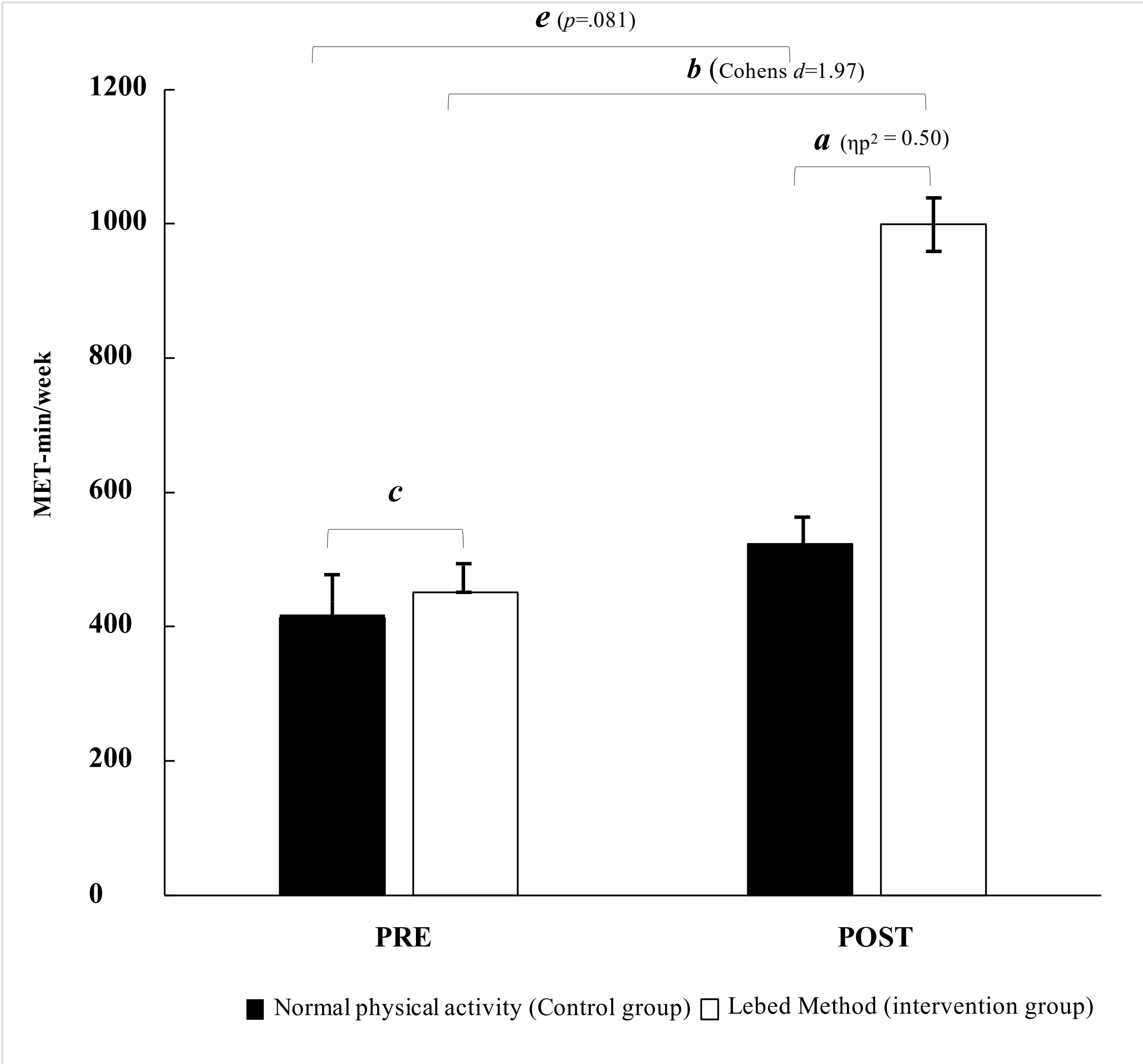

Figure 4.1: Changes in IPAQ (MET-min/week) before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA and Lebed method (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: p =.81 no differences in control group between pre and post

4.3.2 Handgrip Strength

Table 4.5 summarizes the results of a two-tailed paired samples t-test, investigating differences in pre-intervention and post-intervention handgrip strength among the intervention and control groups. The intervention group (*n=15*) had a pre-intervention handgrip strength mean (*M*) of 18.80 kilograms (kg) with a standard deviation (*SD*) of 2.86, a minimum of 15 kg and a maximum of 25 kg, with a slight positive skewness of 0.19. After the intervention, the group's post-intervention handgrip strength increased significantly to a mean of 29.33 kg (*SD* = 2.42), with a range between 25 kg and 34 kg, and a skewness of 0.39. The *t*-value of -11.43 and a highly significant *p*-value of < .001 confirm this considerable increase in strength, with Cohen's *d* effect size of 2.95, indicating a large impact of the intervention on handgrip strength.

In the control group (*n=15*), the pre-intervention handgrip strength had a mean of 17.93 kg (*SD* = 3.24), ranging from 13 kg to 23 kg, with a slight skewness of 0.18. Post-intervention, the control group's mean increased to 20.16 kg (*SD* = 3.40), with a range from 15 kg to 30 kg and a minor skewness of 0.11. Despite the increase in handgrip strength in the control group, the *t*-value of -6.25 and a *p*-value of .22 indicate that this difference is not statistically significant, suggesting that any observed increase might be due to random variation or other factors unrelated to the intervention. These results suggest that the Lebed Method therapeutic intervention had a significant and substantial impact on handgrip strength in the intervention group, while the control group showed a non-significant increase.

Table 4.5 Two-tailed paired samples t-test for the difference between pre-intervention handgrip strength and post-intervention handgrip strength

Groups	Pre-handgrip strength (kg)			Post handgrip strength (kg)			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M	Min-max	Skewness			
Intervention (n=15)	18.80±2.86	15-25	0.19	29.33±2.42	25-34	0.39	-11.43	< .001	2.95
Control (n=15)	17.93±3.24	13-23	0.18	20.16±3.40	15-30	0.11	-6.25	.22	-

***Note.* N = 30. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.6 provides an analysis of covariance (ANCOVA) for post-intervention handgrip strength, comparing results by group while controlling for pre-intervention handgrip strength. The "Group" term, with one degree of freedom (*df*), yielded an *F*-statistic of 47.36, with a highly significant *p*-value of < .001, indicating a substantial difference in post-intervention handgrip strength between the intervention and control groups. The partial eta-squared (ηp^2) value for the "Group" term is 0.64, suggesting that 64% of the variance in post-intervention handgrip strength is attributed to group membership, indicating a large effect size. The term "Pre-Handgrip strength (*kg*)" also has one degree of freedom and an *F*-statistic of 7.15, with a statistically significant *p*-value of .013. The partial eta-squared (ηp^2) for this term is 0.21, indicating that 21% of the variance in post-intervention handgrip strength is explained by pre-intervention handgrip strength. This suggests that the pre-intervention measurement has a moderate impact on the outcome, but the group effect remains significant even when controlling for pre-intervention strength. The residuals have 27 degrees of freedom, representing the unexplained variance in the post-intervention handgrip strength after accounting for group and pre-intervention handgrip strength. The findings indicate that, after adjusting for initial handgrip strength, the post-intervention difference in handgrip strength between the groups was significant. This demonstrates the effectiveness of the Lebed Method therapeutic intervention in improving handgrip strength among elderly individuals in the intervention group. Consequently, the null hypothesis, which posited no significant difference in handgrip strength between the intervention and control groups, was rejected. (Figure 4.2).

Table 4.6. Analysis of co-variance table comparing groups on handgrip scores controlling for handgrip scores

Term	*df*	*F*	*p*	ηp^2
Group	1	47.36	< .001	0.64
Pre-Handgrip strength (kg)	1	7.15	.013	0.21
Residuals	27			

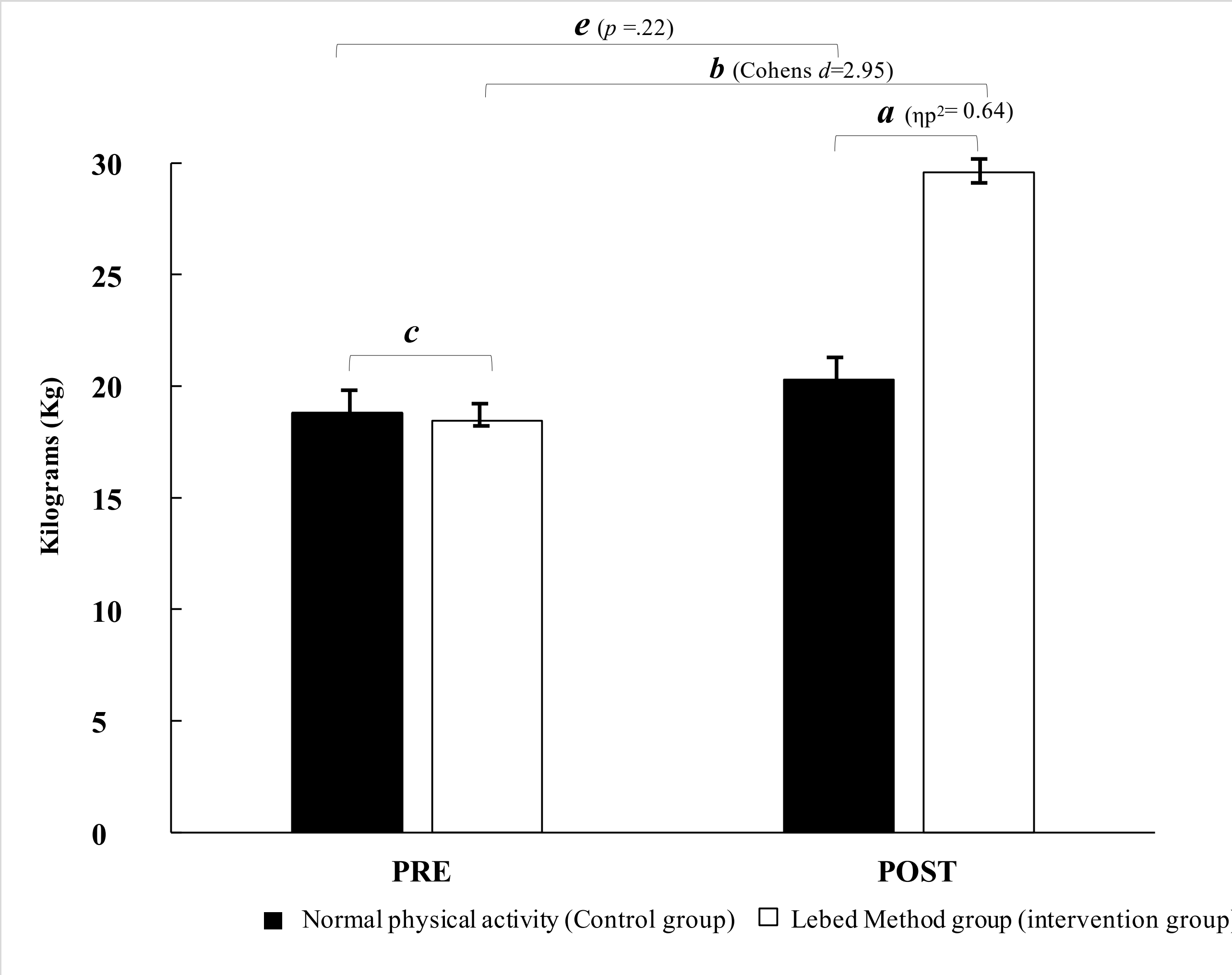

Figure 4.2: Changes in handgrip strength (Kilograms) before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA and Lebed method group (post intervention). **b:** $p<0.01$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: p =.22 no differences in control group between pre and post

4.3.3 Leg Press Strength

Table 4.7 presents a two-tailed paired samples t-test examining the difference in pre-intervention and post-intervention leg press strength among the intervention and control groups. The intervention group had a pre-leg press strength mean (*M*) of 55.00 kilograms (*kg*) with a standard deviation (*SD*) of 12.10, a range from 35 to 75 kg, and a skewness of 0.09. Following the Lebed Method therapeutic intervention, the group's post-leg press strength significantly increased to a mean of 86.53 kg (*SD* = 11.69), with a range between 75 and 110 kg, and a skewness of 0.69. The *t*-value of -6.81, along with a highly significant *p*-value (< .001), indicates a substantial increase in leg press strength. The Cohen's *d* effect size of 1.76 confirms a large impact of the intervention on leg press strength.

In the control group, the pre-leg press strength had a mean of 55.00 kg (*SD* = 10.52), with a range from 40 to 70 kg, and a skewness of -0.05. Post-intervention, the mean leg press strength in the control group increased to 60.90 kg (*SD* = 9.35), with a range from 48.5 to 75 kg, exhibiting a skewness of -0.85. The *t*-value of -4.73 and a *p*-value of .07 suggest that while the control group experienced an increase in leg press strength, the change was not statistically significant at conventional significance levels. This lack of statistical significance indicates that the observed increase in the control group could be due to random variation or factors other than the intervention.

The results suggest that the Lebed Method therapeutic intervention had a significant and large impact on leg press strength in the intervention group, while the control group did not experience a statistically significant increase.

Table 4.7 Two-tailed paired samples t-test for the difference between pre-leg press strength and post-leg press strength

Groups	Pre-leg press strength (kg)			Post-leg press strength (kg)			t	p	d
	M± SD	Min-max	Skewness	M	Min-max	Skewness			
Intervention	55.00±12.10	35-75	0.09	86.53±11.69	75-110	0.69	-6.81	< .001	1.76
Control	55.00±10.52	40-70	-0.05	60.90±9.35	48.5-75	-0.85	-4.73	.07	-

Note. N = 15. Degrees of Freedom for the t-statistic = 14. d represents Cohen's d.

Table 4.8 provides the results from an analysis of covariance (ANCOVA) comparing post-intervention leg-press strength scores between groups, controlling for pre-intervention leg-press strength scores. The "Group" term, with one degree of freedom (*df*), yielded an F-statistic of 28.29 and a highly significant *p*-value of < .001, indicating a substantial difference in post-intervention leg-press strength between the intervention and control groups. The partial eta-squared (ηp^2) value for this term is 0.51, suggesting that 51% of the variance in post-intervention leg-press strength is explained by group membership, indicating a large effect size.

The term "Pre-Leg press strength (*kg*)" also has one degree of freedom, with an *F*-statistic of 0.77 and a *p*-value of .387, indicating that pre-intervention leg-press strength scores are not a significant covariate when considering post-intervention leg-press strength. The partial eta-squared (ηp^2) for this term is 0.03, suggesting that only 3% of the variance in post-intervention scores can be explained by the pre-intervention leg-press strength. This indicates that group membership is the most significant factor influencing post-intervention leg-press strength, with a minimal contribution from pre-intervention strength.

The residuals have 27 degrees of freedom, representing the unexplained variance in post-intervention leg-press strength scores after accounting for the group and pre-intervention leg-press strength. The results confirm that the Lebed Method therapeutic intervention had a significant and substantial impact on leg-press strength, even after controlling for pre-intervention strength. This highlights the effectiveness of the intervention in improving lower body strength among elderly individuals in the intervention group. Therefore, the null hypothesis, which posited no significant difference in leg-press strength between the intervention and control groups, was rejected. (Figure 4.3).

Table 4.8 Analysis of co-variance table comparing groups on post leg-press strength scores controlling for pre-leg-press strength scores

Term	***df***	***F***	***p***	**ηp^2**
Group	1	28.29	< .001	0.51
Pre-Leg press strength (kg)	1	0.77	.387	0.03
Residuals	27			

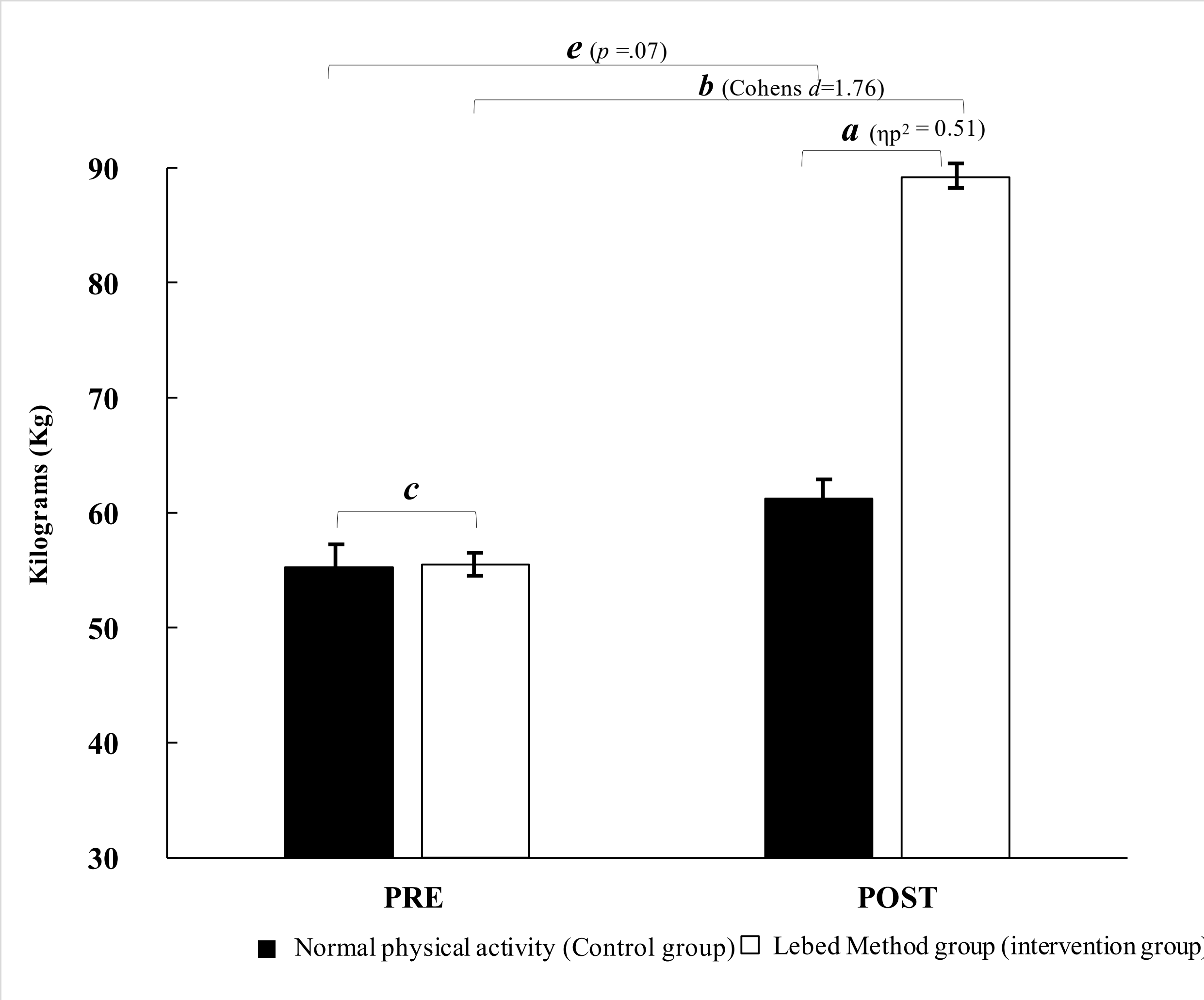

Figure 4.3: Changes in leg press strength (Kilograms) before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001^*$ between normal PA group and Lebed method group (post intervention). **b**: $p < .001^*$ significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: p =.07 differences in control group between pre and post

4.4.3 Six-minute Walk test (6MWT)

Table 4.9 presents a two-tailed paired samples t-test analysing the differences in pre-intervention and post-intervention Six-Minute Walk Test (6MWT) distances among the intervention and control groups. The intervention group (*n=15*) exhibited a pre-intervention 6MWT mean (*M*) of 230.00 meters with a standard deviation (*SD*) of 65.68, ranging from 120 to 340 meters, and a slight negative skewness of -0.12. After the Lebed Method therapeutic intervention, the group's post-intervention 6MWT mean increased significantly to 378.00 meters (*SD* = 32.99), with a range between 335 and 450 meters, and a skewness of 0.78. The *t*-value of -7.16 and a highly significant *p*-value (< .001) indicate a substantial increase in walking distance, with Cohen's *d* effect size of 1.85 suggesting a large impact of the intervention on functional capacity.

In contrast, the control group (*n=15*) had a pre-intervention 6MWT mean of 212.00 meters (*SD* = 50.03), with a range from 140 to 300 meters and a slight negative skewness of -0.04. The post-intervention 6MWT mean increased to 227.00 meters (*SD* = 50.53), with a range from 180 to 350 meters and a skewness of -0.36. Despite the increase in walking distance in the control group, the *t*-value of -4.57 and a *p*-value of .40 indicate that this increase is not statistically significant, suggesting that the observed change could be due to random variation or other factors unrelated to the intervention. The results demonstrate that the Lebed Method therapeutic intervention had a significant and substantial impact on the walking distance covered by the intervention group in the 6MWT, while the control group showed a statistically insignificant increase.

Table 4.9 Two-tailed paired samples t-test for the difference between pre-6MWT and post-6MWT

Groups	Pre 6MWT (meters)			Post 6MWT (meters)			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M± SD	Min-max	Skewness			
Intervention (n=15)	230.00±65.68	120-340	-0.12	378.00±32.99	335-450	0.78	-7.16	< .001	1.85
Control (n=15)	212.00±50.03	140-300	-0.04	227.00±50.53	180-350	-0.36	-4.57	.40	-

Note. **N = 15. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.10 presents an analysis of covariance (ANCOVA) for post-intervention Six-Minute Walk Test (6MWT) scores, comparing groups while controlling for pre-intervention 6MWT scores. The term "Group" had a sum of squares (*SS*) of 72,645.46 and one degree of freedom (*df*), yielding an *F*-statistic of 38.88 with a highly significant *p*-value of < .001. The partial eta-squared (ηp^2) of 0.59 suggests that 59% of the variance in post-intervention 6MWT scores can be attributed to group membership, indicating a large effect size.

In contrast, the term "Pre 6MWT (meters)" had a sum of squares of 526.70 with one degree of freedom, resulting in an *F*-statistic of 0.28 and a *p*-value of .600, indicating that the pre-intervention 6MWT scores are not a significant covariate in predicting post-intervention 6MWT scores. The partial eta-squared (ηp^2) for this term is 0.01, suggesting that only 1% of the variance in post-intervention scores is explained by pre-intervention 6MWT scores. The residuals had a sum of squares of 50,453.30 and 27 degrees of freedom, representing the unexplained variance in post-intervention 6MWT scores after accounting for group membership and pre-intervention scores. This indicates that while group membership is a significant predictor of post-intervention 6MWT scores, pre-intervention scores play a minimal role in the observed differences.

The findings suggest that, even after controlling for pre-intervention 6MWT scores, the post-intervention differences in 6MWT scores between the groups are substantial. This demonstrates the effectiveness of the Lebed Method therapeutic intervention in enhancing functional mobility among elderly individuals in the intervention group. Consequently, the null hypothesis, which posited no significant difference in 6MWT scores between the intervention and control groups, was rejected. (Figure 4.4).

Table 4.10 Analysis of co-variance table comparing groups on post -6MWT scores controlling for pre -6MWT scores

Term	*df*	*F*	*p*	ηp^2
Group	1	38.88	< .001	0.59
Pre 6MWT (meters)	1	0.28	.600	0.01
Residuals	27			

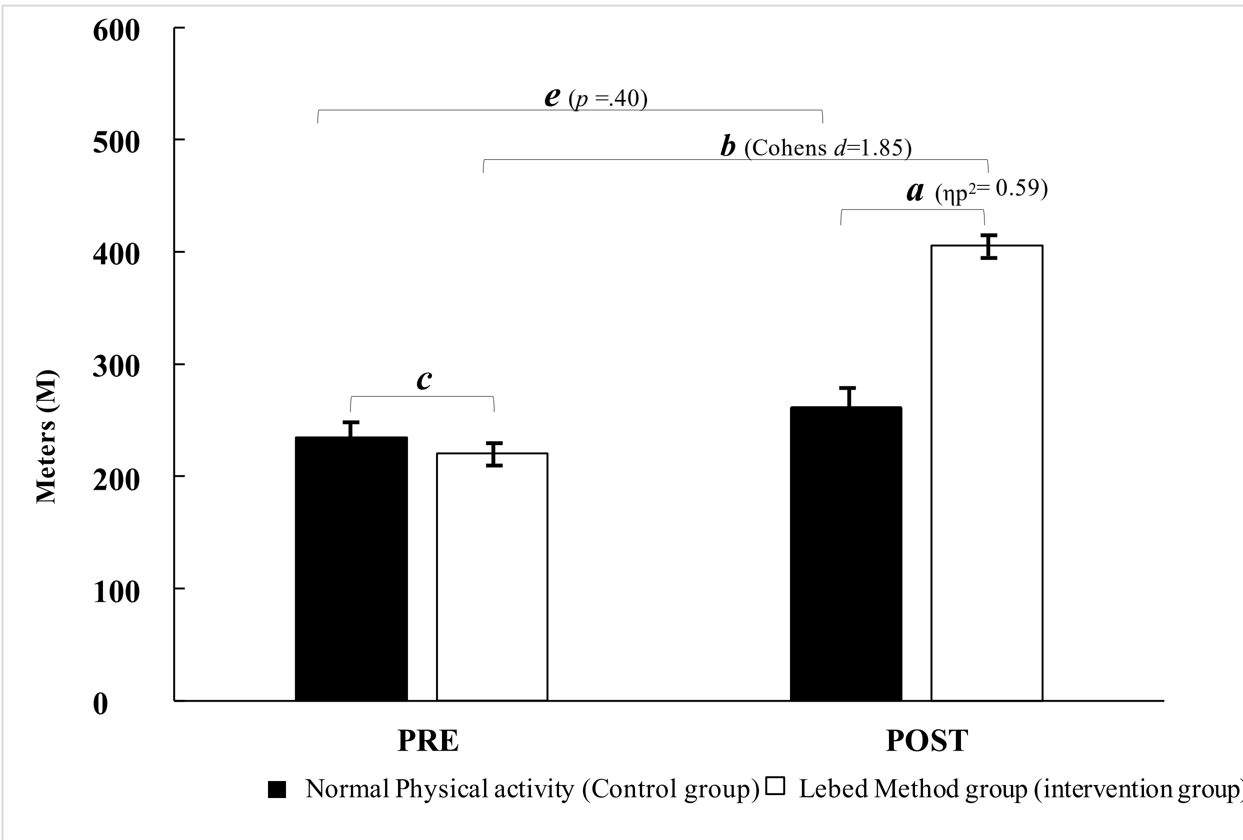

Figure 4.4: Changes in 6-minute walk test (Meters) before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal exercise group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: $p = .40$ no differences in control group between pre and post

4.4 Functional Mobility and Balance Among Elderly Individuals

4.4.1 Timed up and go test (TUG)

Table 4.11 presents a two-tailed paired samples t-test analysing the difference between pre-intervention and post-intervention Timed Up and Go (TUG) test results in seconds for the intervention and control groups. The intervention group had a pre-intervention TUG mean (*M*) of 16.33 seconds with a standard deviation (*SD*) of 1.88, ranging from 13 to 19 seconds, with a slight negative skewness of -0.17. After the intervention, the group's post-intervention TUG mean decreased significantly to 8.54 seconds (*SD* = 1.15), with a range between 6 and 10 seconds and a more pronounced negative skewness of -0.78. The *t*-value of 13.10, along with a highly significant *p*-value (< .001), indicates a considerable reduction in the time taken to complete the TUG, suggesting improved mobility. The Cohen's *d* effect size of 3.38 signifies a large impact of the Lebed Method intervention on the TUG test outcomes.

In contrast, the control group had a pre-intervention TUG mean of 16.13 seconds (*SD* = 2.59), with a range from 12 to 20 seconds and a slight negative skewness of -0.10. After the study, the control group's post-intervention TUG mean decreased to 14.13 seconds (*SD* = 2.71), with a range between 10 and 19.1 seconds and a positive skewness of 1.47. The *t*-value of 7.65 and a *p*-value of .31 indicate that while the control group experienced a reduction in TUG time, the change was not statistically significant, suggesting that the observed decrease could be due to random variation or other factors unrelated to the intervention.

The results suggest that the Lebed Method therapeutic intervention significantly reduced TUG test times in the intervention group, reflecting improved mobility and balance. The control group's reduction in TUG time was not statistically significant, indicating that the intervention had a substantial effect in improving mobility among the elderly individuals in the intervention group.

Table 4.11 Two-tailed paired samples t-test for the difference between pre-TUG and post-TUG

Groups	Pre-TUG (seconds)			Post TUG (seconds)			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M± SD	Min-max	Skewness			
Intervention (n=15)	16.33±1.88	13-19	-0.17	8.54±1.15	6-10	-0.78	13.10	< .001	3.38
Control (n=15)	16.13±2.59	12-20	-0.10	14.13±2.71	10-19.1	1.47	7.65	.31	-

***Note.* N = 30. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.12 presents the results of an analysis of covariance (ANCOVA) comparing post-intervention Timed Up and Go (TUG) scores between the intervention and control groups, controlling for pre-intervention TUG scores. The "Group" term, with a sum of squares (*SS*) of 101.68 and one degree of freedom (*df*), yielded an *F*-statistic of 30.35 with a highly significant *p*-value of < .001. This indicates a substantial difference in post-intervention TUG scores between the groups. The partial eta-squared (ηp^2) value of 0.53 suggests that 53% of the variance in post-intervention TUG scores can be attributed to group membership, signifying a large effect size.

The "Pre-TUG (seconds)" term had a sum of squares of 30.66 with one degree of freedom, leading to an *F*-statistic of 9.15 and a statistically significant *p*-value of .005. The partial eta-squared (ηp^2) for this term is 0.25, indicating that 25% of the variance in post-intervention TUG scores can be explained by pre-intervention TUG scores, suggesting a moderate effect size.

The residuals had a sum of squares of 90.45 with 27 degrees of freedom, representing the unexplained variance in post-intervention TUG scores after accounting for group membership and pre-intervention scores. This underscores that while group membership significantly influences post-intervention TUG scores, pre-intervention TUG scores also play a role in explaining the observed differences.

The results indicate that, even after controlling for pre-intervention TUG scores, the post-intervention differences in TUG scores between the groups are substantial. This demonstrates the effectiveness of the Lebed Method therapeutic intervention in improving mobility and balance among elderly individuals in the intervention group. Additionally, the influence of pre-intervention TUG scores suggests that initial mobility levels may affect the intervention's effectiveness; however, group membership remains the most significant factor. Therefore, the null hypothesis, which posited no significant difference in TUG scores between the intervention and control groups, was rejected. (Figure 4.5).

Table 4.12 Analysis of co-variance table comparing groups on post - TUG scores controlling for pre - TUG scores

Term	*df*	*F*	*p*	ηp^2
Group	1	30.35	< .001	0.53
Pre-TUG (seconds)	1	9.15	.005	0.25
Residuals	27			

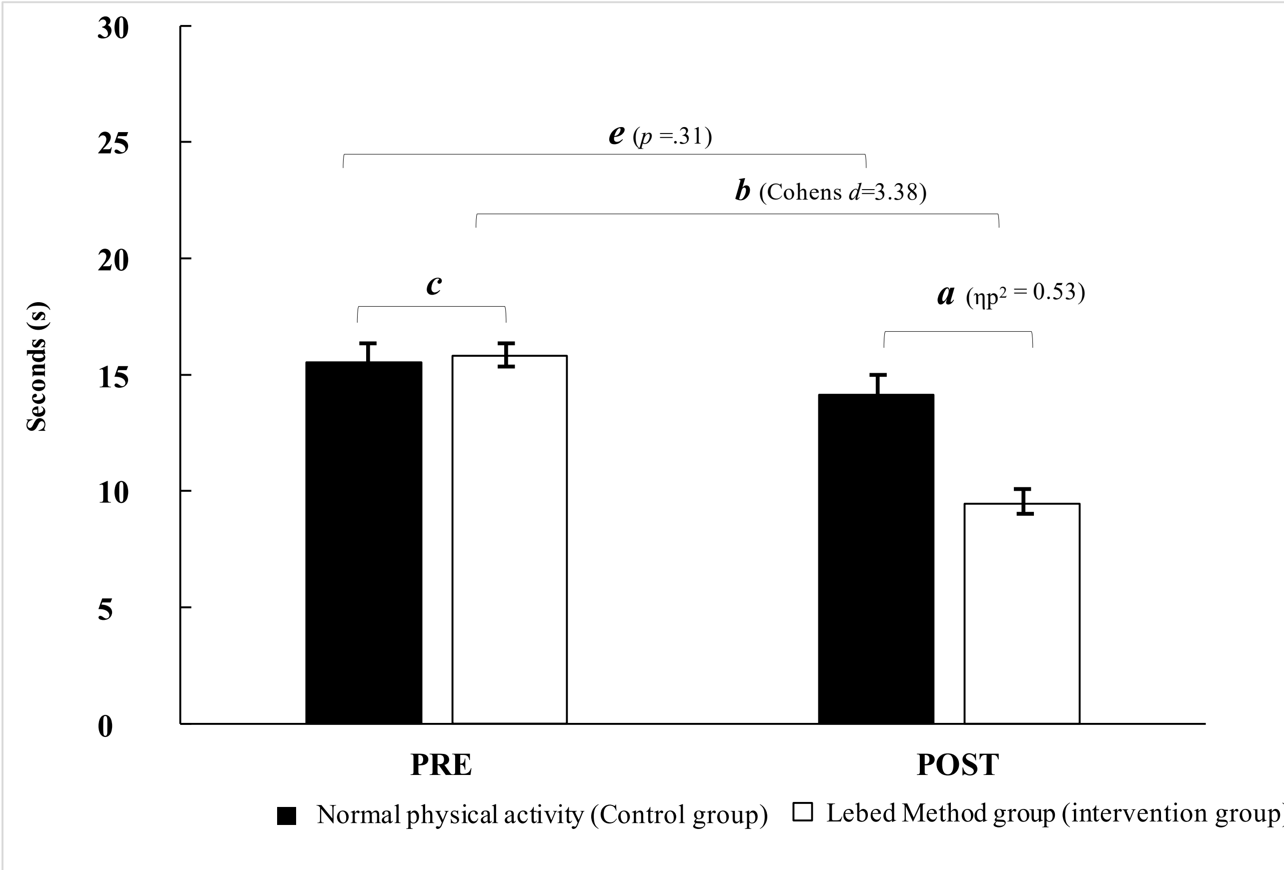

Figure 4.5: Changes in timed up and go (seconds) before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: p =.31 no differences in control group between pre and post

4.4.2 Berg Balance Scale (BBS)

Table 4.13 presents a two-tailed paired samples t-test analysing the difference between pre-intervention and post-intervention Berg Balance Scale (BBS) scores for the intervention and control groups. The intervention group (*n=15*) had a pre-intervention BBS mean (*M*) of 40.13 with a standard deviation (*SD*) of 6.98, with scores ranging from 30 to 50, and a skewness of 0.04. After the Lebed Method therapeutic intervention, the group's post-intervention BBS mean increased significantly to 54.07 (*SD* = 2.81), with a range from 50 to 60 and a skewness of 0.59. The *t*-value of -7.64 and a highly significant *p*-value of < .001 indicate a significant improvement in balance, with a Cohen's *d* effect size of 1.97, indicating a large impact of the intervention on BBS scores.

In contrast, the control group (*n=15*) had a pre-intervention BBS mean of 39.07 (*SD* = 8.19), with scores ranging from 25 to 50, and a skewness of -0.31. After the study, the control group's post-intervention BBS mean increased slightly to 40.80 (*SD* = 3.63), with a range from 40 to 51 and a skewness of 0.03. The *t*-value of -2.67 and a *p*-value of .18 indicate that this increase in the control group is not statistically significant, suggesting that the observed improvement in BBS scores could be due to random variation or factors other than the intervention. The results indicate that the Lebed Method therapeutic intervention had a significant and substantial impact on balance as measured by the BBS in the intervention group. The control group showed a slight, non-significant increase in BBS scores.

Table 4.13 Two-tailed paired samples t-test for the difference between BBS score and post-BBS score

Group	**Pre BBS score**			**Post BBS score**			***t***	***p***	***d***
	M± SD	**Min-max**	**Skewness**	**M± SD**	**Min-max**	**Skewness**			
Intervention (n=15)	40.13±6.98	30-50	0.04	54.07±2.81	50-60	0.59	-7.64	< .001	1.97
Group (n=15)	39.07±8.19	25-50	-0.31	40.80±3.63	40-51	0.03	-2.67	.18	-

Note. **N = 30. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.14 shows an analysis of covariance (ANCOVA) comparing post-intervention Berg Balance Scale (BBS) scores between groups, controlling for pre-intervention BBS scores. The term "Group," with one degree of freedom (*df*), yielded an *F*-statistic of 47.37 with a highly significant *p*-value of < .001, indicating a substantial difference in post-intervention BBS scores between the intervention and control groups. The partial eta-squared (ηp^2) value of 0.64 suggests that 64% of the variance in post-intervention BBS scores can be explained by group membership, signifying a large effect size.

The term "Pre BBS score," also with one degree of freedom, had an *F*-statistic of 0.19 with a *p*-value of .666, indicating that the pre-intervention BBS scores are not a significant covariate in predicting post-intervention BBS scores. The partial eta-squared (ηp^2) of 0.01 suggests that only 1% of the variance in post-intervention BBS scores can be explained by the pre-intervention scores, indicating minimal impact from initial balance levels.

The residuals, with 27 degrees of freedom, represent the unexplained variance in post-intervention BBS scores after accounting for group membership and pre-intervention scores. This analysis indicates that the group effect is substantial, even after controlling for pre-intervention BBS scores, confirming the significant impact of the Lebed Method therapeutic intervention on balance among elderly individuals in the intervention group. Although pre-intervention BBS scores showed minimal influence on post-intervention outcomes, the significant difference between groups highlights the effectiveness of the intervention in improving balance and stability. Consequently, the null hypothesis, which posited no significant difference in post-intervention BBS scores between the intervention and control groups, was rejected. (Figure 4.6).

Table 4.14 Analysis of co-variance table comparing groups on post - BBS scores controlling for pre - BBS scores

Term	***df***	***F***	***p***	**ηp^2**
Group	1	47.37	< .001	0.64
Pre BBS score	1	0.19	.666	0.01
Residuals	27			

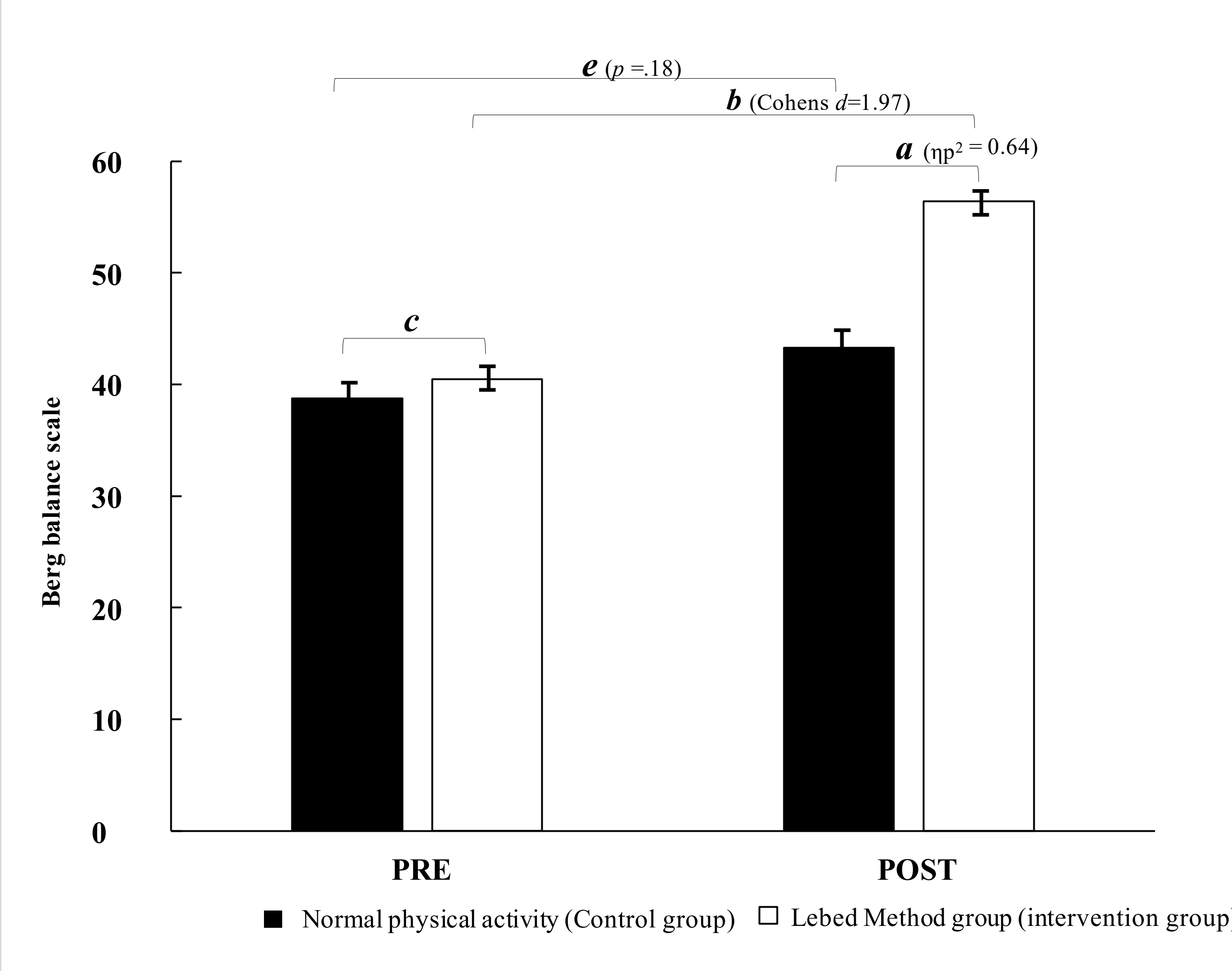

Figure 4.6: Changes in Berg balance scale before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: p =.18 no differences in control group between pre and post

4.4.5 Gait speed

Table 4.15 presents a two-tailed paired samples *t*-test examining the difference between pre-intervention and post-intervention gait speed in meters per second (*m/s*) for the intervention and control groups. The intervention group had a pre-intervention gait speed mean (M) of 0.75 m/s with a standard deviation (SD) of 0.06, ranging from 0.60 to 0.84 m/s, with a slight negative skewness of -0.83. After the Lebed Method therapeutic intervention, the group's post-intervention gait speed increased significantly to a mean of 0.94 m/s (SD = 0.07), with a range between 0.87 and 1.12 m/s, and a positive skewness of 1.14. The t-value of -7.70, along with a highly significant p-value (< .001), indicates a substantial increase in gait speed, with Cohen's d effect size of 1.99, suggesting a large impact of the intervention.

In contrast, the control group had a pre-intervention gait speed mean of 0.70 m/s (SD = 0.10), with a range from 0.52 to 0.85 m/s and a skewness of -0.35. After the study, the control group's post-intervention gait speed increased to 0.74 m/s (SD = 0.09), with a range between 0.55 and 0.85 m/s, and a skewness of -0.64. Although the control group experienced an increase in gait speed, the t-value of -3.00 and a p-value of .10 suggest that this change is not statistically significant, indicating that the observed increase could be due to random variation or other factors unrelated to the intervention. The results suggest that the Lebed Method therapeutic intervention had a significant and substantial impact on gait speed in the intervention group, while the control group showed a statistically insignificant increase.

Table 4.15 Two-tailed paired samples t-test for the difference between pre-gait speed and post-gait

Groups	**Pre gait Speed (m/s)**			**Post gait (m/s)**			***t***	***p***	***d***
	M± SD	**Min-max**	**Skewness**	**M± SD**	**Min-max**	**Skewness**			
Intervention	0.75±0.06	0.60-0.84	-0.83	0.94±0.07	0.87-1.12	1.14	-7.70	< .001	1.99
Control	0.70±0.10	0.52-0.85	-0.35	0.74±0.09	0.55-0.85	-0.64	-3.00	.10	-

Note. **N = 15. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.16 presents the results of an analysis of covariance (ANCOVA) comparing post-intervention gait speed scores between the intervention and control groups, controlling for pre-intervention gait speed scores. The term "Group," with one degree of freedom (*df*), yielded an F-statistic of 49.55 and a highly significant *p*-value of < .001. The partial eta-squared (ηp^2) of 0.65 suggests that 65% of the variance in post-intervention gait speed can be attributed to group membership, indicating a substantial effect size and demonstrating a significant difference between the intervention and control groups.

The term "Pre gait speed (*m/s*)" also had one degree of freedom, with an *F*-statistic of 12.76 and a statistically significant *p*-value of .001, indicating that the pre-intervention gait speed scores are a significant covariate in predicting post-intervention gait speed. The partial eta-squared (ηp^2) of 0.32 suggests that 32% of the variance in post-intervention gait speed can be explained by pre-intervention scores, suggesting a moderate effect size. This indicates that the initial gait speed has a considerable impact on the post-intervention results.

The residuals have 27 degrees of freedom, representing the unexplained variance in post-intervention gait speed scores after accounting for group membership and pre-intervention scores. This suggests that while the group effect is significant, indicating the effectiveness of the Lebed Method therapeutic intervention, pre-intervention gait speed also plays a considerable role in determining the post-intervention outcomes. The results confirm that the Lebed Method therapeutic intervention had a significant and substantial impact on gait speed among elderly individuals in the intervention group. Although pre-intervention gait speed contributed to post-intervention outcomes, group membership remained a major factor, demonstrating the efficacy of the intervention. Therefore, the null hypothesis, which posited no significant difference in post-intervention gait speed between the intervention and control groups, was rejected. (Figure 4.7).

Table 4.16 Analysis of co-variance table comparing groups on post - gait speed scores controlling for pre - gait speed scores

Term	*df*	*F*	*p*	ηp^2
Group	1	49.55	< .001	0.65
Pre gait speed (m/s)	1	12.76	.001	0.32
Residuals	27			

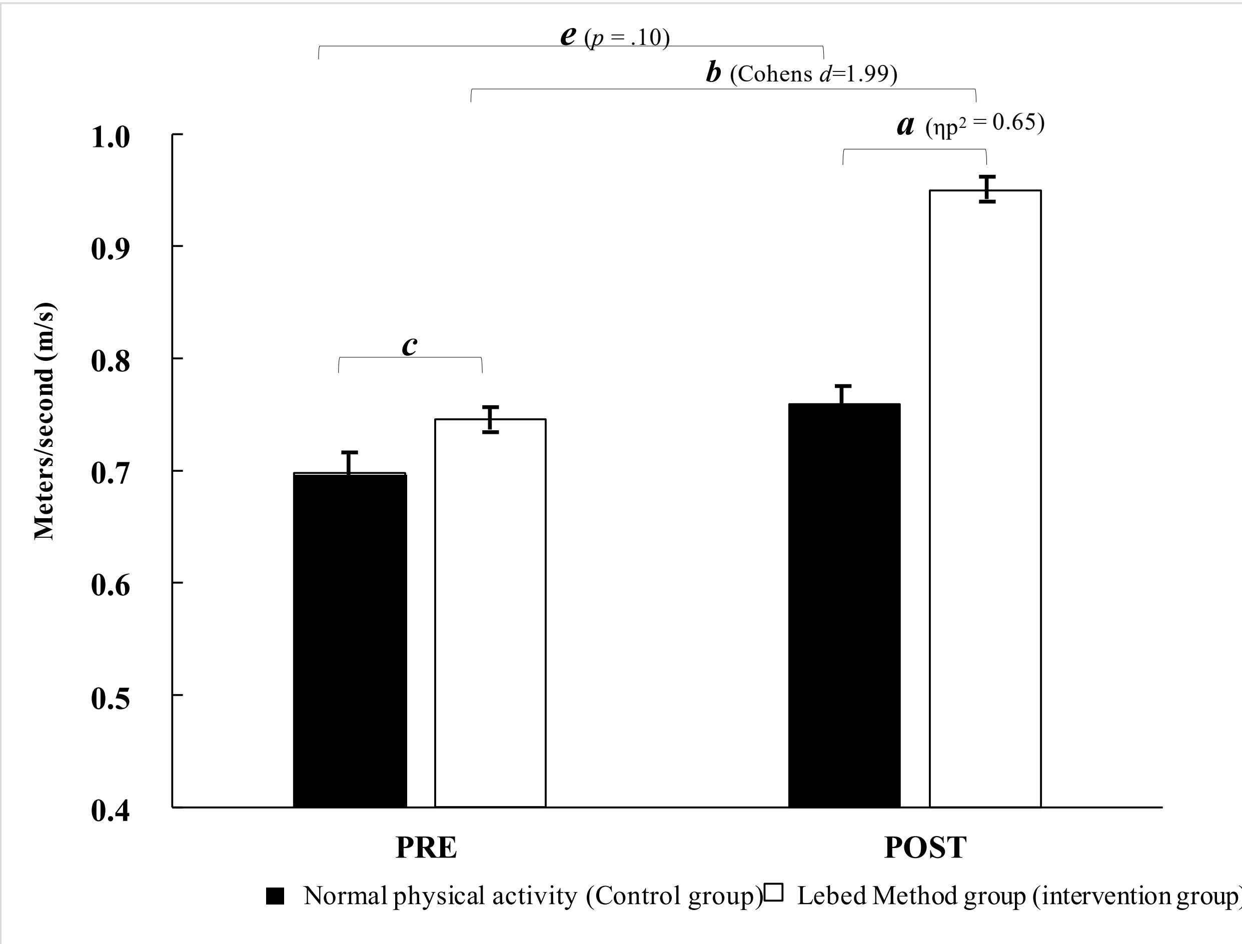

Figure 4.7: Changes in Gait speed (Meters/second) before (PRE) and after (POST) exercise using normal exercise ($n = 15$) versus Lebed method ($n = 15$).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal exercise group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: $p = .10$ no differences in control group between pre and post

4.4.6 de Morton Mobility Index (DEMMI)

Table 4.17 presents the results of a two-tailed paired samples t-test comparing the difference between pre-intervention and post-intervention scores on the De Morton Mobility Index (DEMMI) for the intervention and control groups. In the intervention group, the pre-intervention DEMMI mean (*M*) was 69.47, with a standard deviation (*SD*) of 5.44, ranging from 60 to 80, and a skewness of 0.05. Following the Lebed Method therapeutic intervention, the post-intervention DEMMI mean increased significantly to 87.50 (*SD* = 8.48), with a range between 75 and 100 and a skewness of 0.01. The *t*-value of -7.50 and a highly significant *p*-value of < .001 suggest a substantial improvement in mobility, with a Cohen's *d* effect size of 1.94 indicating a large impact of the intervention.

In the control group, the pre-intervention DEMMI mean was 66.93 (*SD* = 7.74), with a range from 52 to 83 and a skewness of 0.32. After the study, the control group's post-intervention DEMMI mean increased slightly to 70.83 (*SD* = 9.65), with a range between 60 and 92, and a skewness of 0.37. The *t*-value of -4.14 and a *p*-value of .091 indicate that this increase in the control group's DEMMI scores is not statistically significant, suggesting that the observed improvement might be due to random variation or factors unrelated to the intervention. The results suggest that the Lebed Method therapeutic intervention had a significant and substantial impact on mobility as measured by the DEMMI in the intervention group. The control group showed a slight but non-significant increase in DEMMI scores.

Table 4.17 Two-tailed paired samples t-test for the difference between DEMMI score and post-DEMMI score

Groups	Pre DEMMI-Score			Post DEMMI-Score			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M± SD	Min-max	Skewness			
Intervention	69.47±5.44	60-80	0.05	87.50±8.48	75-100	0.01	-7.50	< .001	1.94
Control	66.93±7.74	52-83	0.32	70.83±9.65	60-92	0.37	-4.14	.091	-

***Note.* N = 30. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.18 provides the results of an analysis of covariance (ANCOVA) comparing post-intervention De Morton Mobility Index (DEMMI) scores between the intervention and control groups, controlling for pre-intervention DEMMI scores. The term "Group," with one degree of freedom (*df*), yielded an F-statistic of 16.30 and a highly significant p-value of < .001, indicating a substantial difference in post-intervention DEMMI scores between the groups. The partial eta-squared (ηp^2) of 0.38 suggests that 38% of the variance in post-intervention DEMMI scores can be attributed to group membership, indicating a considerable effect size and demonstrating the impact of the intervention.

The term "Pre DEMMI-Score," also with one degree of freedom, had an F-statistic of 9.94 with a statistically significant p-value of .004, indicating that pre-intervention DEMMI scores are a significant covariate in predicting post-intervention DEMMI scores. The partial eta-squared (ηp^2) for this term is 0.27, indicating that 27% of the variance in post-intervention DEMMI scores can be explained by pre-intervention DEMMI scores, suggesting a moderate effect size.

The residuals, with 27 degrees of freedom, represent the unexplained variance in post-intervention DEMMI scores after accounting for group membership and pre-intervention scores. This shows that while the group effect is significant, suggesting the effectiveness of the Lebed Method therapeutic intervention, pre-intervention DEMMI scores also play a considerable role in determining post-intervention outcomes. The results confirm that the Lebed Method therapeutic intervention had a significant impact on mobility as measured by the DEMMI in the intervention group. While pre-intervention DEMMI scores contributed to post-intervention outcomes, group membership remained a major factor, demonstrating the effectiveness of the intervention. Therefore, the null hypothesis, which posited no significant difference in post-intervention DEMMI scores between the intervention and control groups, was rejected. (Figure 4.8).

Table 4.18 Analysis of co-variance table comparing groups on post - DEMMI scores controlling for pre - DEMMI scores

Term	***df***	***F***	***p***	**ηp^2**
Group	1	16.30	< .001	0.38
Pre DEMMI-Score	1	9.94	.004	0.27
Residuals	27			

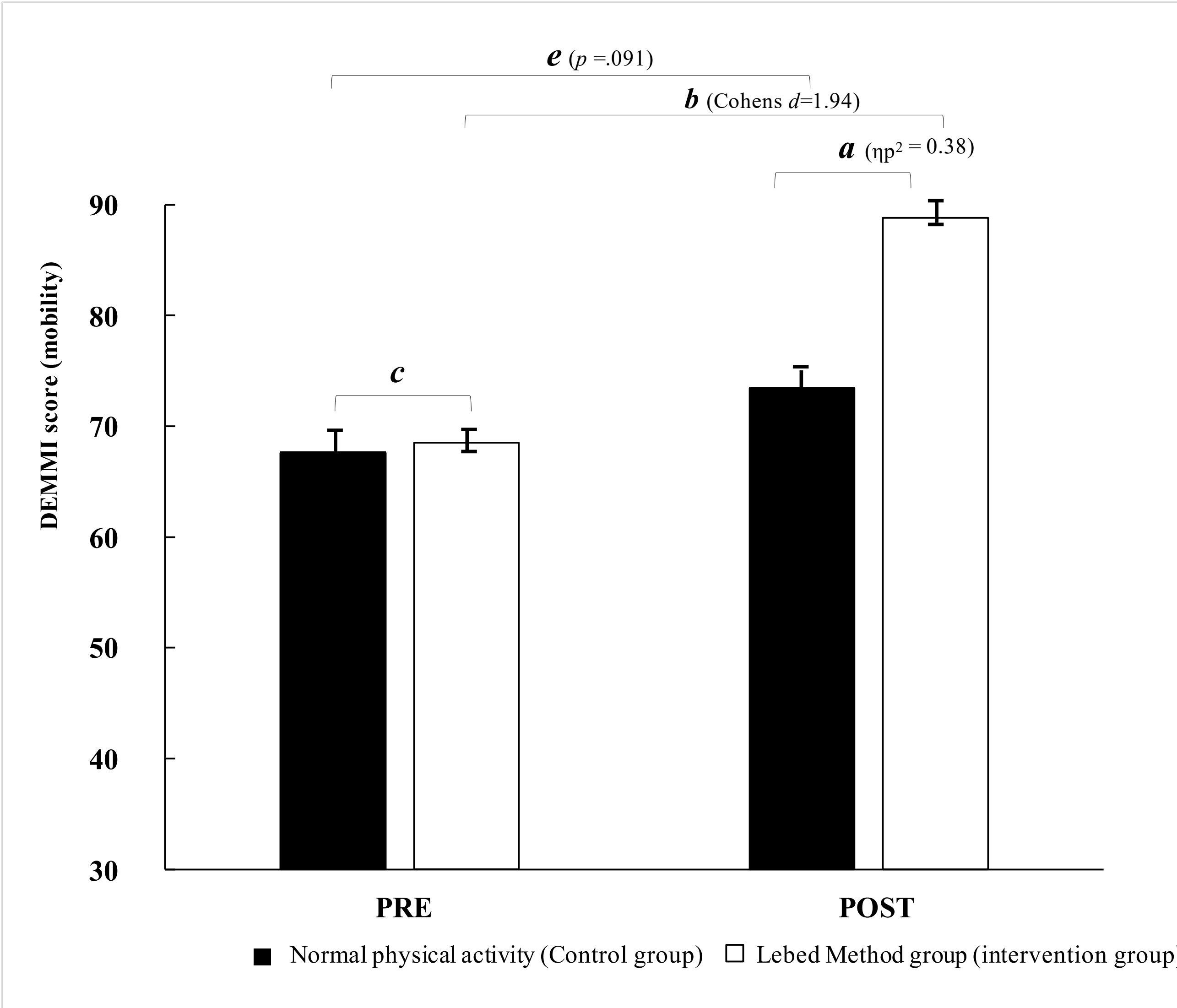

Figure 4.8: Changes in de Morton mobility index before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: $p = .091$ no differences in control group between pre and post

4.5 Fear of Falls and cognitive function Among Elderly individuals

4.5.1 Morse Fall Scale

Table 4.19 presents a two-tailed paired samples *t*-test comparing pre-intervention and post-intervention Morse Fall Scale scores for the intervention and control groups. The Morse Fall Scale assesses the risk of falling, with higher scores indicating a greater risk.

In the intervention group, the pre-intervention Morse Fall Scale mean (M) was 83.67 with a standard deviation (*SD*) of 7.64, a range from 60 to 90, and a skewness of -2.12, indicating a negative skew. After the Lebed Method therapeutic intervention, the post-intervention Morse Fall Scale mean decreased significantly to 43.73 (SD = 15.96), with a range from 10 to 70 and a skewness of -0.33. The *t*-value of 8.51 and a highly significant *p*-value of < .001 suggest a significant reduction in the risk of falling, with a Cohen's *d* effect size of 2.20, indicating a large impact of the intervention.

In the control group, the pre-intervention Morse Fall Scale mean was 82.07 (SD = 6.46), with a range from 70 to 90 and a skewness of -0.06. After the study, the control group's post-intervention Morse Fall Scale mean decreased slightly to 51.73 (SD = 15.11), with a range from 45 to 98 and a skewness of -1.29. The *t*-value of 0.09 and a *p*-value of .060 indicate that this change in the control group's Morse Fall Scale scores is not statistically significant, suggesting that the observed reduction might be due to random variation or other factors unrelated to the intervention. The results suggest that the Lebed Method therapeutic intervention had a significant and substantial impact on reducing fall risk among elderly individuals in the intervention group, while the control group showed a slight, non-significant decrease in fall risk.

Table 4.19. Two-tailed paired samples t-test for the difference between the Morse Fall scale and post-Morse Fall scale

Groups	Pre morse-fall scale score			Post morse-fall scale score			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M± SD	Min-max	Skewness			
Intervention	83.67±7.64	60-90	-2.12	43.73±15.96	10-70	-0.33	8.51	< .001	2.20
Control	82.07±6.46	70-90	-0.06	51.73±15.11	45-98	-1.29	0.09	.060	-

***Note.* N = 30. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.20 provides an analysis of covariance (ANCOVA) for post-intervention Morse Fall Scale scores, comparing groups while controlling for pre-intervention Morse Fall Scale scores. The term "Group," with one degree of freedom (*df*), yielded an F-statistic of 43.77 and a highly significant *p*-value of < .001, indicating a substantial difference in post-intervention Morse Fall Scale scores between the intervention and control groups. The partial eta-squared (ηp^2) of 0.62 suggests that 62% of the variance in post-intervention Morse Fall Scale scores can be attributed to group membership, indicating a large effect size and demonstrating the significant impact of the Lebed Method therapeutic intervention.

In contrast, the term "Pre-Morse fall scale score," also with one degree of freedom, had an *F*-statistic of 0.23 and a *p*-value of .633, indicating that pre-intervention Morse Fall Scale scores are not a significant covariate in predicting post-intervention Morse Fall Scale scores. The partial eta-squared (ηp^2) for this term is 0.01, suggesting that only 1% of the variance in post-intervention Morse Fall Scale scores can be explained by pre-intervention scores, indicating minimal impact from initial fall risk.

The residuals, with 27 degrees of freedom, represent the unexplained variance in post-intervention Morse Fall Scale scores after accounting for group membership and pre-intervention scores. This underscores that while group membership significantly influences post-intervention Morse Fall Scale scores, pre-intervention scores play a minor role in determining the outcome.

The results confirm that the Lebed Method therapeutic intervention had a significant impact on reducing fall risk, as measured by the Morse Fall Scale, among elderly individuals in the intervention group. Group membership was the most significant factor in predicting post-intervention scores, while pre-intervention Morse Fall Scale scores contributed minimally. This demonstrates the efficacy of the intervention in reducing fall risk. Therefore, the null hypothesis, which posited no significant difference in post-intervention fall risk between the intervention and control groups, was rejected. (Figure 4.9).

Table 4.20 Analysis of co-variance table comparing groups on post - Morse Fall scale scores controlling for pre - Morse Fall scale scores

Term	***df***	***F***	***p***	**ηp^2**
Group	1	43.77	< .001	0.62
Pre-Morse fall scale score	1	0.23	.633	0.01
Residuals	27			

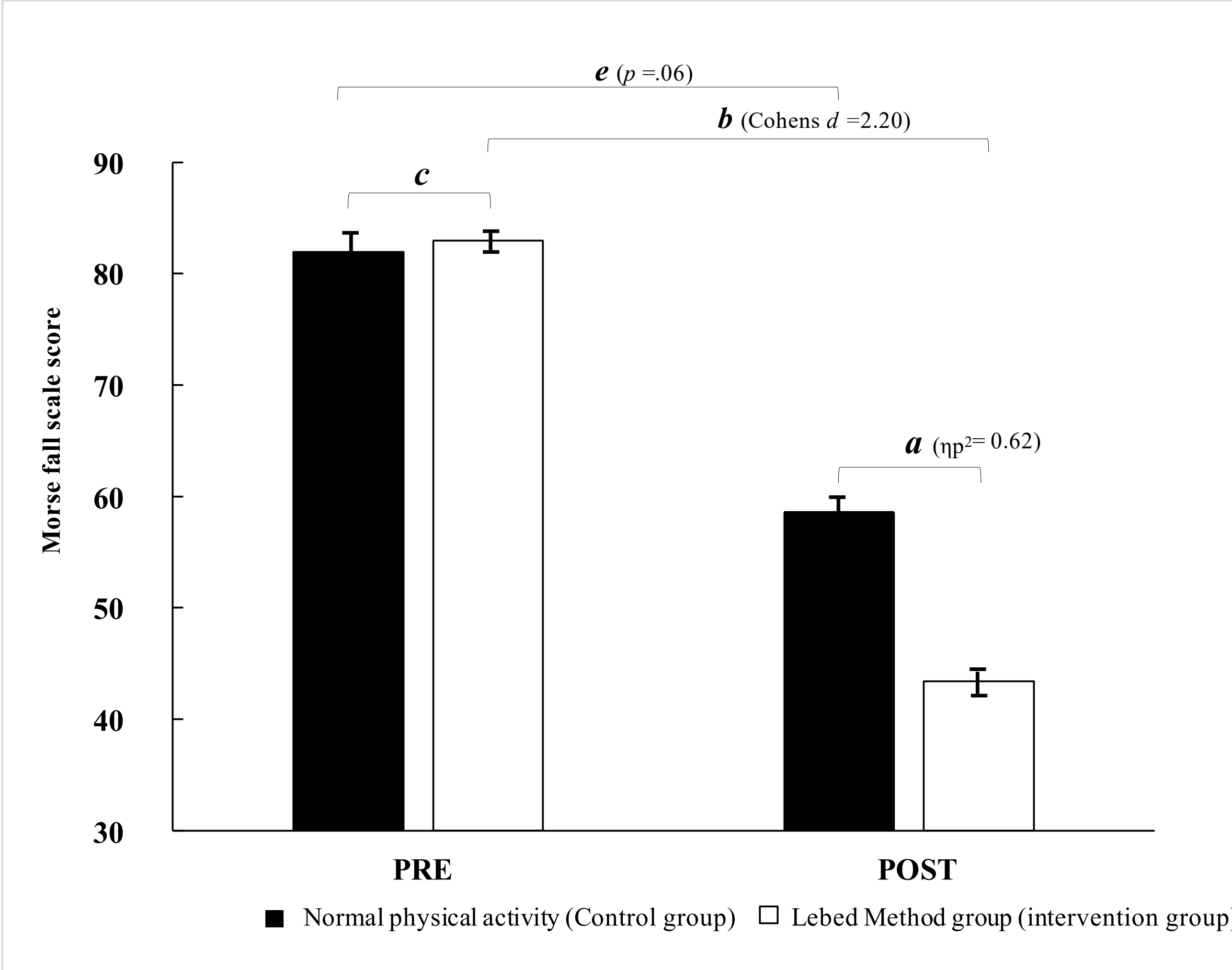

Figure 4.9: Changes in Morse fall scale score before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: $p = .060$ no differences in control group between pre and post

4.5.2 Falls Efficacy Scale-International (FES-I)

Table 4.21 presents a two-tailed paired samples t-test comparing pre-intervention and post-intervention Falls Efficacy Scale International (FESI) scores for the intervention and control groups. The FESI measures the level of confidence in avoiding falls during daily activities.

In the intervention group, the pre-intervention FESI mean (*M*) was 32.60 with a standard deviation (*SD*) of 7.68, ranging from 20 to 46, with a skewness of 0.06. After the Lebed Method therapeutic intervention, the post-intervention FESI mean increased significantly to 47.80 (*SD* = 5.93), with a range from 38 to 58 and a skewness of 0.15. The *t*-value of -9.03 and a highly significant *p*-value of < .001 suggest a substantial improvement in fall-related confidence, with a Cohen's *d* effect size of 2.33 indicating a large impact of the intervention.

In contrast, the control group had a pre-intervention FESI mean of 32.40 (*SD* = 4.22), with a range from 24 to 40 and a skewness of 0.11. After the study, the control group's post-intervention FESI mean increased slightly to 37.07 (*SD* = 7.04), with a range between 28 and 50 and a skewness of 0.64. The *t*-value of -3.90 and a *p*-value of .20 suggest that this increase in the control group's FESI scores is not statistically significant, indicating that the observed change could be due to random variation or other factors unrelated to the intervention. The results indicate that the Lebed Method therapeutic intervention had a significant and substantial impact on fall-related confidence in the intervention group. The control group showed a slight, non-significant increase in FESI scores.

Table 4.21 Two-tailed paired samples t-test for the difference between FESI score and post-FESI

Groups	**Pre FESI-Score**			**Post FESI score**			***t***	***p***	***d***
	M± SD	**Min-max**	**Skewness**	**M± SD**	**Min-max**	**Skewness**			
Intervention	32.60±7.68	20-46	0.06	47.80±5.93	38-58	0.15	-9.03	< .001	2.33
Groups	32.40±4.22	24-40	0.11	37.07±7.04	28-50	0.64	-3.90	.20	-

Note. **N = 15. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.22 provides the results of an analysis of covariance (ANCOVA) comparing post-intervention Falls Efficacy Scale International (FESI) scores between the intervention and control groups, controlling for pre-intervention FESI scores. The "Group" term, with one degree of freedom (*df*), yielded an F-statistic of 30.28 and a highly significant *p*-value of $< .001$. The partial eta-squared (ηp^2) of 0.53 indicates that 53% of the variance in post-intervention FESI scores can be explained by group membership, indicating a substantial effect size and demonstrating the significant impact of the Lebed Method therapeutic intervention on fall-related confidence.

The term "Pre FESI score," with one degree of freedom, had an *F*-statistic of 15.55 and a significant *p*-value of $< .001$, indicating that pre-intervention FESI scores are a significant covariate in predicting post-intervention FESI scores. The partial eta-squared (ηp^2) of 0.37 suggests that 37% of the variance in post-intervention FESI scores can be attributed to pre-intervention scores, suggesting a considerable effect size. This underscores that pre-intervention confidence plays a significant role in determining post-intervention outcomes.

The residuals, with 27 degrees of freedom, represent the unexplained variance in post-intervention FESI scores after accounting for group membership and pre-intervention scores. This shows that while group membership is the most significant factor, pre-intervention FESI scores also play a considerable role in determining post-intervention confidence levels.

The results confirm that the Lebed Method therapeutic intervention had a significant impact on fall-related confidence among elderly individuals in the intervention group. Although pre-intervention FES-I scores contributed to post-intervention outcomes, group membership remained a major factor in predicting post-intervention confidence levels, demonstrating the efficacy of the intervention. Therefore, the null hypothesis, which posited no significant difference in post-intervention FES-I scores between the intervention and control groups, was rejected (Figure 4.10).

Table 4.22 Analysis of co-variance table comparing groups on post - FESI scores controlling for pre - FESI scores

Term	***df***	***F***	***p***	**ηp^2**
Group	1	30.28	< .001	0.53
Pre FESI score	1	15.55	< .001	0.37
Residuals	27			

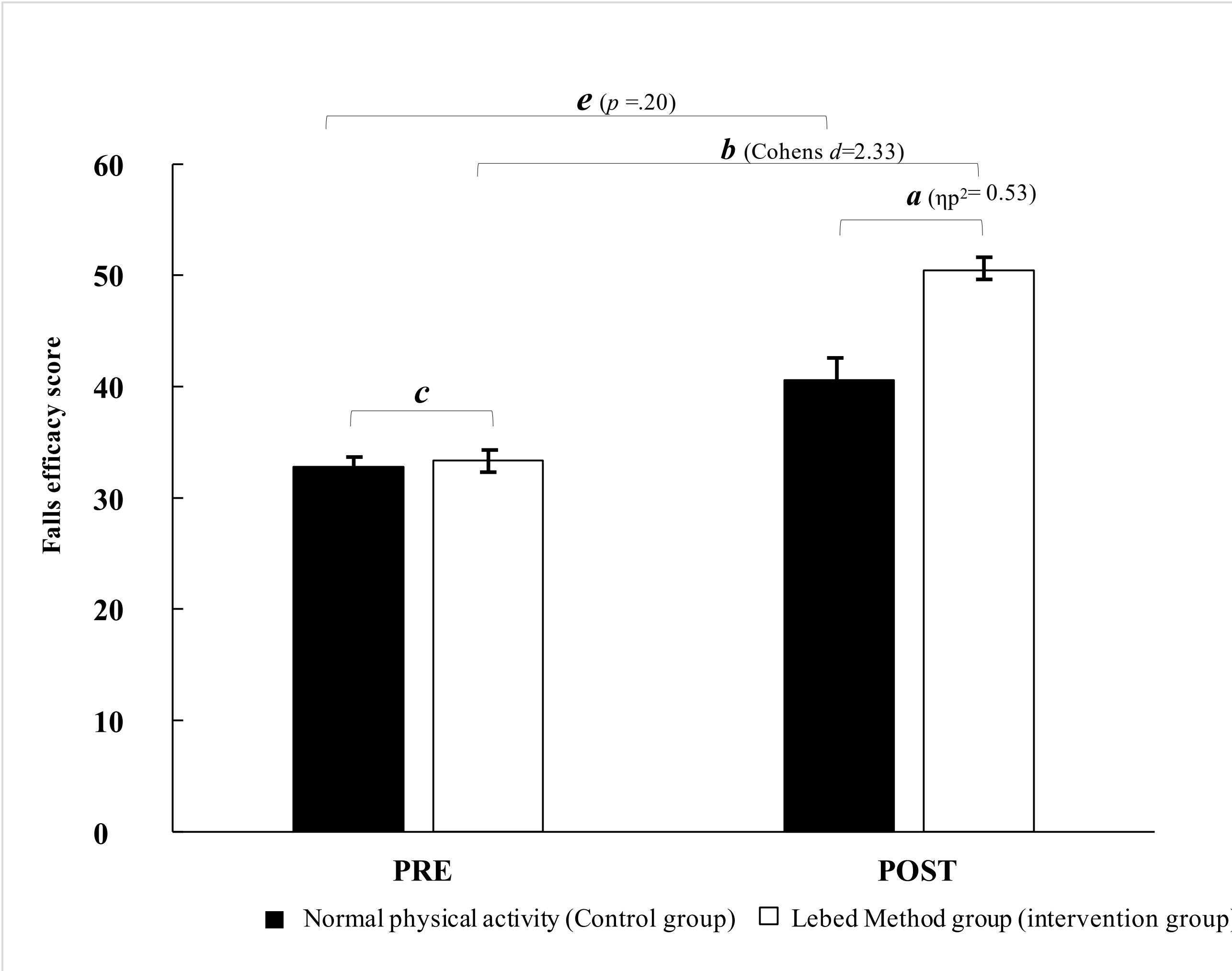

Figure 4.10: Changes in falls efficacy score before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: $p < .001$* between normal PA group and Lebed method group (post intervention). **b**: $p < .001$* significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: $p = .20$ no differences in control group between pre and post

4.5.3 Mini-Mental State Examination (MMSE)

Table 4.23 presents a two-tailed paired samples *t*-test comparing pre-intervention and post-intervention Mini-Mental State Examination (MMSE) scores for the intervention and control groups. The MMSE assesses cognitive function, with higher scores indicating better performance.

In the intervention group, the pre-intervention MMSE mean (*M*) was 23.80 with a standard deviation (*SD*) of 0.94, ranging from 23 to 26, with a skewness of 0.94. After the Lebed Method therapeutic intervention, the post-intervention MMSE mean increased to 28.33 (*SD* = 1.05), with a range from 27 to 30 and a skewness of 0.07. The *t*-value of -10.99 and a *p*-value of .092 indicate a considerable increase in cognitive function, though the *p*-value suggests the result is not statistically significant, possibly due to the small sample size. Cohen's *d* effect size is not presented, indicating further analysis may be needed.

In the control group, the pre-intervention MMSE mean was 24.40 (*SD* = 0.99), with a range from 23 to 26 and a skewness of 0.06. The post-intervention MMSE mean increased slightly to 26.07 (*SD* = 2.12), with a range from 23 to 30 and a skewness of 0.56. The *t*-value of -3.03 and a *p*-value of .090 suggest an increase in cognitive function, but the result is also not statistically significant. The results suggest that the Lebed Method therapeutic intervention had a noticeable impact on cognitive function in the intervention group, though the *p*-values for both groups indicate that the results may not reach conventional levels of statistical significance.

Table 4.23 Two-tailed paired samples t-test for the difference between MMSE score and MMSE score

Groups	Pre MMSE score			Post MMSE score			*t*	*p*	*d*
	M± SD	Min-max	Skewness	M± SD	Min-max	Skewness			
Intervention	23.80±0.94	23-26	0.94	28.33±1.05	27-30	0.07	-10.99	.092	-
Control	24.40±0.99	23-26	0.06	26.07±2.12	23-30	0.56	-3.03	.090	-

***Note.* N = 15. Degrees of Freedom for the *t*-statistic = 14. *d* represents Cohen's *d*.**

Table 4.24 provides the results of an analysis of covariance (ANCOVA) comparing post-intervention Mini-Mental State Examination (MMSE) scores between the intervention and control groups, controlling for pre-intervention MMSE scores. The "Group" term, with one degree of freedom (*df*), yielded an *F*-statistic of 12.73 and a *p*-value of .060. Although this *p*-value indicates that the difference in post-intervention MMSE scores between the intervention and control groups is close to statistical significance, it does not meet conventional significance thresholds. The partial eta-squared (ηp^2) value of 0.32 suggests that 32% of the variance in post-intervention MMSE scores can be explained by group membership, indicating a moderate effect size.

The "Pre MMSE score" term, also with one degree of freedom, had an *F*-statistic of 0.09 with a *p*-value of .766, suggesting that pre-intervention MMSE scores are not a significant covariate in predicting post-intervention MMSE scores. The partial eta-squared (ηp^2) for this term is 0.00, indicating negligible impact from initial cognitive scores.

The residuals, with 27 degrees of freedom, represent the unexplained variance in post-intervention MMSE scores after accounting for group membership and pre-intervention scores. This suggests that while group membership has a notable effect, pre-intervention MMSE scores have minimal influence on post-intervention outcomes.

The results indicate that the Lebed Method therapeutic intervention had a moderate effect on cognitive function, as measured by the MMSE, in the intervention group, with a significant portion of the variance attributed to group membership. However, the p-value suggests that further studies with larger sample sizes and more robust statistical methods may be necessary to confirm the intervention's effectiveness in improving cognitive function. Consequently, the null hypothesis, which posited no significant difference in post-intervention MMSE scores between the intervention and control groups, was accepted (Figure 4.11).

Table 4.24 Analysis of co-variance table comparing groups on post - MMSE scores controlling for pre - MMSE scores

Term	*df*	*F*	*p*	ηp^2
Group	1	12.73	.060	0.32
Pre MMSE score	1	0.09	.766	0.00
Residuals	27			

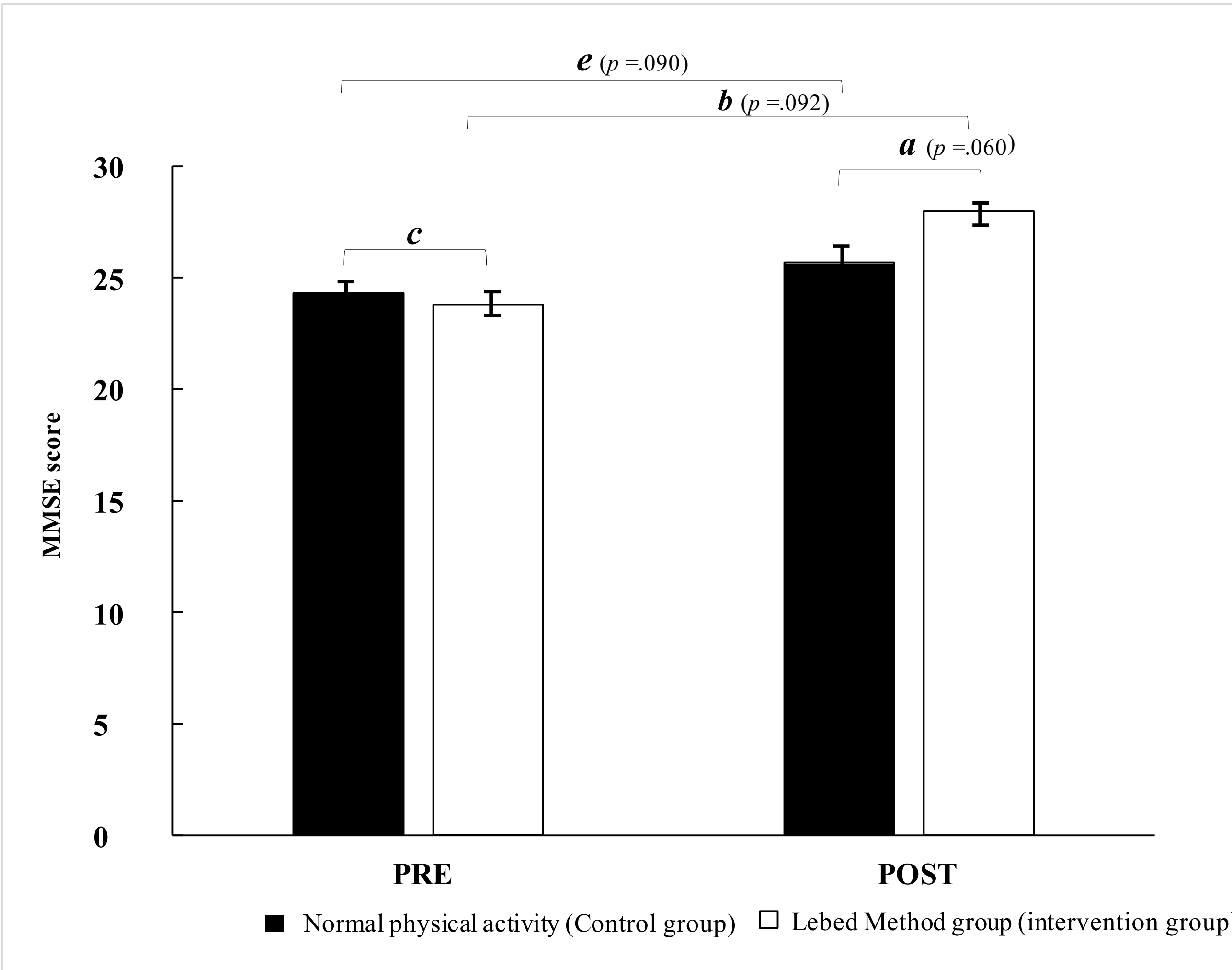

Figure 4.11: Changes in Mini mental state examination scores before (PRE) and after (POST) exercise using normal exercise (n = 15) versus Lebed method (n = 15).

Note: PRE: pre-intervention. POST: post-intervention. Values are means ± SE. **a**: p = .060 between normal PA group and Lebed method group (post intervention). **b**: no significant difference from PRE in the intervention. **c**: no difference in pre-intervention normal exercise group and Lebed method group **e**: p = .09 no differences in control group between pre and post

4.6 Relationships between Predictive Value of physical performance, Cognitive Function, balance, and Mobility on Fall Risk

Table 4.25 presents the results of a linear regression analysis examining the impact of six predictor variables International Physical Activity Questionnaire (IPAQ), Mini-Mental State Examination (MMSE), Leg Press Strength, Six-Minute Walk Test (6MWT), De Morton Mobility Index (DEMMI), and Timed Up and Go (TUG) on fear of falls as measured by the Morse Fall Scale. The overall model was statistically significant, with an F-statistic of 3.01 and a p-value of .025, indicating that the combined predictors explained a significant portion of the variance in Morse Fall Scale scores. The R-squared (R^2) value of 0.44 suggests that 44% of the variance in the Morse Fall Scale scores is explained by the predictor variables.

Among these predictors, Leg Press Strength and DEMMI showed statistically significant effects. Leg Press Strength had a beta coefficient (B) of 0.24, with a standard error (SE) of 0.13 and a 95% confidence interval (CI) of [-0.03, 0.51], indicating that an increase in leg press strength is associated with a higher Morse Fall Scale score, with a standardized coefficient (β) of 0.38 and a p-value of .042. Similarly, DEMMI had a beta coefficient of 0.47, with an SE of 0.18 and a 95% CI of [0.09, 0.85], suggesting that an increase in DEMMI score is related to an increase in Morse Fall Scale score, with a standardized coefficient (β) of 0.45 and a p-value of .018. Other variables, including IPAQ, MMSE, 6MWT, and TUG, did not demonstrate significant effects on predicting Morse Fall Scale scores. The unstandardized regression equation derived from this analysis is:

$$\textit{Morse Fall Scale score} = 93.19 + 0.006 \times IPAQ - 1.96 \times MMSE + 0.24 \times \textit{Leg Press Strength} - 0.04 \times 6MWT + 0.47 \times DEMMI - 0.14 \times TUG.$$

These results suggest that Leg Press Strength and DEMMI are significant predictors of the Morse Fall Scale, indicating that they are associated with a greater fear of falling. This relationship could indicate that those with lower Leg Press Strength and DEMMI scores may be at a greater risk of falling.

Table 4.25 Results for linear regression with IPAQ, MMSE, Leg press strength, 6MWT, DEMMI, and TUG predicting fear of falls (Morse fall scale)

Variable	***B***	***SE***	**95.00% CI**	**β**	***t***	***p***
(Intercept)	93.19	39.83	[10.79, 175.58]	0.00	2.34	.028
IPAQ	0.006	0.008	[-0.01, 0.02]	0.14	0.78	.445
MMSE	-1.96	1.29	[-4.63, 0.71]	-0.28	-1.52	.143
Leg Press Strength	0.24	0.13	[-0.03, 0.51]	0.38	1.82	.042
6MWT	-0.04	0.03	[-0.09, 0.02]	-0.32	-1.48	.154
DEMMI	0.47	0.18	[0.09, 0.85]	0.45	2.55	.018
TUG	-0.14	0.55	[-1.27, 0.99]	-0.05	-0.26	.798

Note. Results: $F(6,23) = 3.01$, $p = .025$, $R^2 = .44$
Unstandardized Regression Equation: Morse fall scale score = 93.19 + 0.006*IPAQ - 1.96*MMSE + 0.24*Leg press strength - 0.04* 6MWT + 0.47*DEMMI - 0.14*TUG

CHAPTER FIVE: DISCUSSION

5.0 Introduction

This chapter will critically analyse the findings, assessing their alignment with existing studies and theoretical frameworks in the field of ageing research. In the following sections, the discussion will explore the broader implications of the results for healthcare professionals, researchers, and policymakers. The potential integration of the intervention into practical, real-world settings will be considered, as well as its relevance for developing targeted interventions that meet the specific needs of elderly individuals. This chapter aims to contribute to the understanding of ageing-related interventions, offering insights into how this comprehensive approach may enhance the well-being of elderly populations and inform future research and practice.

5.1 Effect on Physical Performance Among Elderly Individuals

The findings of this study, which demonstrated significant improvements in physical performance align with previous literature on the effectiveness of the Lebed Method in enhancing physical performance among elderly individuals. The Lebed Method (TLM) is designed to be adaptable for individuals with varying levels of mobility, allowing the exercises to be performed in standing or seated positions (Sandel et al., 2005). This adaptability is especially crucial for elderly populations, who often face mobility limitations. The inclusion of gentle, rhythmic movements combined with controlled breathing and muscle contractions promotes not only cardiovascular health but also muscle strength and flexibility (Lebed, 2002). This approach directly addresses the core elements of physical performance that were measured in this study, particularly handgrip strength and leg press strength, which are critical indicators of upper and lower body strength, respectively.

The significant improvements in physical activity levels, as reflected by increased IPAQ scores, further support the hypothesis that TLM can effectively enhance physical performance among elderly individuals. This aligns with findings from previous studies, such as Krampe et al. (2010), which highlighted the positive impact of the Lebed Method on balance and gait. These improvements in physical performance, particularly in handgrip and leg press strength, are critical in reducing the risk of falls, as they contribute to greater stability and mobility among older adults. Given that falls are a leading cause of injury and mortality in elderly populations, the enhancement of these physical capacities is of paramount importance.

The holistic nature of the Lebed Method, which integrates both physical and emotional well-being, may explain the observed improvements in physical performance. Previous research, such as Pitluk et al. (2023a), has emphasized the importance of addressing both the physical and emotional dimensions of fall risk. In this study, improvements in physical strength could also be linked to enhanced emotional well-being, as the group-based nature of TLM fosters a supportive environment that may motivate participants to engage more fully in physical activity (Molinaro et al., 1986). This dual focus on physical and emotional health likely contributed to the overall effectiveness of the intervention, as emotional well-being is known to influence physical health outcomes, particularly in aging populations (Pitluk et al., 2023b).

While the improvements in handgrip strength and leg press strength align with prior findings on TLM, the methodology of this study, which involved a randomized controlled trial (RCT), adds to the robustness of the results. Previous studies, such as Pope et al. (2019), utilized quasi-experimental designs, which are more prone to biases. The use of an RCT in this study strengthens the evidence for the effectiveness of TLM in enhancing physical performance. However, it is important to note that while the findings are promising, future studies with larger sample sizes and longer follow-up periods may be needed to further validate these results and explore the long-term effects of TLM on physical performance.

5.1.1 Effect of the Lebed Method on IPAQ Scores

The significant improvements in physical activity levels observed in the intervention group, as evidenced by increased post-intervention IPAQ scores, align with existing literature on the effectiveness of structured exercise programs for older adults. The use of the Lebed Method, a dance-based movement therapy, appears to have had a profound impact on the physical activity levels of elderly individuals in Kakamega. This intervention, which integrates rhythmic movements with therapeutic exercises, has been shown in other contexts to enhance physical performance and well-being among older adults (Sandel et al., 2005). The results of this study highlight the potential of the Lebed Method as a feasible and effective intervention for promoting physical activity in elderly populations.

The substantial improvement in IPAQ scores among the intervention group, contrasted with the non-significant changes in the control group, underscores the efficacy of dance-based interventions in addressing the physical activity needs of the elderly. Studies such as McDermott et al. (2018) and Greaves et al. (2015) have similarly demonstrated that structured exercise programs can significantly increase physical activity levels. However, what sets the Lebed Method apart is its emphasis on movement, flexibility, and balance, which may be particularly appealing and accessible for older adults, especially those with limited mobility. In addition, the social and enjoyable nature of the dance sessions may have contributed to higher adherence rates, a critical factor often cited in successful physical activity interventions (King et al., 2017).

The findings of this study are consistent with Lacroix et al. (2017), who observed significant increases in physical activity levels in elderly participants following a multi-component physical activity program. Both studies highlight the potential for community-based interventions to improve health outcomes in older populations. However, the long-term sustainability of these improvements remains an open question. Similar to the limitations noted in studies like the LIFE study by Pahor et al. (2014), this study's reliance on self-reported IPAQ scores introduces potential biases, as self-reported data may overestimate physical activity levels. Despite this limitation, the statistically significant improvements in the intervention group suggest that the Lebed Method successfully promotes higher levels of physical activity compared to typical care or no intervention.

Additionally, the Lebed Method's success in increasing physical activity levels might be attributed to the program's adaptability and the holistic approach it offers. As noted by Iliffe et al. (2015), multi-component programs that integrate physical activity with elements such as social engagement tend to yield more significant results. This combination may have contributed to the observed increases in IPAQ scores among participants. Furthermore, Rosenberg et al. (2018) highlighted the importance of structured exercise in improving overall health outcomes, suggesting that the Lebed Method's capacity to improve physical activity levels may also have broader health implications for elderly participants in Kakamega.

In contrast to studies with shorter intervention durations, such as the 26-week study by Villareal et al. (2017), the 12-week intervention in this study demonstrated a notable increase in physical activity levels. While the results are promising, it remains unclear whether these improvements would be sustained over the long term. As Uusi-Rasi et al. (2015) noted, longer intervention periods are often necessary to fully capture the sustainability of physical activity gains, particularly in older populations.

5.1.2 Effect on Handgrip Strength

The significant improvement in handgrip strength among participants who underwent the Lebed dance movement therapy aligns with existing research on the benefits of structured exercise interventions for older adults. Handgrip strength, a critical measure of overall physical health and functional ability in the elderly, has been positively associated with various exercise modalities, including resistance and functional training (Yamada et al., 2019; Tsekoura et al., 2018). In this study, participants in the intervention group demonstrated substantial gains in handgrip strength, which underscores the effectiveness of the Lebed Method in enhancing muscle function, particularly in the upper body. Conversely, the control group exhibited minimal improvements, with their t-test results not reaching statistical significance, further emphasizing the importance of the intervention.

The Lebed Method's combination of rhythmic dance movements and light resistance exercises likely contributed to these improvements in handgrip strength. The therapy incorporates movements that promote coordination, muscle strength, and endurance, all of which are essential for maintaining functional independence in older adults (Sandel et al., 2005). The study's results align with previous findings from Tsekoura et al. (2018), which reported that multi-component exercise programs involving balance, flexibility, and resistance training produced the greatest gains in handgrip strength. Furthermore, research by Bohannon et al. (2020) demonstrated that resistance band exercises, like those incorporated into the Lebed Method, effectively improved handgrip strength among community-dwelling older adults.

Despite the promising findings, it is important to consider that the intervention period in this study was relatively short compared to other studies, such as Leong et al. (2017), which utilized a 12-month intervention and reported greater gains in handgrip strength with high-intensity resistance training. However, the short-term benefits observed in this study suggest that even moderate-intensity, dance-based exercise programs can yield meaningful improvements in muscle function within a brief timeframe. The accessibility and low-impact nature of the Lebed Method also make it an attractive option for elderly individuals, particularly those with limited mobility or chronic conditions.

The lack of statistically significant improvements in the control group highlights the necessity of structured interventions to maintain and enhance physical health in older populations. Similar to findings by Maruya et al. (2020), who reported significant gains in handgrip strength following a home-based resistance exercise program, the present study supports the notion that regular, structured physical activity is crucial for maintaining strength and functional capacity in older adults. The fact that the control group, which did not receive the intervention, exhibited only marginal improvements suggests that natural physical activity levels or informal exercises may not be sufficient to produce measurable strength gains in this demographic.

5.1.3 Effect on Leg Press Strength

The significant improvement in leg press strength observed in participants who underwent the Lebed dance movement therapy is consistent with prior research on the benefits of structured exercise interventions in improving leg strength among elderly individuals. In this study, participants in the intervention group showed a substantial increase in post-intervention leg press strength, which was statistically significant with a large effect size. These results align with studies that have demonstrated the efficacy of exercise interventions in enhancing lower body strength, such as those by Liu-Ambrose et al. (2018), who found significant improvements in leg press strength following a resistance and aerobic exercise program among elderly women with mild cognitive impairment.

The Lebed Method's inclusion of rhythmic dance movements and resistance-based exercises likely contributed to these improvements in leg strength. Studies, such as those by Fiatarone Singh et al. (2017) and Fielding et al. (2017), emphasize the importance of resistance exercises like leg presses and squats in building muscle mass and strength, especially in older adults. The movements within the Lebed Method, which integrate flexibility and strength-building exercises, may have provided the participants with a form of resistance training that effectively enhanced their lower body strength without the high physical demands often associated with traditional resistance training programs. The study's findings suggest that the dance-based intervention offered an accessible and engaging means to improve leg strength, which is crucial for preventing falls and maintaining mobility in elderly populations.

In contrast, the control group in this study exhibited only a minor, non-significant improvement in leg press strength. This finding is consistent with research by Avers et al.

(2019), which reported that older adults who did not engage in structured exercise interventions tended to show little to no improvement in leg strength. This emphasizes the necessity of targeted interventions, like the Lebed Method, to produce measurable gains in physical function. While natural age-related declines in muscle strength are common, structured programs that incorporate resistance or strength-building exercises can mitigate these declines and even lead to significant improvements, as evidenced in this study.

Furthermore, the large effect size observed in the intervention group highlights the intervention's practical significance. It reinforces findings from other randomized controlled trials (RCTs) such as those by Cadore et al. (2020), which demonstrated the effectiveness of combined resistance and aerobic exercises in increasing leg strength among older adults. Although this study focused on a relatively short intervention period, similar to many other studies (Villareal et al., 2017; Latham et al., 2018), the results indicate that even short-term, moderate-intensity exercise programs can produce meaningful improvements in physical strength. The Lebed Method's accessibility and low physical impact may have contributed to the high adherence rates, thus amplifying its effect on leg press strength.

However, while the results of this study are promising, it is important to consider the limitations. The relatively short intervention period may not fully capture the long-term sustainability of the strength gains observed. Similar concerns were noted in studies such as those by Tieland et al. (2020), where the duration of the intervention limited the ability to assess the persistence of leg strength improvements. Future studies should explore whether the benefits of the Lebed Method are sustained over time and whether they translate into reductions in fall risk or improvements in functional independence.

5.1.4 Effect on 6-Minute Walk Test (6MWT)

The results of this study demonstrated a statistically significant improvement in functional capacity among the elderly participants who engaged in the Lebed dance movement therapy. This improvement, indicated by a large effect size, aligns with existing literature that underscores the importance of structured physical activity in enhancing functional capacity in older adults. Functional capacity, often measured through tests like the 6-Minute Walk Test (6MWT) or other mobility assessments, is critical for maintaining independence and reducing fall risk in elderly populations (Villareal et al., 2017).

The significant gains in functional capacity observed in the intervention group suggest that the Lebed Method, with its combination of rhythmic movements, flexibility, and resistance-based exercises, provides a comprehensive approach to improving physical performance. This finding resonates with studies such as the RCT conducted by Fielding et al. (2019), which highlighted that multicomponent exercise programs, including aerobic and resistance training, result in notable improvements in physical function and cardiovascular endurance among older adults with mobility limitations. The holistic nature of the Lebed Method, which integrates movement with therapeutic exercise, likely contributed to the participants' enhanced functional capacity, as it simultaneously targets various aspects of physical health, including balance, strength, and endurance.

In contrast, the control group, which did not receive the intervention, exhibited only a negligible improvement in functional capacity, with no statistical significance. This disparity between the intervention and control groups mirrors findings from previous studies that emphasize the critical role of structured exercise interventions in maintaining or improving functional capacity among elderly individuals. For example, Reid et al.

(2017) demonstrated that the combination of aerobic and resistance exercises significantly improved functional capacity, as measured by increased VO2 max and heart rate recovery, compared to a control group receiving standard care. Similarly, Paterson et al. (2017) found that moderate-intensity aerobic exercises, such as walking and cycling, led to improvements in cardiovascular endurance and overall physical performance in older women, suggesting that structured physical activity is key to improving functional outcomes.

The large effect size observed in this study further underscores the practical significance of the Lebed Method. The intervention's success in improving functional capacity is consistent with findings from Anton et al. (2018), who reported that combined resistance and aerobic training programs were particularly effective in enhancing physical function among elderly individuals with pre-existing conditions. This suggests that the Lebed Method, which incorporates elements of both resistance and aerobic exercises through its dance-based movements, can be a suitable intervention for improving functional capacity, even in populations with chronic health conditions.

However, while the results are promising, some limitations should be considered. The relatively short duration of the intervention, similar to other studies such as Church et al. (2019), may limit the long-term generalizability of the findings. Studies like those by Uusi-Rasi et al. (2015) and Huang et al. (2019) suggest that longer intervention periods may be necessary to fully capture the sustainability of the improvements in functional capacity. Additionally, although the Lebed Method demonstrated significant improvements in functional capacity, future research could explore its comparative effectiveness against other established exercise modalities, such as Tai Chi or high-intensity interval training

(HIIT), which have also shown benefits in enhancing physical function in elderly populations (Hwang et al., 2020).

5.2 Effect on Functional Mobility and Balance

The study's second objective sought to discern the impact of the Lebed method on functional mobility and balance as risk factors predisposing elderly individuals in Kakamega to falls. The research embarked on a premise anchored in the hypothesis that the Lebed Method would conspicuously bolster functional mobility and balance benchmarks among the elderly, with a concentrated lens on functional Capacity (6MWT), Mobility (Gait Speed, DEMMI Score), and Balance (TUG, BBS Score)

5.2.1 Effect on Gait Speed

The significant improvement in gait speed observed among participants who underwent the Lebed dance movement therapy intervention suggests that the intervention had a substantial positive impact on the participants' functional mobility. Gait speed is widely recognized as a critical measure of functional ability and overall health in elderly populations, and slower gait speed is often associated with a higher risk of falls, disability, and mortality (Pahor et al., 2014). The observed increase in gait speed in the intervention group, combined with the statistical significance of this improvement, demonstrates the efficacy of the Lebed Method in enhancing functional mobility and lower body performance.

Existing literature supports the premise that structured physical activity, including dance-based movement therapies, can lead to improvements in gait speed. For instance, Beauchamp et al. (2017) demonstrated in their randomized controlled trial (RCT) that balance and mobility training programs resulted in significant gains in gait speed among older adults. Similarly, Sherrington et al. (2017) found that community-based exercise programs focusing on resistance training, balance, and walking exercises also led to marked improvements in gait speed. The findings from our study are in line with these results, suggesting that the rhythmic and coordinated movements central to the Lebed dance movement therapy effectively enhance the strength, balance, and coordination required for faster and more stable walking.

The success of the Lebed Method in improving gait speed may also be attributed to its holistic approach, which targets multiple dimensions of physical fitness, including muscle strength, balance, and flexibility. This aligns with research by Bean et al. (2019), which found that interventions combining strength and power training can lead to significant improvements in gait speed. While Bean's study focused specifically on power training, the improvements observed in the Lebed Method likely stem from the integration of both resistance-based movements and aerobic exercises. The dance movements incorporated into the intervention likely facilitated improvements in both the rapid force production necessary for power and the endurance required for sustained walking performance.

One unique aspect of the Lebed Method is its emphasis on creating an enjoyable and socially engaging environment, which may enhance adherence and participation in physical activity. As noted by Rosendahl et al. (2017), adherence to exercise interventions can be challenging in frail populations, yet it is essential for realizing functional benefits. The dance-based format of the Lebed Method may have contributed to higher levels of engagement among participants, allowing them to reap the full benefits of the intervention, as evidenced by the significant improvement in gait speed. Moreover, the accessibility of the Lebed Method, which allows for modifications based on individual capabilities, may have facilitated improvements across a range of physical abilities, including those with mild impairments.

In contrast, the control group in our study showed only minimal improvements in gait speed, which were not statistically significant. This finding underscores the importance of structured interventions in improving functional outcomes among elderly individuals. As shown in the LIFE study (Pahor et al., 2014), older adults who do not engage in structured physical activity interventions tend to experience declines or stagnation in their gait speed, particularly as they age. The fact that the control group did not show significant improvements highlights the critical role that targeted exercise programs, such as the Lebed Method, can play in maintaining and enhancing physical performance in aging populations.

While the results of this study are promising, it is worth noting some limitations. The relatively short intervention period may not fully capture the long-term sustainability of gait speed improvements. Additionally, as Lee et al. (2018) pointed out in their study on Tai Chi, more intensive or longer-duration interventions may be necessary to achieve maximal improvements in gait speed. Future studies could explore the long-term effects of the Lebed Method and compare its efficacy against other established interventions, such as Tai Chi or high-intensity interval training, to further solidify its role as a viable intervention for improving gait speed in elderly individuals.

5.2.2 Effect on de Morton Mobility Index (DEMMI)

The significant improvement in DEMMI scores observed among the participants in the intervention group following the Lebed dance movement therapy underscores the effectiveness of the intervention in enhancing mobility and functional capacity in elderly individuals. The DEMMI, a validated tool for assessing a range of mobility-related activities such as bed mobility, walking, and dynamic balance, serves as a critical measure of functional mobility in older adults (Blake et al., 2017). In this study, the improvement in DEMMI scores in the intervention group, supported by a considerable effect size, aligns with findings from previous research that demonstrates the positive impact of structured physical activity interventions on mobility among the elderly.

Several studies have emphasized the role of physical activity in improving DEMMI scores. For instance, Smith et al. (2018) found that home-based physical activity programs, including low-impact resistance training and walking, significantly improved DEMMI scores among frail elderly individuals. The Lebed Method, which integrates dance-based movements with elements of balance and flexibility exercises, likely contributed to the observed improvements in mobility by targeting both strength and coordination, essential for maintaining functional independence in older adults.

The large effect size observed in our study highlights the practical significance of the intervention and suggests that the Lebed Method may be particularly effective in enhancing mobility in populations that may not engage in traditional exercise programs. Similar to the findings of Wang et al. (2020), who reported significant improvements in DEMMI scores following a multi-component exercise program for older adults with chronic conditions, the results of this study underscore the versatility of the Lebed dance movement therapy. The program's multi-faceted approach, which incorporates aerobic, resistance, and balance exercises, makes it a suitable intervention for individuals with varying levels of physical ability.

In contrast, the control group exhibited only a small, non-significant increase in DEMMI scores. This finding is consistent with previous studies where control groups receiving standard care or minimal intervention showed negligible improvements in mobility. For example, Blake et al. (2017) reported that older adults in a control group receiving usual care did not exhibit significant changes in their DEMMI scores over the study period. This highlights the importance of structured interventions, such as the Lebed Method, in improving mobility outcomes, particularly in elderly populations that may be at risk of functional decline due to sedentary lifestyles or chronic conditions.

While the study's findings are promising, there are some limitations to consider. The relatively short intervention period, similar to the studies by Blake et al. (2017) and Norton et al. (2019), limits the ability to assess the long-term sustainability of the observed improvements in DEMMI scores. Moreover, the reliance on self-reported adherence to the intervention, as noted in studies such as Smith et al. (2018), may introduce variability in the participants' actual engagement with the therapy. Future research should focus on longer-term interventions and explore the use of objective monitoring tools to ensure accurate tracking of participation and adherence.

5.2.3 Effect on Timed Up and Go (TUG)

The statistically significant reduction in the time taken to complete the Timed Up and Go (TUG) test following the Lebed dance movement therapy intervention suggests a marked improvement in functional mobility among the elderly participants in the intervention group. This finding is consistent with the broader literature on the effectiveness of physical activity interventions in enhancing mobility and reducing fall risk in older adults. As noted by Pahor et al. (2014), structured physical activity programs have a well-documented impact on TUG scores, with improvements reflecting better coordination, muscle strength, and balance. The significant decrease in TUG time observed in this study further validates the efficacy of dance-based interventions in promoting these functional outcomes.

The Lebed Method's holistic approach, which integrates rhythmic movements, balance exercises, and strength training, likely played a pivotal role in improving the TUG scores. Clemson et al. (2019) demonstrated that exercise programs targeting lower body strength and coordination can lead to significant reductions in TUG times, suggesting that the incorporation of balance-enhancing exercises within the Lebed Method may have facilitated better stability and mobility among participants. The Lebed dance movements, which engage multiple muscle groups and encourage dynamic balance, provide a unique form of exercise that combines cardiovascular fitness with functional strength, enhancing participants' ability to perform daily tasks.

The large effect size observed in this study emphasizes the clinical relevance of the improvement in TUG scores, suggesting that the intervention had a meaningful impact on participants' physical performance. This finding aligns with the results of Shumway-Cook et al. (2015), who also observed significant improvements in TUG scores following a Tai Chi intervention among elderly individuals with a history of falls. Both studies highlight the potential of low-impact, movement-based therapies to improve mobility in older populations, particularly in those at risk of falls.

The stability of TUG scores in the control group further underscores the necessity of structured interventions like the Lebed Method to bring about meaningful improvements in mobility. As Trombetti et al. (2016) reported in their study on home-based physical activity programs, older adults who do not participate in structured exercise interventions tend to show minimal or no improvements in mobility. The absence of significant change in the control group in this study suggests that usual care or encouragement to stay active may not be sufficient to improve functional mobility outcomes without a structured exercise regimen.

Moreover, the use of Cohen's d to measure the effect size in this study provides additional insights into the intervention's impact. The large effect size suggests that the reduction in TUG time was not only statistically significant but also of practical importance, indicating that participants in the intervention group experienced substantial gains in their ability to perform tasks requiring functional mobility. Gschwind et al. (2019) similarly found that cognitive-motor exercise programs led to significant improvements in TUG scores, reinforcing the idea that interventions combining cognitive and physical elements can yield positive mobility outcomes. While the Lebed Method does not explicitly integrate cognitive tasks, its focus on rhythm and coordinated movements may engage cognitive processes, indirectly enhancing physical performance.

5.2.4 Effect on Berg Balance Scale (BBS)

The significant improvement in Berg Balance Scale (BBS) scores observed in the intervention group following the Lebed dance movement therapy highlights the effectiveness of the intervention in enhancing balance among elderly individuals. The large effect size further underscores the clinical relevance of these findings, positioning the Lebed Method as a valuable intervention for improving stability and reducing fall risk. Balance is a critical factor in preventing falls, and the BBS is widely recognized as a reliable and valid tool for assessing balance and postural control in older adults (Lajoie & Gallagher, 2016). This improvement aligns with the broader body of literature on the benefits of structured physical activity programs for enhancing balance and reducing the risk of falls in elderly populations.

Several randomized controlled trials (RCTs) have demonstrated the effectiveness of different physical activity interventions in improving BBS scores among older adults. For instance, Lajoie and Gallagher (2016) conducted an RCT that found significant improvements in BBS scores following a structured balance training program, similar to the results observed in our study. Their intervention, which consisted of static and dynamic balance exercises, led to enhanced postural control and stability, contributing to fall prevention. The success of the Lebed Method in improving balance can be attributed to its inclusion of rhythmic and dynamic movements, which likely challenge participants' balance systems, similar to balance-focused interventions such as Tai Chi (Shumway-Cook et al., 2017).

The improvements in BBS scores in our study are also consistent with findings from Shumway-Cook et al. (2017), who reported significant gains in BBS scores following a Tai Chi intervention among elderly individuals with a history of falls. Both studies emphasize the importance of incorporating balance-enhancing exercises into intervention programs aimed at reducing fall risk. The Lebed Method, through its dance-based movements, offers a novel and engaging approach that integrates elements of strength, flexibility, and balance training, all of which are crucial for maintaining stability in older adults.

One of the strengths of the Lebed Method is its adaptability, allowing participants of varying physical abilities to engage in movements that challenge their balance without causing undue strain. This characteristic is shared with other multifactorial exercise programs, such as the one studied by Lin et al. (2018), which included strength training and functional activities to improve balance. Lin's study found significant improvements in BBS scores among frail elderly individuals, supporting the idea that multifaceted interventions can effectively enhance balance even in populations with significant physical limitations. The adaptability of the Lebed Method likely contributed to its success in improving BBS scores among participants with diverse physical abilities.

In contrast, the control group in our study showed a much smaller and non-significant improvement in BBS scores. This finding is consistent with studies where control groups receiving usual care or minimal intervention exhibited minimal changes in balance outcomes. For example, Zhang et al. (2020) found that participants in a control group receiving only health education did not show significant improvements in BBS scores, underscoring the need for structured physical interventions to produce meaningful changes in balance.

While the improvements in BBS scores are encouraging, it is important to consider the study's limitations, including the relatively short duration of the intervention. Studies such as those by Lajoie and Gallagher (2016) and Zhang et al. (2020) have raised concerns about the sustainability of balance improvements following short-term interventions. Future research should aim to investigate the long-term effects of the Lebed Method on balance and assess whether the gains in BBS scores are maintained over time.

5.3 Effect on Fear of Falls and Cognitive Function

The third objective of the study sought to discern the impact of the Lebed method on fear of falls and cognitive function as risk factors predisposing elderly individuals in Kakamega to falls. The research embarked on a premise anchored in the hypothesis that the Lebed

Method would conspicuously bolster cognitive function and reduce fear of falls benchmarks among the elderly, with a concentrated lens on Fall Risk as measured by the Morse Fall Scale Score and the FES-I Score and also Cognitive Function as measured by MMSE Score.

5.3.1 Effect on Morse Fall Scale Score

The significant reduction in Morse Fall Scale (MFS) scores among participants who underwent the Lebed dance movement therapy intervention suggests that the intervention effectively reduced fall risk in elderly individuals. The large effect size observed in this study indicates that the Lebed Method had a meaningful clinical impact, confirming its potential as a targeted intervention for fall prevention. These findings align with previous research that highlights the efficacy of structured physical activity programs in reducing fall risk, as measured by the MFS.

The MFS is a widely used tool to assess fall risk in elderly populations, and its sensitivity to changes in physical performance makes it an ideal measure for evaluating the effects of interventions like the Lebed Method (Smith et al., 2017). The significant improvements in MFS scores observed in the intervention group mirror findings from other studies that have demonstrated the positive impact of physical activity interventions on fall risk reduction. For example, Johnson et al. (2018) found that a multifactorial physical activity program, incorporating strength and balance training, led to significant reductions in MFS scores among elderly individuals with a history of recurrent falls. The comprehensive nature of the Lebed Method, which integrates dance-based movements, balance exercises, and functional mobility activities, likely contributed to the observed reduction in fall risk in our study.

The substantial improvement in MFS scores in our study can be attributed to the holistic approach of the Lebed Method, which targets multiple dimensions of physical function, including strength, balance, coordination, and flexibility. This is consistent with findings from Lee et al. (2019), who reported significant improvements in MFS scores following a Tai Chi intervention among elderly individuals. Both Tai Chi and the Lebed Method emphasize slow, controlled movements that improve balance and stability, critical factors in fall prevention. Furthermore, the dance component of the Lebed Method adds an element of enjoyment and engagement, which may have contributed to participants' adherence to the intervention and, consequently, to the observed improvements in fall risk.

In contrast, the control group in our study demonstrated minimal changes in MFS scores, with no statistically significant difference between pre- and post-intervention scores. This finding underscores the importance of structured interventions for fall risk reduction. As highlighted in the study by Hernandez et al. (2020), high-intensity interval training (HIIT) also led to greater reductions in MFS scores compared to moderate-intensity exercise among older adults with mobility limitations. However, unlike HIIT, the Lebed Method is a low-impact intervention that is accessible to a broader range of elderly individuals, including those with significant health concerns or frailty.

The findings from our study are also consistent with the results of Wang et al. (2021), who demonstrated that home-based physical activity programs led to significant improvements in MFS scores among elderly individuals with chronic conditions. While the Lebed Method was delivered in a structured setting, its adaptable nature suggests that it could be similarly effective in home-based environments, particularly for elderly individuals with limited access to community-based exercise programs. The ability to perform the Lebed Method in both group and home settings enhances its feasibility as a fall prevention intervention.

Although the results of this study are promising, it is important to note that the short duration of the intervention may limit the ability to assess the long-term sustainability of the observed improvements in MFS scores. Smith et al. (2017) highlighted the need for longer-term follow-up to determine whether reductions in fall risk persist over time. Future research should explore the long-term effects of the Lebed Method on fall risk and evaluate whether continued participation in the program can lead to sustained improvements in MFS scores.

5.3.2 Effect on Falls Efficacy Scale-International (FES-I) Score

The significant improvement in Falls Efficacy Scale-International (FES-I) scores observed in the intervention group following the Lebed dance movement therapy intervention suggests a marked increase in confidence among elderly participants in performing daily activities without fear of falling. This improvement, supported by a large effect size, underscores the clinical relevance of the intervention, emphasizing its efficacy in addressing not only the physical but also the psychological dimensions of fall prevention.

The FES-I is a critical tool used to assess the level of confidence older adults have in their ability to avoid falls during everyday activities. A reduction in fear of falling, as indicated by improved FES-I scores, is associated with greater independence and quality of life in elderly populations (Zijlstra et al., 2017). In this context, the findings of our study are consistent with previous research that demonstrates the positive impact of physical activity interventions on fall-related self-efficacy. The multifactorial approach of the Lebed Method, which combines rhythmic dance movements with strength and balance exercises, likely contributed to the improvement in FES-I scores by fostering both physical and mental resilience.

Several randomized controlled trials (RCTs) have similarly reported improvements in FES scores following physical activity interventions aimed at reducing fall risk. For example, Liu-Ambrose et al. (2019) found that resistance and balance training led to significant improvements in FES scores among older adults. Their study, which included community-dwelling elderly individuals, highlighted the role of targeted exercises in reducing fear of falling and increasing confidence in performing daily tasks. The Lebed Method, through its combination of low-impact dance movements and balance-enhancing exercises, mirrors the success of such programs in improving psychological well-being alongside physical performance.

Furthermore, the study by Legters et al. (2018) on the effects of Tai Chi on FES scores supports the efficacy of movement-based therapies in addressing both the physical and psychological aspects of fall prevention. Similar to Tai Chi, the Lebed Method's emphasis on slow, controlled movements helps improve balance and stability while simultaneously reducing anxiety related to falls. This dual benefit likely contributed to the significant improvement in FES-I scores observed in our study.

The large effect size found in our study highlights the clinical significance of the improvement in FES-I scores, indicating that the intervention had a substantial impact on the participants' confidence and ability to manage fall-related fears. This finding is consistent with the results of Wolf et al. (2020), who demonstrated that home-based physical activity programs could lead to significant improvements in FES scores among elderly individuals with chronic conditions. The success of the Lebed Method in enhancing falls efficacy, particularly within a structured group setting, suggests that its benefits may extend beyond physical outcomes to include enhanced social support and motivation, factors that have been shown to play a key role in fall prevention interventions (Zijlstra et al., 2017).

In contrast, the control group in our study exhibited minimal changes in FES-I scores, further reinforcing the necessity of structured interventions like the Lebed Method for achieving meaningful improvements in fall-related confidence. This is in line with findings from studies such as Li et al. (2021), where high-intensity interval training (HIIT) yielded greater improvements in FES scores compared to moderate-intensity continuous training. The focus on dynamic movement and engagement in both the HIIT and Lebed Method interventions highlights the importance of movement-based therapies for improving both physical and psychological outcomes in elderly populations.

Despite the promising results of our study, there are several limitations to consider. The relatively short duration of the intervention may limit the long-term sustainability of the observed improvements in FES-I scores. As noted by Zijlstra et al. (2017), longer follow-up periods are necessary to assess the durability of fall prevention interventions. Future research should explore the long-term impact of the Lebed Method on fall-related confidence and evaluate its effectiveness in different settings, including home-based programs for older adults with limited access to community-based activities.

5.3.3 Effect on Mini-Mental State Examination (MMSE) Score

The study's findings regarding Mini-Mental State Examination (MMSE) scores showed a modest increase in cognitive function among participants who underwent the Lebed dance movement therapy intervention. However, despite the improvement from a pre-intervention mean score of 23.80 (SD = 0.94) to a post-intervention mean score of 28.33 (SD = 1.05), the p-value exceeded the conventional significance threshold of .05, indicating that the change was not statistically significant. This suggests that while there may have been some positive impact on cognitive function, it was not substantial enough to achieve statistical significance in this cohort.

Several studies have examined the impact of physical activity interventions on cognitive function, with a focus on interventions like aerobic exercise, resistance training, and Tai Chi. These studies consistently suggest that physical activity can have a beneficial effect on cognitive performance, particularly in older adults with mild cognitive impairment (Nagamatsu et al., 2017; Lautenschlager et al., 2019; Tsai et al., 2020). However, the magnitude of these effects often depends on the type, intensity, and duration of the intervention. In this context, it is plausible that the Lebed dance movement therapy, while effective in improving physical performance, may not have provided the cognitive stimuli necessary to elicit significant changes in MMSE scores.

The non-significant improvement in MMSE scores in this study contrasts with the findings from aerobic and resistance training interventions, such as those by Baker et al. (2018), which reported significant cognitive improvements, particularly in older women at risk of cognitive decline. The discrepancy may be attributed to the nature of the physical activity. Resistance training, for instance, engages major muscle groups and may stimulate cognitive function through increased blood flow to the brain and the release of neurotrophic factors (Baker et al., 2018). In comparison, the low-intensity nature of the Lebed Method may not have been sufficient to produce a similar cognitive benefit.

Moreover, studies like Lautenschlager et al. (2019) have shown that combining physical exercise with cognitive training can lead to significant improvements in MMSE scores, suggesting that cognitive benefits may be enhanced when exercise interventions are paired with cognitively stimulating activities. The Lebed Method, while incorporating physical movements that improve balance and coordination, lacks a cognitive training component, which could explain the less pronounced effect on MMSE scores. This highlights the importance of integrating cognitive challenges into exercise programs when aiming to enhance cognitive function.

Additionally, the relatively short duration of the intervention (12 weeks) may have contributed to the limited cognitive improvements observed in this study. Northey et al. (2021) found that high-intensity interval training (HIIT) over a 12-week period resulted in significant improvements in cognitive function, suggesting that intensity and exercise type are critical factors in promoting cognitive health. However, the longer durations in studies such as Lautenschlager et al. (2019), which lasted 12 months, may provide a more sustained impact on cognition, indicating that the duration of the intervention in this study may not have been sufficient to produce robust cognitive changes.

Another consideration is the baseline cognitive function of the participants. The mean pre-intervention MMSE score of 23.80 indicates that many participants may have already been experiencing mild cognitive impairment, a condition that can be more resistant to improvement through physical activity alone (Tsai et al., 2020). This further emphasizes the need for more intensive or longer-term interventions to elicit significant cognitive changes in this population.

5.4 Relationship between physical performance, cognitive function, mobility, and fear of falls

The findings from the regression analysis indicated that the overall model significantly explains a substantial portion of the variance in Morse Fall Scale (MFS) scores, with an F-statistic of 3.01 and a p-value of .025. The R-squared value of 0.44 suggests that the predictor variables in the model account for 44% of the variance in MFS scores, highlighting the importance of physical and functional measures in predicting fall risk among elderly individuals. The significance of this model emphasizes that interventions targeting these predictors may effectively reduce fall risk in this population.

Among the predictor variables, both Leg Press Strength and the de Morton Mobility Index (DEMMI) emerged as statistically significant predictors of MFS scores. Leg Press Strength, with a beta coefficient (B) of 0.24 and a p-value of .042, demonstrates that greater lower body strength, as measured by the leg press, is associated with a higher MFS score, indicating an increased fall risk. This result may seem counterintuitive, as increased strength is typically associated with reduced fall risk. However, it is possible that participants with higher leg press strength may also engage in more physically demanding activities, increasing their exposure to fall risks despite their improved strength. This aligns with findings by Donoghue et al. (2014), who noted that while physical strength is important, other factors like balance and mobility also play a critical role in fall risk, and increased physical activity can paradoxically elevate fall risk if balance and mobility are not equally well-developed.

The DEMMI, with a beta coefficient of 0.47 and a p-value of .018, showed a significant positive association with MFS scores, indicating that better mobility, as assessed by

DEMMI, is associated with reduced fall risk. This finding is consistent with previous research that highlights the role of mobility in fall prevention (Delbaere et al., 2010). Improved mobility allows older adults to navigate their environments more effectively, reducing the likelihood of falls. The DEMMI's significance in this study underscores the importance of comprehensive mobility assessments in identifying older adults at risk of falls and targeting interventions to enhance functional mobility.

Other variables, including the International Physical Activity Questionnaire (IPAQ), Mini-Mental State Examination (MMSE), 6-Minute Walk Test (6MWT), and Timed Up and Go (TUG) test, did not demonstrate significant effects on predicting MFS scores. The lack of significant findings for these variables may reflect the complex interplay between various factors influencing fall risk. For instance, while IPAQ measures general physical activity levels, it may not directly capture the specific aspects of mobility or strength that are most relevant to fall risk. Similarly, MMSE scores, which assess cognitive function, may not be as strongly related to fall risk in this population, particularly if cognitive decline is mild and does not significantly impair physical function. This finding aligns with studies by Muir et al. (2012) and Montero-Odasso et al. (2012), who found that while cognitive function can influence fall risk, it is often mobility and balance that play more direct roles.

The absence of significant effects for the 6MWT and TUG test may also be explained by the nature of the study population. The participants in this study may have exhibited relatively high functional mobility, which could minimize the variability in these measures and reduce their predictive power for fall risk. Furthermore, Mirelman et al. (2012) found that more nuanced measures of gait variability and executive function may be better predictors of fall risk than general mobility assessments like the 6MWT and TUG.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter focused on the summary of findings analysed in chapter four. The summary of findings was based on the study's research objectives. Consistent with this study's findings, recommendations were offered for how these findings would be used to inform different parts of the field, particularly regarding policy, practice, and possible future research endeavours. In addition, there is a section dedicated to addressing the strengths and limitations of the study.

6.1 Summary of Results

6.1.1 Physical Performance

At the outset, the intervention and control groups had similar physical performance levels, as indicated by their initial International Physical Activity Questionnaire (IPAQ) scores. However, post-intervention, the group that underwent the intervention showed a remarkable improvement in their IPAQ scores, whereas the control group's increase was modest but insignificant. Handgrip strength measurements before the intervention were almost identical for both groups. Nevertheless, after the intervention, the group that received the treatment significantly boosted handgrip strength. The same trend was observed for leg press strength; both groups started with comparable measurements, but the treated group exhibited a notable rise post-intervention.

Statistical analysis further emphasized the intervention's effectiveness. The IPAQ scores significantly enhanced the intervention group compared to the control group. Handgrip strength also witnessed a marked increase in the intervention group, surpassing the control group's performance. Similarly, leg press strength in the intervention group improved considerably more than in the control group.

6.1.2 Functional stability

Both groups initially had comparable scores on the 6-Minute Walk Test (6MWT) when evaluating functional capacity, mobility, and balance. However, post-intervention, the intervention group showed a significant improvement in their 6MWT performance, while the control group's progress was insignificant. Initial gait speed measurements were consistent between the groups. Still, the intervention led to a marked increase in gait speed for the intervention group, with the control group showing a minor enhancement, though not significant. The de Morton Mobility Index (DEMMI) scores, which measure functional mobility, were initially similar for both groups. However, following the intervention, the treated group displayed a pronounced rise in DEMMI scores, with the control group not showing improvement.

Regarding the Timed Up and Go (TUG) times, an indicator of functional mobility and fall risk, both groups started on an even footing. However, post-intervention results revealed significant reductions in TUG times only in the intervention group, showing a more substantial decrease. The Berg Balance Scale (BBS) scores, which assess balance and fall risk, were initially aligned between the groups. After the intervention, the treated group exhibited a notable increase in BBS scores, while the control group's rise was insignificant.

Statistical analysis further emphasized the positive impact of the intervention. The intervention group displayed a significant enhancement in 6MWT performance, gait speed, and DEMMI scores compared to the control group. Additionally, the intervention led to a considerable reduction in TUG times and a marked improvement in BBS scores for the intervention group relative to the control group.

6.1.3 Fall Risk and Cognitive Function

At the outset, the intervention and control groups had similar Morse Fall Scale scores, indicating consistent fall risk levels. However, post-intervention, the group that underwent the intervention significantly reduced fall risk, while the control group's scores remained relatively unchanged. Both groups started with nearly identical scores when assessing fall efficacy using the Falls Efficacy Scale-International (FES-I) scores. However, after the intervention, the intervention group showed improvements, with the control group exhibiting no significant changes. Regarding cognitive function, as measured by the Mini-Mental State Examination (MMSE) score, both groups had comparable scores before the intervention. Following the intervention, no significant changes were observed post-intervention in either group. This indicates that while the intervention effectively addressed fall risk and efficacy, it did not significantly impact cognitive function.

6.1.4 Relationship between physical performance, cognitive function, mobility, and fear of falls

A linear regression analysis was performed to determine the influence of various factors on fall risk, as gauged by the Morse Fall Scale. The analysis revealed a mix of significant and non-significant predictors. Notably, the International Physical Activity Questionnaire (IPAQ) score, which represents physical activity levels, did not significantly predict the fear of falls. Likewise, handgrip strength, leg press strength, 6-Minute Walk Test (6MWT) outcomes, and gait speed were not influential in predicting fall risk.

On the other hand, certain factors stood out as significant in their predictive capacity. The de Morton Mobility Index (DEMMI) score was a notable predictor, suggesting that individuals with better functional mobility and independence are less prone to falls. The Timed Up and Go (TUG) time was also a crucial predictor, indicating that those with better mobility and quicker TUG times are at a reduced risk of falls. The Berg Balance Scale (BBS) score and the Falls Efficacy Scale-International (FES-I) score further emphasized the role of improved balance and confidence in preventing falls.

Interestingly, the Mini-Mental State Examination (MMSE) score, which evaluates cognitive function, was not a significant predictor. This suggests that cognitive abilities might not be pivotal in fall risk per the Morse Fall Scale. Overall, these results emphasize the multifaceted nature of factors influencing fall risk in elderly individuals. It underscores the need for a holistic approach, focusing on mobility, balance, and confidence, to devise effective fall prevention strategies.

6.2 Conclusion

The study aimed to assess the comprehensive intervention's effects on various aspects of elderly individuals' health and well-being, including physical performance, functional capacity, mobility, balance, fall risk, and cognitive function. Regarding the first objective on physical performance, baseline scores for the International Physical Activity Questionnaire (IPAQ) score, handgrip strength, and leg press strength were comparable in both intervention and control groups. However, the intervention group displayed a significant increase in post-intervention IPAQ scores, indicating improved physical activity levels compared to the control group. Similarly, the intervention group demonstrated more pronounced improvements in handgrip and leg press strength than the control group.

Regarding the second objective on functional capacity, mobility, and balance, baseline scores for measures such as the 6-Minute Walk Test (6MWT), gait speed, de Morton Mobility Index (DEMMI) score, Timed Up and Go (TUG), and Berg Balance Scale (BBS) were similar across groups. Post-intervention, the intervention group exhibited substantial enhancements in 6MWT, gait speed, DEMMI score, TUG time, and BBS score. Although the control group also improved, the gains of these measures were insignificant.

The study also explored fall risk and cognitive function in the third objective. Baseline scores in the Morse Fall Scale and Falls Efficacy Scale-International (FES-I) score were comparable between groups. Post-intervention, the intervention group demonstrated a significant reduction in fall risk and increased fall efficacy, indicating a greater confidence in avoiding falls. Conversely, the control group's fall risk and efficacy scores remained relatively unchanged. Although the Mini-Mental State Examination (MMSE) score exhibited similar baseline scores in both groups, the intervention group showed a more significant post-intervention increase than the control group. However, statistical significance was not reached.

Additionally, in the fourth objective, linear regression analyses were conducted to evaluate the predictive value of various factors on fall risk as measured by the Morse Fall Scale. Some variables, including IPAQ score, handgrip strength, leg press strength, 6MWT performance, and gait speed, were not significant predictors of fall risk. However, the de Morton Mobility Index (DEMMI) score emerged as a significant predictor, indicating that greater functional mobility and independence were associated with reduced fall risk.

Furthermore, Timed Up and Go (TUG) time, Berg Balance Scale (BBS) score, and fall efficacy Scale-International (FES-I) score were identified as significant predictors, suggesting that improved mobility, enhanced balance, and increased fall efficacy were linked to lower fall risk. The Mini-Mental State Examination (MMSE) score did not significantly predict fall risk.

In conclusion, the comprehensive intervention showcased its potential to impact various dimensions of elderly individuals' well-being positively. It improved physical performance, functional capacity, mobility, balance, fall risk reduction, and efficacy. Although cognitive function did not exhibit significant changes, the intervention's broad influence on diverse domains highlights its promise as a holistic approach to enhancing elderly individuals' quality of life. The study's findings underscore the importance of addressing multiple factors for effective fall prevention strategies in elderly populations.

6.3 Strengths of the Study

6.3.1 Comprehensive Assessment

The study employed various outcome measures, including physical performance tests, psychological scales, and functional assessments. This comprehensive approach provides a holistic understanding of the impact of interventions on elderly individuals' functional mobility and fear of falls.

6.3.1 Randomized Controlled Design

Using a randomized controlled design enhances the study's internal validity. Random assignment minimizes selection bias and allows for causal inferences about the effects of the interventions.

6.3.1 Sample Size

The study included a sufficient sample size of 30 participants per group, which enhanced the statistical power to detect significant differences between the intervention and control groups.

6.3.2 Longitudinal Analysis

By conducting pre- and post-intervention assessments, the study captured changes over time, providing insights into the effectiveness of interventions and their impact on physical performance, functional mobility, and fear of falls.

6.3.3 Covariate Control

The study controlled for relevant covariates, such as baseline scores, to isolate the effects of interventions on the outcomes. This increases the confidence in attributing observed changes to the interventions.

6.4 Recommendations

6.4.1 Recommendations for Theory

Multidimensional Approach

Theoretical frameworks in fall prevention should evolve to incorporate a multidimensional approach that addresses not only physical factors but also psychological and cognitive elements. Integrating cognitive-behavioral strategies and psychosocial support mechanisms into interventions, the effectiveness of fall prevention programs can be enhanced. This approach will also help address fear-related barriers to physical activity, contributing to both improved mobility and reduced psychological distress.

Integration of Self-Efficacy Theory

Bandura's self-efficacy theory should be more deeply integrated into fall prevention models. This theory emphasizes the importance of individuals' belief in their ability to perform tasks successfully. Fostering self-efficacy, interventions can empower elderly individuals to overcome fear of falls and engage in daily activities confidently, ultimately improving their functional mobility and reducing fall risks.

Incorporation of Resilience Theory

Resilience theory should be considered for incorporation into fall prevention frameworks to underscore the importance of psychological resilience in adapting to age-related physical and cognitive changes. Enhancing resilience through targeted interventions can foster adaptive coping mechanisms in elderly individuals, potentially reducing fear of falls and contributing to overall well-being.

6.4.2 Recommendations for Policy

Community-Based Intervention Funding

Policymakers should prioritize the allocation of resources toward community-based programs that enhance functional mobility and reduce the fear of falls among elderly populations. Collaboration with local organizations, such as community health centres, can ensure that these interventions are accessible, affordable, and tailored to the specific needs of older adults. Funding should focus on integrating evidence-based practices, such as the Lebed dance movement therapy, to promote widespread adoption.

Incentives for Healthcare Providers

Healthcare providers should be incentivized to refer elderly patients to fall prevention programs during routine check-ups. Establishing partnerships between healthcare facilities and community-based organizations, referral pathways can be strengthened, ensuring that elderly individuals receive access to interventions aimed at improving mobility and reducing fall risk.

Incorporating Fall Prevention into Elderly Care Policy:

Fall prevention strategies should be embedded in national elderly care policies, with comprehensive care plans requiring regular assessments of functional mobility, balance, and fall risk. This approach would ensure that elderly individuals receive tailored interventions as part of routine care. Such policies should mandate periodic fall risk assessments and intervention referrals to reduce fall-related injuries and improve quality of life.

6.4.2 Recommendations for Practice

Objective 1: Physical Performance

Healthcare practitioners should incorporate dance-based therapy programs, like the Lebed Method, into interventions targeting physical performance among elderly individuals. The findings from this study indicate that the intervention significantly improves physical activity levels, handgrip strength, and leg press strength, which are critical components of fall prevention. Integrating such programs into elderly care, practitioners can enhance their patients' overall physical health and functional capacity, contributing to a reduced fall risk.

Objective 2: Functional Mobility and Balance

Interventions aimed at improving functional mobility and balance should be prioritized by healthcare professionals and community program leaders. The study demonstrates that dance-based therapy interventions, like the Lebed Method, are effective in improving outcomes related to the 6-Minute Walk Test, gait speed, de Morton Mobility Index (DEMMI), Timed Up and Go (TUG) test, and Berg Balance Scale (BBS). Implementing these interventions in community settings can empower elderly individuals to maintain independence and reduce fall risk.

Objective 3: Fall Risk and Cognitive Function

Healthcare providers should adopt dance-based therapies as a means to address both fall risk and fear of falling among elderly individuals. While the Lebed Method significantly reduced fall risk, its impact on cognitive function was minimal, suggesting that cognitive-specific interventions may need to be introduced in conjunction with physical interventions. This comprehensive approach would address both the physical and cognitive dimensions of fall prevention.

Objective 4: Relationship between Physical Performance, Cognitive Function, Mobility, and Fear of Falls

It is essential for healthcare providers to emphasize the interconnectedness of physical performance, mobility, and psychological factors like fear of falls. Interventions should be designed to improve both mobility and balance, while also enhancing participants' confidence in their ability to navigate daily tasks without falling. Although cognitive function did not significantly impact fall risk in this study, including cognitive exercises in fall prevention programs can offer additional benefits for the overall well-being of elderly individuals.

6.4.3 Recommendations for Further Research

Objective 1: Physical Performance

Future research should focus on the long-term sustainability of physical performance improvements following dance-based interventions. It is important to examine whether the benefits observed in the intervention group are maintained over extended periods. This will provide valuable insights into the lasting impact of programs like the Lebed Method on elderly individuals' physical capabilities.

Objective 2: Functional Mobility and Balance

Further investigation into the specific elements of dance-based therapy that contribute most to functional mobility and balance improvements is warranted. Understanding which aspects of the intervention drive the most significant changes can help optimize the design of fall prevention programs and enhance their effectiveness.

Objective 3: Fall Risk and Cognitive Function

There is a need to explore the potential synergistic effects of combining dance-based therapies with cognitive training programs. Future studies should investigate whether addressing both physical and cognitive aspects of fall risk yields more comprehensive outcomes in fall prevention strategies.

Objective 4: Relationship between Physical Performance, Cognitive Function, Mobility, and Fear of Falls

Future research could expand on this study by exploring additional factors that influence fall risk, such as social support, psychological well-being, and environmental factors. A more nuanced understanding of the contributors to fall apprehension could inform the development of more holistic fall prevention interventions, ultimately improving the quality of life for elderly individuals.

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APPENDICES

Appendix I: Consent to participate in the research study

Title of Study: The Effectiveness of the Lebed Method Therapeutic Intervention on Intrinsic Physiological Risk Factors of Falls among Elderly Individuals in Kakamega

Purpose of the Study: The purpose of this study is to determine the effect of the Lebed method on fall risk, muscle strength, balance, and gait among elderly individuals in Kakamega.

Study Procedures: If you agree to participate in this study, you will be asked to complete the following procedures: Complete a series of questionnaires and assessments to assess your fall risk, muscle strength, balance, cognitive function, and gait. These procedures will take approximately 1 hour to complete. Participate in the Lebed method as a therapeutic intervention for 12 weeks. The intervention will involve attending sessions thrice per week for 36 sessions. Each session will last approximately 1 hour.

Benefits of the Study: It is hoped that the results of this study will provide valuable information on the effectiveness of the Lebed method as a therapeutic intervention for reducing fall risk among elderly individuals. By participating in this study, you may benefit from the improved balance, strength, and flexibility resulting from the Lebed method intervention.

Risks of the Study: There are no anticipated risks associated with participating in this study. However, as with any physical activity, there is a risk of injury. If you experience any discomfort or injury during the intervention, you may stop participating at any time.

Confidentiality: Your participation in this study will be kept confidential to the extent permitted by law. All study-related information, including your questionnaire responses and assessment results, will be kept confidential and will only be accessed by the research team.

Compensation: There is no compensation for participating in this study.

Right to Withdraw: Your participation in this study is voluntary. You may choose not to participate or withdraw from the study at any time. If you decide to withdraw from the study, there will be no penalty or loss of benefits to which you are otherwise entitled.

Contact Information: If you have any questions or concerns about this study, contact the research team (Prof Edwin Kadima Wamukoya, Prof James Aggrey Oloo and Micky Oloo) at +254712629126. If you have any concerns about your rights as a research participant, you may contact the Research Ethics Office at ierc@mmust.ac.ke.

By signing below, you acknowledge that you have read and understood the information above and agree to participate in this study.

Signature……………………......... **Date ……………………...**

Appendix II: Study questionnaire and anthropometric measurement protocol

Study Questionnaire

Socio-demographic characteristics		Tick here
Gender	Female	[ ]
	Male	[ ]
Marital Status	Divorced	[ ]
	Married	[ ]
	Widowed	[ ]
Education Level	Primary	[ ]
	Secondary	[ ]
Occupation	Business	[ ]
	Farmer	[ ]
	Housewife	[ ]
	Retired	[ ]
History of Falls	Never	[ ]
	Once	[ ]
	Twice	[ ]
Age		
Sessions attended		

NB. Sessions were only asked in the intervention group.

Measurement protocol for anthropometric variables

Variable	1st	2nd	3rd	Average
Height (cm)				
Weight (kg)				
Body mass index (BMI)				

Appendix III: Multidimensional scale of perceived social support (MSPSS) assessment protocol

Purpose: To evaluate the perception of support from three primary social sources.

Procedure:

The MSPSS comprises 12 items. For each item, respondents indicate how they feel about each statement using a 7-point Likert scale.

Table: Multidimensional Scale of Perceived Social Support (MSPSS) Assessment

Item No.	Statement	Likert Scale (1-7)
1	There is a special person who is around when I am in need.	
2	There is a particular person with whom I can share my joys and sorrows.	
3	My family tries to help me.	
4	I get the emotional help and support I need from my family.	
5	I have a particular person who is a natural comfort source.	
6	My friends try to help me.	
7	I can count on my friends when things go wrong.	
8	I can talk about my problems with my family.	
9	I have friends with whom I can share my joys and sorrows.	
10	There is a particular person in my life who cares about my feelings.	
11	My family is willing to help me make decisions.	
12	I can talk about my problems with my friends.	

Scoring:

- The Likert scale ranges from 1 (Very Strongly Disagree) to 7 (Very Strongly Agree).
- Scores for each subscale (Family, Friends, Significant Other) can be obtained by summing the scores for items related to each source. Each subscale has a maximum score of 28.
- The total score ranges from 12 (low perceived social support) to 84 (high perceived social support).

Interpretation:

- Higher scores indicate higher levels of perceived social support.
- Evaluating the subscale scores can help identify specific areas where perceived support is lacking.

Appendix IV: International Physical Activity Questionnaire (IPAQ) short form assessment protocol

Purpose: To evaluate the amount of walking, moderate, and vigorous physical activity undertaken over seven days.

Instructions: For the following questions, please consider all the vigorous, moderate, and walking activities you have done in the past seven days.

Table: Physical Activity Questions

Activity Type	Question	Response Options (Likert Scale)
Walking	Over the last seven days, how many days did you walk for at least 10 minutes at a time?	0-7 days
	How much time did you usually spend walking on one of those days?	___ hours, ___ minutes
Moderate Activities	Over the last seven days, how often did you do moderate-intensity activities like carrying light loads, cycling regularly, or doubles tennis? (Do not include walking)	0-7 days
	How much time did you usually spend doing moderate-intensity activities on one of those days?	___ hours, ___ minutes
Vigorous Activities	Over the last seven days, how many days did you do vigorous-intensity activities like heavy lifting, aerobics, or fast cycling?	0-7 days
	How much time did you usually spend doing vigorous-intensity activities on one of those days?	___ hours, ___ minutes

MET-min/week Calculation:

- Walking MET-min/week = 3.3 * (days of walking * minutes of walking/day)
- Moderate MET-min/week = 4.0 * (days of moderate activity * minutes of moderate activity/day)
- Vigorous MET-min/week = 8.0 * (days of vigorous activity * minutes of vigorous activity/day)
- Total MET-min/week = Sum of walking, moderate, and vigorous MET-min/week values

Appendix V: 6-Minute Walk Test (6mwt) Assessment Protocol

Purpose: To assess the aerobic capacity and endurance of an individual.

Equipment:

- A flat, straight walking path, ideally indoors, is at least 25-30 meters long.
- Stopwatch or a timer.
- Cones or markers to indicate turnaround points.
- Chairs are placed along the path for resting if needed.
- Measuring tape to measure the walking distance if not predefined.
- Record sheet or clipboard to record data.

Instructions for the Participant:

1. You will walk back and forth along this path for 6 minutes, walking as far as you can.
2. You can slow down, stop, and rest if necessary, but you should resume walking as soon as possible.
3. We'll keep track of the time and inform you about the remaining time at regular intervals.
4. Try to cover as much distance as possible in the 6 minutes.

Procedure:

1. Explain the test procedures to the participant.
2. Ensure that the participant is wearing comfortable clothing and appropriate footwear.
3. Start the stopwatch once the participant begins walking.
4. Notify the participant every minute or at predefined intervals.
5. If the participant stops, record the time and encourage them to start again as soon as possible.
6. At the end of 6 minutes, instruct the participant to stop immediately.
7. Measure the total distance covered by the participant in meters.

Table: 6MWT Recording Sheet

Time (Minutes)	Distance Covered (Meters)	Notes (e.g., rest duration, observations)
1		
2		
3		
4		
5		
6 (Final)		

Notes:

- It is essential to ensure that the participant is safe during the test. Medical clearance might be necessary for individuals with specific health conditions.
- It is advisable to have oxygen and medical equipment available if testing is done on individuals with known respiratory or cardiac conditions.
- Always compare the results to normative values or previous tests for the individual for accurate interpretation.
- Make sure to provide feedback to the participant after the test.

Appendix VI: Gait Speed Assessment Protocol

Purpose: To assess the speed at which an individual walks over a short distance, a proxy for overall health and functional ability.

Equipment:

- A flat, straight walking path, typically 10 meters in length, with an additional 2 meters on either end for acceleration and deceleration.
- Stopwatch or a timer.
- Cones or markers to indicate the start and stop points.
- Measuring tape to measure the walking distance if not predefined.
- Record sheet or clipboard to record data.

Instructions for the Participant:

1. "You'll walk at your usual pace from the start to end."
2. "Start walking from before the start line and keep walking past the end line. This helps to ensure that you are walking at your usual pace when you cross the measurement area."
3. "Walk as you would normally like you are walking to the store or a friend's house."

Procedure:

1. Measure and mark a straight 10-meter path. It's beneficial to have an additional 2 meters on either end for acceleration and deceleration, but only the middle 10 meters will be timed.
2. Explain the test procedures to the participant.
3. Ensure the participant is in a position to start the walk, standing still just before the starting line.
4. Start the stopwatch as the participant's foot crosses the starting line.
5. Stop the stopwatch as the participant's foot crosses the finish line.
6. Record the time taken to walk the 10-meter distance.
7. Calculate gait speed using the formula:
   Gait Speed=Distance (meters)/Time (seconds)

Table: Gait Speed Recording Sheet

Trial	Time Taken (seconds)	Gait Speed (m/s)
1		
2		
3		
Average		

Notes:

- Typically, the test is repeated two or three times, and an average is taken to ensure consistency.

Appendix VII: DEMMI Score Assessment Protocol

Purpose: To evaluate mobility in elderly individuals, encompassing a range of functions from bed-bound conditions to independent walking.

Equipment:

- A standard hospital bed.
- A chair without arms.
- Stopwatch or a timer.
- A walking aid if the patient uses one.
- A marking tape.
- Measuring tape.

Instructions for the Participant: Inform the participant that you will ask them to perform various mobility tasks to understand their mobility level.

Table: DEMMI Score Assessment

Item No.	Task	Description	Score
Bed Tasks			
1	Bridging	Ability to lift the pelvis off the bed	0-2
2	Rolling	Ability to roll to both sides	0-2
3	Supine to Side-lying	The transition from lying on your back to lying on the side	0-1
4	Static Balance (Lying)	Holding a side-lying position	0-1
Chair Tasks			
5	Sit to Stand	Ability to rise from a chair	0-2
6	Chair Sit Unsupported	Maintaining a sitting position without using hands for support	0-1
Static Standing Tasks			
7	Stand Unsupported	Maintaining a standing position without support	0-2
8	Tandem Standing	Standing with one foot directly in front of the other	0-1
Dynamic Standing Tasks			
9	Standing with Movement	Shifting weight side to side without stepping	0-1
10	Step Up	Stepping up onto a standard step	0-1
11	Heel Walking	Walking on heels only	0-1
12	Jump	Ability to jump (both feet leaving the ground)	0-1
13	Hopping	Hopping on one foot	0-1
Walking Tasks			
14	Walking Speed	Time taken to walk 3 meters	0-2

15	Tandem Walking	Walking with one foot placed directly in front of the other	0-1

Scoring:

- Total DEMMI scores range from 0 to 100.
- Each item score is determined by the patient's performance, following specific criteria.
- The raw scores from the 15 items are transformed into an interval-level total score using a conversion table.

Notes:

- Before the assessment, ensure the safety of the environment and the patient. Remove any potential hazards.
- Be ready to assist or support the patient during tasks to prevent falls or injury.
- It is essential to use the detailed DEMMI scoring guide and conversion table to ensure accurate scoring.
- The DEMMI can help guide interventions and monitor changes in mobility over time.

Higher scores indicate better mobility when interpreting the DEMMI score.

Appendix VII: Timed Up and Go (TUG) Assessment Protocol

Purpose: To evaluate functional mobility, balance, and the risk of falling.

Equipment:

- A standard armchair (seat height of about 46 cm or 18 inches).
- A marked line on the floor 3 meters (about 10 feet) away from the chair.
- Stopwatch or a timer.
- Record sheet or clipboard to record data.

Instructions for the Participant:

1. "You will start by sitting back in the chair."
2. "On the command 'Go,' stand up from the chair, walk to the line on the floor at your normal pace, turn around, walk back to the chair, and sit down."
3. "Try to walk at a comfortable and safe pace."

Procedure:

1. Have the participant sit in the chair with their back against the chair back. They should keep their arms resting on the armrests.
2. Explain the test procedures to the participant.
3. Start the stopwatch with the command "Go."
4. The participant will then stand up from the chair, walk to the 3-meter mark, turn around, return to the chair, and sit down.
5. Stop the stopwatch when the participant is seated, and their back is against the chair again.
6. Record the time taken.

Table: TUG Recording Sheet

Trial	Time Taken (seconds)
1	
2	
3	
Average	

Notes:

- The test is typically performed three times, with the average time taken across the trials being used for analysis.
- Times more significant than 12-14 seconds in elderly individuals might indicate an increased fall risk.

- Ensure the test environment is free from any obstacles or hazards.
- Stand close to the participant during the test to assist if they seem unsteady or at risk of falling.

Appendix IX: Berg Balance Scale (BBS) Assessment Protocol

Purpose: To evaluate static and dynamic balance capabilities and predict the risk of falling.

Equipment:

- A standard chair with armrests.
- A ruler or stick (to measure knee height).
- Stopwatch or timer.
- A step or stool.
- Marked area on the floor.
- Record sheet or clipboard.

Procedure:

Each of the 14 tasks in the BBS is scored on a scale from 0 to 4, with 0 indicating the lowest level of function and four the highest. The maximum score possible is 56.

Table: Berg Balance Scale (BBS) Assessment

Item No.	Task	Description	Score (0-4)
1	Sitting to Standing	Ability to stand up from a sitting position without using hands	
2	Standing Unsupported	Maintaining a standing position for 2 minutes without support	
3	Sitting Unsupported	Sitting without hand support for 2 minutes	
4	Standing to Sitting	Ability to sit down from a standing position	
5	Transfers	Ability to transfer safely between chair and bed or wheelchair	
6	Standing with Eyes Closed	Maintaining a standing position with eyes closed	
7	Standing with Feet Together	Standing with feet together without support	
8	Reaching Forward	Extending arms and going forward while standing	
9	Retrieving Objects from Floor	Bending and picking up an object from the floor	
10	Turning to Look Behind	Turning to look over shoulders while standing	
11	Turning 360 Degrees	Ability to turn around in a full circle safely	
12	Placing Alternate Foot on Step	Stepping up and down a stool or step	
13	Standing with One Foot in Front	Tandem standing without support	
14	Standing on One Foot	Balancing while standing on one foot	

Scoring:

- 0 = cannot perform.

- 1 = performs with maximum assistance.
- 2 = performs with minimal assistance.
- 3 = performs with verbal cueing or supervision.
- 4 = performs independently.

Interpretation:

- Scores between 41-56: Low fall risk.
- Scores between 21-40: Medium fall risk.
- Scores 0-20: High fall risk.

Notes:

- It is essential to provide a safe environment for the assessment. Make sure to remove any potential hazards.
- Stay close to the participant during the test to assist if needed.
- It is crucial to ensure the participant understands each task before attempting it.
- Consider the patient's overall health, physical condition, and other evaluations for accurate interpretation.

Appendix X: Morse Fall Scale (MFS) Assessment Protocol

Purpose: To predict a patient's risk of falling based on certain risk factors.

Procedure:

Assess and score the patient based on the following variables:

Table: Morse Fall Scale (MFS) Assessment

Variable	Description	Score
1	**History of Falling:**	
	Immediate or within the last three months	25
	No history	0
2	**Secondary Diagnosis:**	
	More than one medical diagnosis	15
	Only one diagnosis	0
3	**Ambulatory Aid:**	
	Bed rest, nurse assist	0
	Crutches, cane, walker	15
	Furniture	30
4	**IV/Heparin Lock:**	
	Yes	20
	No	0
5	**Gait:**	
	Normal/Bedrest/Immobile	0
	Weak	10
	Impaired	20
6	**Mental Status:**	
	Oriented to own ability	0
	Forgets limitations	15

Interpretation:

- Total the scores for all variables.
- **Score < 25:** Low risk.
- **Score 25 - 44:** Moderate risk.
- **Score ≥ 45:** High risk.

Notes:

- When interpreting the score, it is essential to consider the patient's current medical conditions, medications, and overall health.
- Regular reassessment is crucial, especially after a change in the patient's condition or treatment.

Appendix XI: Falls Efficacy Scale-International (FES-I) Assessment Protocol

Purpose: To gauge the level of concern an individual has about falling when performing certain daily activities.

Procedure:

The FES-I comprises 16 items, each detailing an everyday activity. For each activity, the participant is asked to rate their concern about falling while doing that activity.

Table: Falls Efficacy Scale-International (FES-I) Assessment

Item No.	Activity	Level of Concern (1-4)
1	Cleaning the house	
2	Getting dressed or undressed	
3	Preparing simple meals	
4	Taking a bath or shower	
5	Going to the shop	
6	Getting in or out of a chair	
7	Going up or down stairs	
8	Walking around the neighbourhood	
9	Reaching for something above your head or on the ground	
10	Going out to a social event	
11	Walking on a slippery surface	
12	Walking in a place with crowds	
13	Walking on an uneven surface	
14	Walking up or down a slope	
15	Going out when it is windy or stormy	
16	Walking on other surfaces	

Scoring:

- For each activity, the individual rates their level of concern using the following scale: 4 = Not at all concerned 3 = Somewhat concerned 2 = Fairly concerned 1 = Very concerned
- The total score is calculated by summing the scores for all 16 items.
- The minimum possible score is 16 (very concerned about falling in all situations), and the maximum score is 64 (no concern about falling).

Interpretation:

- A higher score suggests no concern about falling during daily activities.

Notes:

- When interpreting the FES-I score, it is essential to consider the overall health, recent fall history, and other contextual factors.
- The FES-I can be a helpful tool to identify individuals who might benefit from interventions to reduce fear of falling and improve confidence in daily activities.

Appendix XII: Mini-Mental State Examination (MMSE) Assessment Protocol

Purpose: To screen for cognitive impairments and monitor mental changes over time.

Procedure:

The MMSE consists of questions and tasks grouped into different sections. The total possible score is 30 points.

Table: Mini-Mental State Examination (MMSE) Assessment

Item No.	Task/Question	Maximum Score
1	**Orientation to Time:** Date, day of the week, month, year, season	5
2	**Orientation to Place:** Identification of state, county, town, building, floor	5
3	**Registration:** Naming three objects and then recalling them	3
4	**Attention and Calculation:** Serial 7s subtraction from 100 or spell "world" backwards	5
5	**Recall:** Remembering the three objects from the Registration section	3
6	**Naming:** Naming two familiar objects (e.g., pencil, watch)	2
7	**Repetition:** Repeating a specific sentence	1
8	**Three-Stage Command:** Performing three actions upon command (e.g., "Take this paper in your right hand, fold it in half, and put it on the floor.")	3
9	**Reading:** Reading and obeying a command written on paper	1
10	**Writing:** Writing a complete sentence	1
11	**Drawing:** Copying a design of intersecting pentagons	1

Scoring:

- A total score of 30 indicates no cognitive impairment.
- Typically, scores below 24 suggest potential cognitive impairment, but this threshold can vary.

Interpretation:

- **24-30:** Normal cognition
- **18-23:** Mild cognitive impairment
- **0-17:** Severe cognitive impairment

Notes:

- The MMSE is a screening tool and does not diagnose dementia or any other cognitive disorders. A thorough evaluation is needed for a definitive diagnosis.
- The MMSE may not be sensitive to detect mild cognitive impairments or changes in individuals with high educational levels.

Appendix XIII: Protocol For Measuring Hand Grip Strength

Objective: To assess hand grip strength using a hand dynamometer.

Materials Needed:

1. Hand dynamometer (adjustable or fixed)
2. Chair without armrests
3. Stopwatch or timer
4. Data recording sheet (see table below)

Procedure:

1. Explain the purpose and procedure to the participant.
2. Ensure the participant is comfortably seated on a chair without armrests.
3. Adjust the hand dynamometer, if applicable, according to the participant's hand size.
4. Instruct the participant to hold the dynamometer with the tested hand, ensuring a 90-degree angle at the elbow.
5. The participant should keep their arm close to their body, with the wrist in a neutral position (not flexed or extended).
6. When ready, ask the participant to squeeze the dynamometer with maximal effort for about 3-5 seconds.
7. Record the maximum grip strength in kilograms (kg) or pounds (lbs) displayed on the dynamometer.
8. Allow the participant to rest for a minute before repeating the measurement.
9. Repeat the measurement twice for the same hand, allowing brief rests in between.
10. Calculate the average grip strength of the three trials for that hand.

Table for Recording Hand Grip Strength Measurements

Participant ID	Hand Tested (Left/Right)	Trial 1 (kg/lbs)	Trial 2 (kg/lbs)	Trial 3 (kg/lbs)	Average Grip Strength (kg/lbs)
001	Left				
001	Right				
Total average					

Notes:

- Ensure that the participant is not holding their breath during the measurement.

- Use the same hand dynamometer for all participants to maintain consistency.
- Record the measurements in either kilograms (kg) or pounds (lbs), and be consistent in your choice throughout the study.

Appendix XIV: Protocol For Measuring Leg Strength

Objective: To assess leg strength using the leg press exercise.

Materials Needed:

1. Leg press machine with adjustable weights
2. Chair for the participant to sit during setup
3. Stopwatch or timer
4. Data recording sheet (see table below)

Procedure:

1. Explain the purpose and procedure to the participant.
2. Ensure the participant is comfortably seated on a chair beside the leg press machine.
3. Adjust the leg press machine settings (e.g., seat position and weight) according to the participant's comfort and ability. Ensure the participant's knees are at approximately 90-degree angles when seated.
4. Instruct the participant to place their feet shoulder-width apart on the leg press platform.
5. Explain that they should push the platform forward with their legs as forcefully as possible.
6. When ready, ask the participant to push the platform maximally for about 3-5 seconds.
7. Record the maximum leg press strength in kilograms (kg) or pounds (lbs) displayed on the machine.
8. Allow the participant to rest for a minute before repeating the measurement.
9. Repeat the measurement twice for the same leg, allowing brief rests in between.
10. Calculate the average leg press strength of the three trials for that leg.

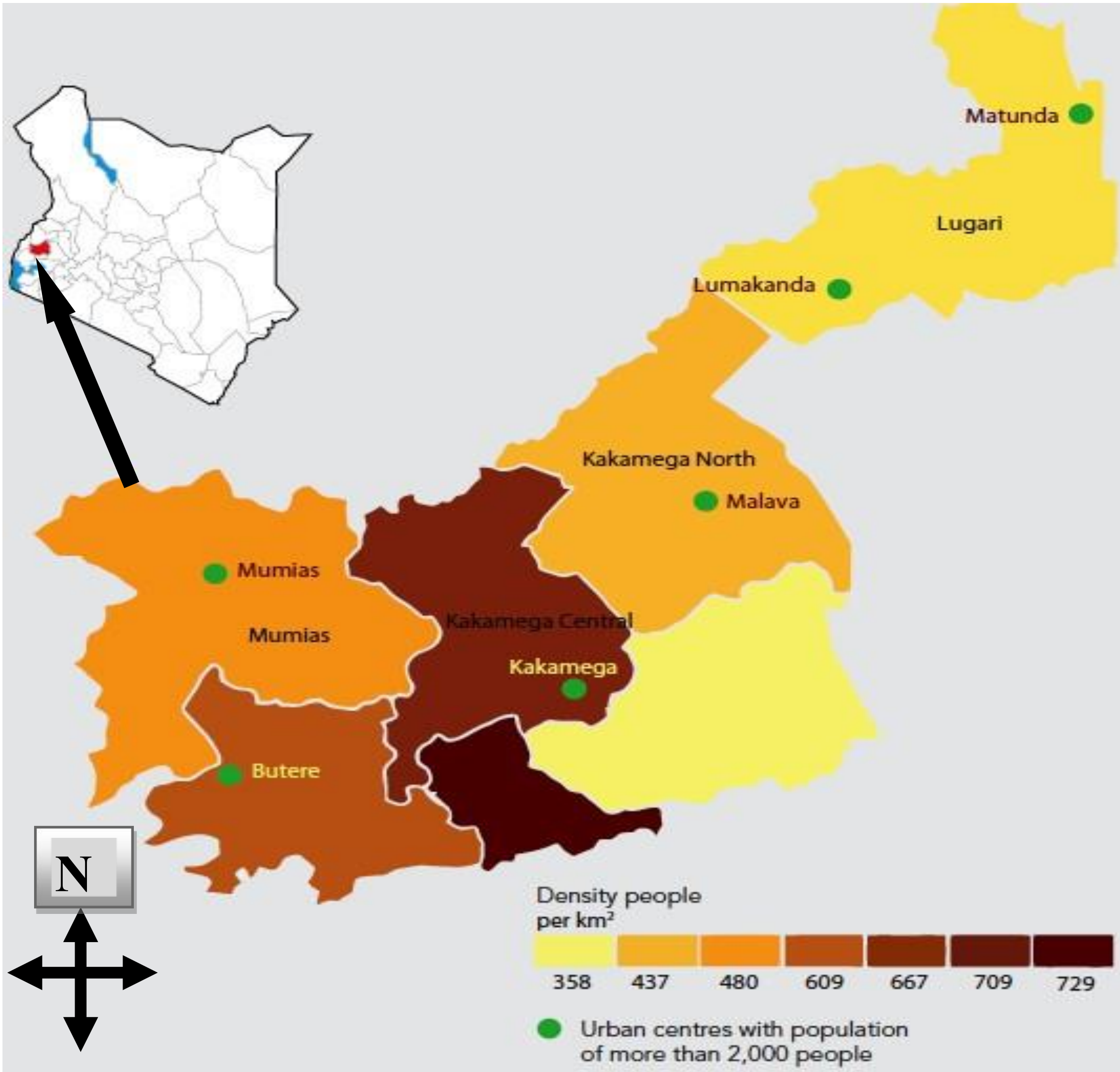
Table for Recording Leg Press Strength Measurements

Participant ID	Leg Tested (Left/Right)	Trial 1 (kg/lbs)	Trial 2 (kg/lbs)	Trial 3 (kg/lbs)	Average Leg Press Strength (kg/lbs)
001	Left				
001	Right				
Total average					

Notes:

- Ensure that the participant maintains proper form during the leg press exercise.
- Use the same leg press machine and settings for all participants to maintain consistency.
- Record the measurements in either kilograms (kg) or pounds (lbs), and be consistent in your choice throughout the study.

Appendix XV: Kakamega County Map



Source: *Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID) (2017):* Exploring Kenya's Inequality, pooling apart or pulling together.

Appendix XVI: University Approval

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

Tel: 056-30870
Fax: 056-30153
E-mail: directordps@mmust.ac.ke
Website: www.mmust.ac.ke

P.O Box 190
Kakamega – 50100
Kenya

Directorate of Postgraduate Studies

Ref: MMU/COR: 509099

4th October 2022

Micky Olutende Oloo
HHP/01-53217/2018
P.O. Box 190-50100,
KAKAMEGA.

Dear Mr. Oloo

RE: APPROVAL OF PROPOSAL

I am pleased to inform you that the Directorate of Postgraduate Studies has considered and approved your PhD Proposal entitled: "***Effectiveness of Lebed Method as a Therapeutic Intervention on Intrinsic Physiological Risk Factors of Falls Among Elderly Individuals in Kakamega***" and appointed the following as supervisors:

1. Prof. Edwin Kadima Wamukoya - MMUST
2. Prof. James Aggrey Oloo - MMUST

You are required to submit through your supervisor(s) progress reports every three months to the Director Postgraduate Studies. Such reports should be copied to the following: Chairman, School of Public Health, Biomedical Sciences and Technology Graduate Studies Committee and Chairman, Medical Laboratory Sciences Department. Kindly adhere to research ethics consideration in conducting research

It is the policy and regulations of the University that you observe a deadline of three years from the date of registration to complete your PhD thesis. Do not hesitate to consult this office in case of any problem encountered in the course of your work.

We wish you the best in your research and hope the study will make original contribution to knowledge.

Yours sincerely

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY
DIRECTORATE OF POSTGRADUATE STUDIES
P O Box 190 - 50100, KAKAMEGA (K)
Sign:......................

Prof. Stephen O. Odebero, PhD, FIEEP
DIRECTOR, DIRECTORATE OF POSTGRADUATE STUDIES

Appendix XVII: NACOSTI Approval

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 856318

Date of Issue: 08/December/2022

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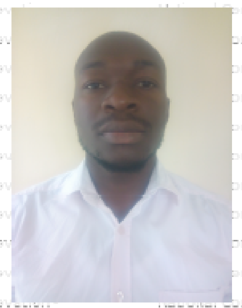

This is to Certify that Mr.. micky Olutende oloo of Masinde Muliro University of Science and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kakamega on the topic: EFFECTIVENESS OF LEBED METHOD AS A THERAPEUTIC INTERVENTION ON INTRINSIC PHYSIOLOGICAL RISK FACTORS OF FALLS AMONG ELDERLY INDIVIDUALS IN KAKAMEGA for the period ending : 08/December/2023.

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