International Egyptian Journal of Nursing Sciences and Research (IEJNSR

Original Article

Effect of Combined Cognitive and Motor Intervention on Muscles Strength, Balance and Daily Activities among Elderly at Risk for Falls

Amal H. Mohamed[1], Fayza M. Mohammed[2], Amira A. El-Houfey[2], Soher Ahmed Awad[3], Aml S. Abdelbaky[4]

[1] Assistant. Prof. of Community Health Nursing, Faculty of Nursing, Minia University, Minia, Egypt.

[2] Assistant. Prof. of Community Health Nursing, Faculty of Nursing, Assuit University, Assiut Egypt.

[3] Lecturer of Gerontological Nursing, Faculty of Nursing, Assuit University, Assiut, Egypt.

[4] Lecturer of Medical Surgical Nursing, Faculty of Nursing, Minia University, Minia, Egypt.

ABSTRACT

Background: One in three seniors falls at least once a year, making falls a serious public health concern. Increased mortality, injuries, loss of independence, and unfavorable psychosocial effects are all linked to falls. **Aim of the study**: To evaluate the effect of combined cognitive and motor interventions on muscle strength, balance, and daily activities among elderly people at risk for falls. **Subjects and method: Design:** A quasi-experimental study (study/control) was used in the current study. **Setting:** the study conducted at six geriatric homes at Minia governorate. **Subject:** total coverage of the elderly at selected places was comprised in the study**. Tools of data collection: Four tools** were used to gather data for this study**:** Structured interviewing sheet; Medical Research Council Scale for Muscle Strength and Berg Balance Scale and The Katz Activities of Daily Living. **Results:** It was found that, combined cognitive & motor exercises group had the highest scores for muscle strength, maintain balance, and becoming independently in performing activity of daily living (ADLs) post 24-week of exercises, compared with the control group. **Conclusion:** Combined cognitive and motor exercise interventions had an adequate influence on the improvement of balance, gait, activity of daily living, and muscle strength in the upper and lower limbs and decreased the risk of falling compared to motor intervention alone. **Recommendation:** Health education among elderly about the effects of combined and cognitive training exercises on balance, muscle strength, and activities of daily living through effective teaching media such as videos, role play, and demonstration.

Keywords: Balance, Cognitive, Daily living activities, Falls, Muscle Strength

Introduction:

Falls is a common and serious clinical issue that could have serious repercussions. Each year, 20 to 30 percent of elderly people are said to fall. All falls are known to be indicators of further falls; they can cause fear of falling and limit a person's daily living activities. In geriatric medicine, falls are viewed as a condition with numerous contributing factors (**Span et al., 2022**).

Falls are the second leading cause of unintentional injury deaths world-wide. Each year an estimated number 684 000 individuals die from falls globally of which over 80% are in low- and middle-income countries. Adults older than 60 years of age suffer the greatest number of fatal falls. more than thirty seven million falls that are severe enough to require medical attention occur each year **(WHO, 2023; Phirom et al., 2020**).

The impact of falls is anticipated to increase with an ageing population, placing more burdensome demands on the health system. Additionally, there is a significant financial and social cost associated with falls, such as mobility-related impairment and loss of independence. When compared to the general older adult population, people with only mild cognitive impairment fall at a significantly higher rate, indicating that falls are more than just a motor issue**. (Span et al., 2022)**.

The deterioration of motor and cognitive functions can be slowed down by appropriate training, whether it is motor or cognitive training **(Rieker, 2022).** According to prior research, physical and cognitive training together significantly improves one's physical and/or cognitive function (**Eggenberger et al., 2020).** Additionally, a few studies have indicated that combined physical-cognitive training outperforms each type of training alone in terms of cognitive and physical performance. A sign of the synergistic effects of the combined training is provided by **Rieker et al. (2022)**.

Motor training for balance and strength appears to be the only intervention program that lowers both the number of fallers and the number of falls among community members when it comes to fall prevention methods. Offering challenging balancing exercises seems to be useful in reducing falls. Through its positive impact on cognitive ability, physical exercise also has a secondary effect on preventing falls. Changing household risks, especially in high-risk populations, adjusting medications, and performing a few surgical procedures, such as pacemaker and cataract surgery, are additional useful strategies. Recent studies have also shown that cognitive training is effective in preventing falls.

Nurses play significant role in offering instruction to improve executive function and gait. Additionally, employing information and communication technologies (ICT) and a mix of motor and cognitive training improves physical function in the elderly (**Span et al., 2022).**

Significance of the Study:

According to the World Health Organization's (WHO) global report on health prevention, aged adults frequently experience a decline in muscle strength that could affect their ability to balance. Additionally, 100% of the data from the 17 control trials for elderly people conducted globally by the WHO revealed that people with muscle weakness and poor balance are five times more likely to fall **(WHO, 2018).** Additionally, according to the

WHO, of the elderly who fell, 25% had issues with their lower limbs, and 17% had balance problems and/or frailty, which came in second to the causes of falls or environmental causes (**Fernando, 2019).** The world faces a problem with the ageing population; in Egypt, the proportion of older persons was 6.9% in 2015 and it increased to 9.2% by 2021, and in 2050, it's predicted to rise to 20.8%. This implies that at that time, about 20 million Egyptians will be elderly. In Egypt, falls among the elderly are thought to occur 33.3% of the time. Geriatric falls, which are frequent causes of illness and mortality, loss of independence, and poor quality of life, are among the most prevalent and important public health issues. The Centre for Disease Control and Prevention (CDC) say that every year, one in three persons 65 and older experience falls (**Abd El Hamied et al., 2023, CDC, 2022 and Ismail et al., 2018).**

Aim of The study

The current research aimed to evaluate the effect of combined cognitive and motor interventions on muscle strength, balance, and daily activities among elderly people at risk for falls.

Research Hypotheses:

The following research hypotheses were devel oped in order to achieve the goal of the current study:

Null Hypothesis: Application of motor and cognitive exercises is expected to be not having effect on improving muscle strength, balance and activities of daily living among elderly people at risk for falls.

H1: The muscle strength of the study participants who received combined cognitive and physical training is expected to be increased better than physical training group alone and control group.

H2: The balance of study subjects who received combined cognitive and physical training is expected to be better than physical training group only and control group.

Subjects and method:

Research design: -

The current study employed a quasi-experimental study design (study/control); this form of research methodology involve one or more group subjects monitored before and after the implementation of an intervention, and was pertinent to the nature of the problem under examination.

Setting:

In Minia governorate there are six geriatric homes. These settings provide many services which include medical assistance including assistance with managing medications, wound care, and monitoring of chronic conditions such as diabetes or heart disease. Also; provide meals and snacks to their residents, with an emphasis on balanced nutrition, and have a choice of meals or may be served a set menu. In addition to social activities which involve games, crafts, and outings. These activities are designed to promote physical health, cognitive function, or socialization with other residents. The current study was carried out at all six geriatric homes.

Subject:

The study population comprised total coverage of the elderly in all geriatric homes at Minia governorate. The total number of elderly in six geriatric homes (291 clients) were selected, 14 clients were excluded from total number because they had exclusion criteria so; the actual study sample became (277 elderly clients), male and female. Which classified into three groups (93 participants) in the combined intervention group, (92 participants) in control and (92) in physical intervention groups were recruited.

Eligible participants: senior citizens who could move safely in different directions without assistance for at least 10 meters.

Exclusion criteria:

Major cognitive impairment, depressive symptoms, neurological disease history, any health issues impacting stepping ability (such as acute painful joint inflammation, mobility limitation), or other unstable medical conditions that prevent exercising were also considered.

Tools for data collection:

Four tools were used to gather data of this study was selected after reviewing relevant literature.

First tool: Structured interviewing sheet: it included personal characteristics of participants as age, sex, level of education etc.

Second tool: The Medical Research Council (MRC) Scale for Muscle Strength: It is a widely used scale for evaluating senior individuals' muscle strength. The Medical Research Council first characterized it in 1943. The MRC scale of muscular strength rates the ability of a specific muscle group in relation to the mobility of a single joint on a scale of 0 to 5. The score varied from 60 (normal) to 0 (quadriplegic), and it was determined by adding the MRC scores from six muscles in the upper and lower limbs on both sides (upper arm abductors, elbow flexors, wrist extensors, hip flexors, knee extensors, and foot dorsal flexors). Each of the six muscular groups is scored on a scale of 0 to 5 after being assessed bilaterally **(O'Neill et al., 2017).**

Scoring system of MRC scale for muscle strength (0-5) as follow

Grade5: represent normal; **grade4:** represent movement against gravity and resistance; **grade3:** represents movement against gravity over (almost) the full range; **grade2:** movement of the limb but not against gravity; **grade1:** visible contraction without movement of the limb (not existent for hip flexion) and finally **grade0:** indicate no visible contraction MRC grade for each muscle given in full numbers: (4+/4.5 =4) (4- =3) (5- = 4

Third tool: Berg Balance Scale (BBS): It is used to objectively determine a patient's ability (or inability) to safely balance during a series of predetermined tasks. It is a 14 item list with each item consisting of a five-point ordinal scale ranging from 0 to 4, with 0 indicating the lowest level of function and 4 the highest level of function and takes approximately 20 minutes to complete. It does not include the assessment of gait **(Patterson et al., 2017).**

Scoring system: The overall score is between 0 and 56. A score of 56 indicates functional balance. A score of < 45 indicates individuals may be at greater risk of falling. The results of the Berg balance scale were interpreted as follows:

- 0 to 20: this means there is an impairment of balance and having a high risk of fall
- 21 to 40: this means acceptable balance performance, and need some type of walking assistance, such as a cane or a walker.
- 41 to 56: this means good balance performance, considered independent and should be able to move around safely without assistance.

Fourth tool: The Katz Activities of Daily Living (ADL) scale; (Katz., 1970)

The Katz Activities of Daily Living (ADL) scale is a widely used graded instrument that assesses six primary and psychosocial functions: bathing, dressing, going to toilet, transferring, feeding, and continence. Katz and collaborators found that these six activities have a hierarchical order in which the most complex functions are lost first. The instrument was originally developed as a measure of function to be used in objective evaluations of chronically ill and aging populations and is now used to evaluate a wide range of groups and settings.

0 = Independent in all six functions (bathing, dressing, feeding, continence, transfer, toileting) 1 = Independent in five functions and dependent in one function 2 = Independent in four functions and dependent in two functions 3 = Independent in three functions and dependent in three functions 4 = Independent in two functions and dependent in four functions 5 = Independent in one function and dependent in five functions 6 = Dependent in all six functions

Validity of the tools:

Tools were examined and reappraised by a panel of 5 experts in the field of geriatric nursing, community health nursing, and medical surgical nursing. The panel reviewed the instruments for clarity, relevance, comprehensiveness, understanding and applicability. Minor changes, such as the rephrasing and rearrangement of some sentences, had been made based on the views and recommendations of experts.

Reliability: The Cronbach's alpha coefficient was used to evaluate the interview questionnaire's internal consistency. The value of Cronbach's alpha was 0.92, 0.97, and 0.88 respectively for The Medical Research Council (MRC) Scale, Berg Balance Scale, and The Katz Activities of Daily Living

Method:

1. Administrative phase:

An official letter approval was obtained from the dean of faculty of Nursing, Minia University to the directors of selected geriatric homes at Minia governorate to carry out the study.

- **Pilot Study:**

A pilot study was conducted to test the tools applicability and feasibility of the study on 10 %(27) elderly people who were included in the current study as no modifications were done.

2. Data collection phase:

Ethical Consideration:

Research proposal was accepted from the ethical committee in Faculty of Nursing; Minia University. There was no risk for study subjects during application of research, the study followed the common ethical principles in clinical research, Informed consent was obtained from participants that were participated in the study after explaining the nature and purpose of the study, Confidentiality and anonymity was assured and study participants have the right to refuse to participate or withdraw from the study.

3. Phases of the intervention program:

Phase I: Preparatory and planning phase:

A thorough examination of the prior and recent literature in the field of the study under consideration using books and pertinent articles to get a complete picture of all factors linked to the research issue. Prior to data collection, the researchers made a site visit to the chosen venue to plan and arrange the processes for recruiting, data collecting, determine place for theoretical and exercises intervention. This stage helped with the direction, planning, and creation of the study's nursing protocol.

Implementation phase: intervention program divided into two parts

Part one (theoretical session) in which researchers started with providing information about the importance of physical activity and cognitive training for the elderly and their caregivers. Intervention had been performed under supervision of the researchers to ensure proper guidance, close monitoring and safety in the performance of the activities. Both motor exercises as well as, combined motor and cognitive training groups were given a booklet containing exercise instructions with illustrations in a simple Arabic language to help them remember the exercise routines and encourage them to perform the exercises at home, as well as for additional information and reference. Also, the control group received the same booklet given to the first and second groups after finishing the data collection period. Throughout the six months' study, strength, balance and walking exercises as well as cognitive training performed once a day for each participant. The studied participants divided into 6 group each group ranged from 28 to 31 elderly according to their number available in selected nursing home the researchers met the elderly (three days per week).

Part two (Demonstration and re-demonstration about exercise) which included strength, balance and walking exercises as well as, the cognitive training.

Motor exercise group: Each elderly person in the exercise group had been performed a series of motor exercises started with 5–10 minutes of warm-up exercises including marching arms and marching legs exercises, followed by 60 minutes of multicomponent exercise program as scheduled below in the strength and balance exercises tables. Exercises ended with 5–10 minutes of cool down including marching arms and marching legs exercises. A rest period was provided whenever necessary.

Combined motor and cognitive training group: Each elderly person in this group perform the same motor exercises mentioned before in motor exercise group, in addition to, cognitive training which involved guided practice on a set of specific tasks designed to solicit targeted cognitive functions.

Control group: Elderly people in the control group were observed and assessed for their usual daily routine using the three study tools and after finishing data collection.

Warm up exercises (5 minutes) before the basic exercises were performed to prepare the body for exercise and reduce the likelihood of injury. These included marching arms and marching legs.		
Strength exercises		
Exercise	**Duration**	**Frequency**
Sit-to-Stand Exercise	Perform 10 repetitions	once a day
Mini-squats	Repeat for about 1 minute.	once a day
Knee Extensors (front of thigh)	Hold for 5-10 seconds.	once a day
Hip extensors (back of the hip)	Hold for 5-10 seconds.	once a day
Knee flexors (back of the thigh	Hold for 5-10 seconds.	once a day
Wall push-ups	Repeat up to 10 times	once a day
Walking over 10 meter forward-backward, sideways and turning figure of 8 walking twice a day.		

Balance exercises		
Exercise	**Duration**	**Frequency**
Single leg exercise	Hold for 10 to 15 seconds on each leg	once a day
Foot taps to step	Perform 10 repetitions on each leg	once a day
Narrow Stance Reaches	Perform 10 reaches with each arm.	once a day
Cool down exercises: repeat marching arms and legs exercises for 5 minutes.		
Cognitive training: it was performed for 30 minutes and included count money, name pictures, repeat a pattern, remember pictures in order (n-back), arranging items in an alternating pattern or from smallest to greatest. Dot copying; copying a drawing (of a pyramid, cylinder, or home). Calculation of allowance, costs, and modifications.		

Evaluation phase:

Three measurements were made using the same study scale: once at the baseline, once throughout the 12-week intervention, and once at the end of the intervention at six months. The amount of falls that elderly people encounter was utilized to gauge how effective preventive exercises were.

Field work:

Data were gathered along six-month period starting in October 2022 and ending in March 2023. The researchers interviewed with the participant and his/ her care givers using the study's data collection tools.

Statistical analysis:

The statistical software for social sciences (SPSS) version 22 was used to arrange, classify, and analyze the collected data. For qualitative and quantitative variables, respectively, the mean and standard deviations of the data were reported using descriptive statistics. The ANOVA-test, repeated measures ANOVA, chi-square test, and correlation r-test were the statistical tests that were employed. When the p-value was less than 0.05, high significance was assumed, and when the p-value was greater than 0.05, no statistical significance difference was taken into account.

Results

Table (1): show that 44.5%, 48.9%, 50.5% respectively of the three study groups their mean ages were (67.2±6.4), (69.8±5.4), and (70.2±4.9) respectively. Concerning to gender, it was observed that, 53.3%, 50 % & 49.7 % respectively of these groups were female, and 50 %, 47.8 %, 44.1 % respectively of them were basic education. No statistically significant differences were found for these characteristics among the groups.

Figure (1): Illustrates that 33.6%, 35.8% and 46.2% respectively of study groups have weak balance state and were a high risk of falls at base line assessment, While, Post 24-week of intervention, it was noticed that 79.3 % and 89.3% of the motor exercises group and combined cognitive & motor exercises group had a good balance performance. There were highly statistically significant differences were found among the groups regarding their balance.

Table (2): clears that 67.3%, 70.7% and 70.9% respectively of the study groups had week contraction against gravity at base line, while, post 24-week of intervention, there were **51.1** % of motor exercise group and **60.2**% of combined cognitive & motor exercises group become normal muscle strength, with highly statistical significant differences between the groups.

Table (3): clears that 65.2%, 85.8% and 67.7% respectively of the study groups have week muscle contraction against gravity at baseline. While, post 24-weeks of intervention 41.4% of motor exercise group and 66.6% of combined motor & cognitive group become normal strength, with statistically significant differences between the groups.

Figure (2): Illustrates that, 33.6%, 34.7% and 37.7% respectively of the study groups were totally dependent in their DALs at base line. While, post 24-weeks of intervention, 70.6 % and 91.4% respectively of both motor exercise and combined cognitive & motor exercises groups becomes independent in performing their DALs.

Table (4): shows that there was a highly statistical significant relationship between increasing muscle strength and promoting balance with increasing ability to perform ADLs in the combined cognitive & motor exercises group post

24-week of exercises, compared with the control group.

Table1: Personal characteristics among the control group, motor exercise, and combined cognitive and motor exercises groups (n = 277)

Personal characteristics	Control group n=92		Motor exercise group n=92		Combined cognitive & motor exercises n=93		P-value
	N	%	N	%	N	%	
Age							0.5
60 < 65	33	35.8	31	33.6	28	30.1	
65 < 70	41	44.5	45	48.9	47	50.5	
70 <75	17	18.5	13	14.2	15	16.2	
≥ 75	1	1.2	3	3.3	3	3.2	
Mean± SD	67.2±6.4		69.8±5.4		70.2±4.9		
Gender	43	46.7	46	50.0	47	50.3	0.7
Male	49	53.3	46	50.0	46	49.7	
Female							
Educational levels							0.4
Cannot read and write	19	20.6	19	20.7	23	24.7	
Can Read and Write	22	23.9	21	22.8	26	27.9	
Basic Education	46	50.0	44	47.8	41	44.1	
University	5	5.5	8	8.7	3	3.3	

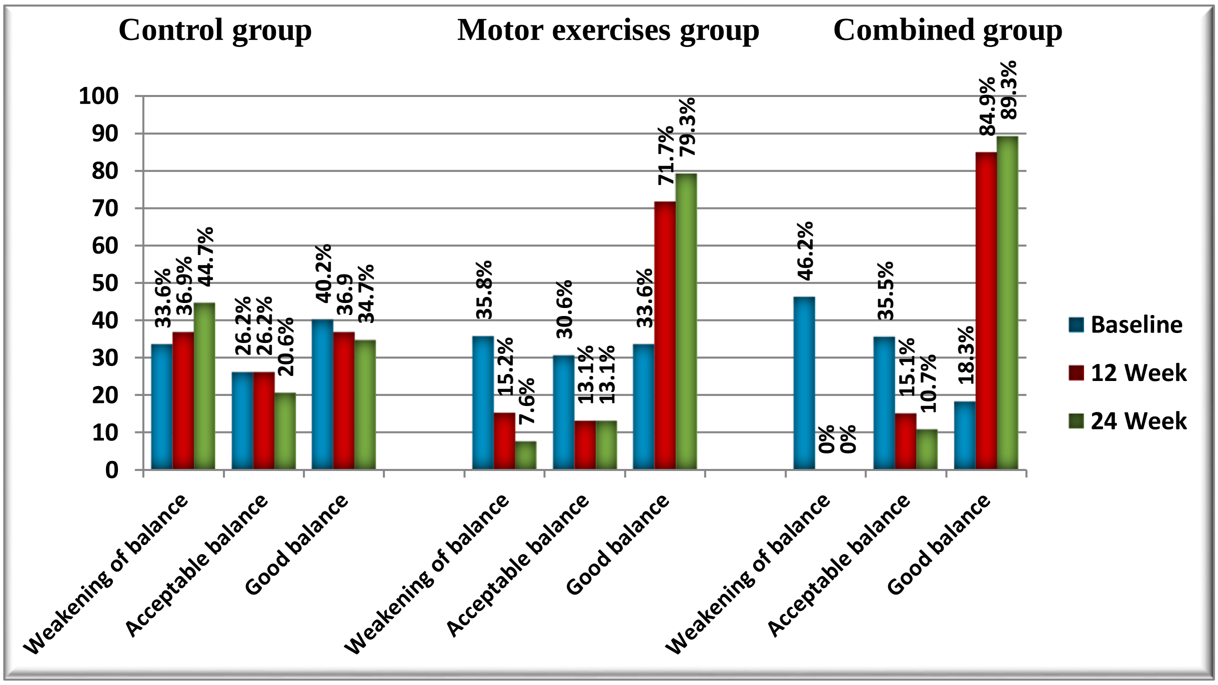

Figure (1): Comparison between the Study Groups Regarding their Balance at Baseline, Post 12-week and 24-week of Intervention (n = 277)

Table (2): Comparison between the Study Groups Concerning the Muscle Strength Scale of Upper Limb at Baseline, Post 12-week and 24-week of Intervention (n = 277)

Variables	Control group n=92						Motor Exercise group n=92						Combined Cognitive and Motor Exercises group n=93					
	Base line		12-week		24-weeks		Base line		12-week		24-weeks		Base line		12-week		24-weeks	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Normal strength	0	00.0	0	00.0	0	00.0	0	00.0	19	20.6	47	51.1	0	00.0	39	41.9	56	60.2
Active movement against gravity and resistance	0	00.0	0	00.0	0	00.0	0	00.0	23	25.0	40	43.4	0	00.0	54	58.1	37	39.8
Week contraction against gravity	62	67.3	74	80.4	83	90.2	65	70.7	22	23.9	5	5.5	66	70.9	0	0	0	00.0
Active movement with gravity eliminated	30	32.7	18	19.6	9	0.8	27	29.3	23	30.5	0	00.0	27	29.1	0	0	0	00.0
Minimal contraction	0	00.0	0	00.0	0	00.0	0	00.0	0	00.0	0	00.0	0	00.0	0	0	0	00.0
Chi-P value	3.5 (0.2)						11.5 (0.05)*						14.8(0.001)**					

NS= not significant * p = ≤.05 (statistical significance) ** p = ≤.01 (highly statistical significance).

Table (3): Comparison of the Study Groups Regarding the Muscle Strength Scale of Lower limb at Baseline, Post 12-week and 24-week of Intervention (n = 277)

Variables	Control group n=92						Motor Exercise group n=92						Combined Motor & Cognitive group n=93					
	Base line		12-week		24-weeks		Base line		12-week		24-weeks		Base line		12-week		24-weeks	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Normal strength	0	00.0	0	00.0	0	00.0	0	00.0	12	13.0	38	41.4	0	00.0	58	62.3	62	66.6
Active movement against gravity and resistance	0	00.0	0	00.0	0	00.0	0	00.0	38	41.3	21	22.8	0	00.0	35	37.7	31	33.4
Week contraction against gravity	60	65.2	72	78.2	77	83.6	79	85.8	42	45.7	33	35.8	63	67.7	0	0	0	00.0
Active movement with gravity eliminated	32	34.8	20	21.8	15	16.4	13	14.2	0	00.0	0	00.0	30	32.3	0	0	0	00.0
Minimal contraction	0	00.0	0	00.0	0	00.0	0	00.0	0	00.0	0	00.0	0	00.0	0	0	0	00.0
Chi-P value	0.12 (0.7)						7.4(0.01)*						14.9(0.001)**					

NS= not significant * p = ≤.05 (statistical significance) ** p = ≤.01 (highly statistical significance).

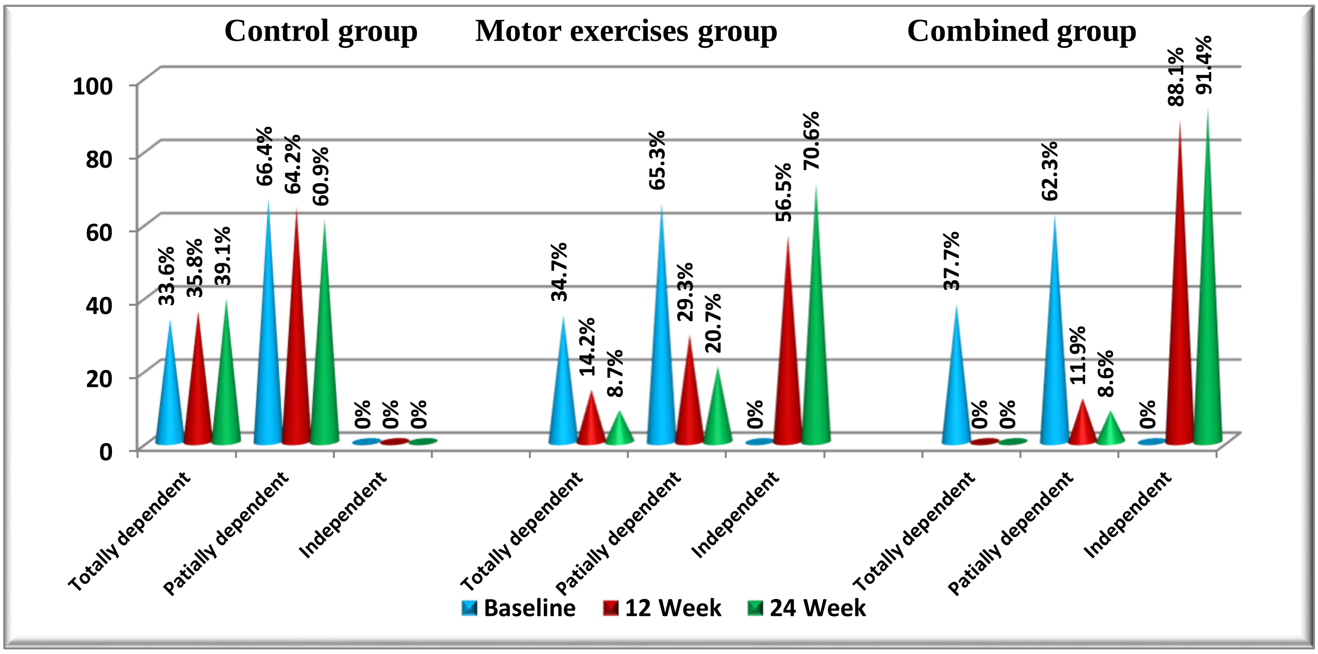

Figure (2): Comparison between the study Groups Regarding to Their Activities of Daily Living at Baseline, Post 12-week and 24-week of intervention (n = 277)

Table (4): Relation between Balance Ability, ADLs and Muscle strength among the Study Groups Post 24-week of intervention (n = 277)

Variables	Control group n=92		Motor Exercise group n=92		Combined Cognitive & Motor Exercises group n=93	
	r	p	R	p	R	P
Balance ability (Berg scale)	- 0.19	0.3	0.13	0.01*	0.31	0.002**
Activity of daily living	- 0.113	0.7	0.24	0.05*	0.53	0.003**
Muscle strength	- 0.21	0.4	0.51	0.01*	0.55	0.001**

NS= not significant   * p = ≤.05 (statistical significance)   ** p = ≤.01 (highly statistical significance).

Discussion

In senior patients, falling is a significant clinical issue that necessitates appropriate treatments. Falls can result in negative outcomes like immobilization and injuries, which lower mobility, independence, quality of life, and life expectancy. Currently, it appears that the only intervention program that lowers both the number of fallers and the number of falls among community residents is motor training for balance and strength **(Abd El Hamied et al., 2023)**.

The aim of this study was to evaluate the effect of combined cognitive and motor intervention on muscles strength, balance and daily activities among elderly at risk for falls.

Regarding to personal characteristics of the studied sample, it was found that ages of the study groups ranged between sixty to seventy-six years old, this disagreed with **(Zhou et al., 2021),** who founded that mean age of the studied sample were 79.8±8.7 and 75.4±5.5 respectively at the age of sixty to seventy-five years. Concerning to gender, it was demonstrated that, around half of the study groups were females; this may be due to female elderly more risk to musculoskeletal problems than males due to loss of calcium during pregnancy and lactation and hormonal changes associated with menopause. This was agreed with **Shirooka et al., (2018)** who reported that more than fifty percent of the studied motor sample was females and nearly half of the studied cognitive sample was female. While disagreed with **Tieri et al., (2019)** who founded that about two thirds of the studied sample was males. In relation to, the level of education; it was found that about half of all study groups had basic education; This consistent with **Montero-Odasso et al., (2018),** who described that; most of the studied sample was basically educated.

Concerning to the comparison between study groups regarding their muscle strength of both upper and lower limbs, the current study displayed that post 24-week of intervention, the combined cognitive & motor exercises group had the highest statistical significant improvement in the muscle strength scores followed by the motor exercises group compared with control group. This indicate that, combined cognitive and motor exercises intervention more effective than motor intervention alone, this consistent with **Faria-Fortini et al., (2021**) and **Li, et al., (2020),** who reported a statistical significant improvement in the muscle strength of the body upper and lower limbs among the majority of the intervention group after the combined physical and cognitive interventions.

From the point's view of the researcher these results were due to that, Firstly, cognitive tasks can increase the attentional demands of motor exercises, which may enhance the activation of neuromuscular pathways involved in movement. When individuals perform motor exercises alone, they may not be fully engaged in the task and may not recruit all the necessary muscles for optimal performance. However, when cognitive tasks are added, individuals may focus more on the movement and attend to the details of the task, leading to more complete muscle activation and improved strength.

Secondly, combining cognitive and motor tasks promote neural plasticity, which refers to the ability of the brain to change and adapt in response to experience. By engaging in cognitive tasks while performing motor exercises, individuals may promote the development of new neural pathways and strengthen existing ones, leading to improved muscle strength.

Furthermore, **Lapierre et al., (2021) and Kim, Kim, & Hong, (2021),** discussed that, cognitive exercises can improve cognitive function, such as attention, memory, and executive function, which are important for motor performance. By improving cognitive function, individuals may be better able to learn and execute motor tasks. Additionally, motor exercises can improve physical function, such as muscle strength and balance, which are important for maintaining independence and preventing falls in older adults. By addressing both cognitive and physical function, combined cognitive and motor exercises may provide a more holistic approach to training.

In respect to maintain balance status; the present results revealed that combined cognitive & motor exercises group achieved a highest significant improvement in the balance status and decrease in the risk of falling after 24-week of intervention compared with the motor exercises group and the control group, this may be due to practicing combined cognitive and motor exercises, have a great effect on cognitive level efficiency, and balance ability, as well as, enhance motor skill interventions, and interpersonal interaction, agility, coordination, and cardio-respiratory fitness. This consistent with **Zhou et al., (2021)** who reported that, there were statistically significant differences between pre and post-test and improved balance status of the studied group on post-test scores over pre-test scores from about one quarter to majority respectively. Moreover, **Lee & Yoon, (2020), Okubo, et al., (2021),** rationalized this by; balance control requires the integration of sensory information from multiple sources, such as vision, proprioception, and vestibular inputs. Cognitive tasks can modulate the processing of sensory information and the attentional focus of the individual, thereby influencing the postural control strategies used to maintain balance.

By combining cognitive tasks with motor exercises, individuals may improve their ability to process and integrate sensory information effectively, leading to better balance control. Motor exercises alone can improve balance ability through motor learning, which involves the acquisition of new movement patterns and the refinement of existing ones. However, adding cognitive tasks to motor exercises may enhance motor learning by promoting deeper processing of the movement and improving retention of the skill. By improving motor learning, individuals may be able to transfer their balance skills to other situations and maintain their balance over longer period **Zhou et al., (2021)**.

Furthermore, the current research clarified that, the highest percentages of combined cognitive & motor exercises group become independent in performing their activity of daily living post 24-week of intervention followed the motor exercises group when compared with the control group. This may be because of that combined cognitive and motor exercises increase physical functioning in older adults or people with neurological impairments and improve performance when executing tasks that call for both motor and cognitive abilities. This in the same line with, **Lisanne et al., (2019)** who reported that, improve level of independency of the experimental group (cognitive and motor exercises group) over the control group and there were statistically significant differences between the studied groups and control group regarding daily activities. Moreover, **Cho, et al., (2021),** summarized that, activity of daily living (ADL) refers to the basic activities that individuals perform daily, such as bathing, dressing, eating, and using the toilet. These activities require the integration of cognitive and motor abilities, and impairment in these domains can lead to difficulty in performing ADLs. Cognitive-motor training involves a combination of exercises that target both cognitive and motor abilities, which may lead to improved performance in both domains. The cognitive exercises in the training program may enhance cognitive function, such as memory, attention, and executive functions, while the motor exercises may improve balance, gait, and overall physical fitness.

With respect to correlation between balance ability, ADLs and muscle strength, the current results revealed a highly statistical significant positive correlation between increasing muscle strength and promoting ability to maintain balance with increasing ability to perform ADLs in the combined cognitive & motor exercises group post 24-week of exercises, compared with the control group.

From researchers point of views this may be due to practicing regular exercises for long time and regular duration enhance physical fitness and improve their muscle strength subsequently. This supported by **Sousa, et al., (2021),** who discussed that, combining cognitive and motor exercises for older adults can improve both cognitive and physical function, leading to improvements in balance, mobility, and functional outcomes. With advanced age, muscle strength tends to decline, which can lead to decreased balance and mobility, and ultimately, difficulty performing (ADLs). This decline in muscle strength is due to several factors, including changes in our nervous system, hormonal changes, and reduced physical activity levels. This is because both cognitive and motor functions are closely linked, and deficits in one area can lead to impairments in the other. Moreover, (**Varela-Vásquez, et al., 2020),** reported a statistical significant effect in both motor exercise and combined cognitive & motor exercises groups.

Conclusion:

The results of a current study showed that combined cognitive and motor exercises interventions had an adequate impact on the improvement of balance, gait, activity daily living, and motor strength in upper and lower limbs, and decreased the risk of falling compared to motor intervention alone because cognitive training focused primarily on executive function exercises on cognitive outcomes, and it suggests that a combination of motor and cognitive treatment tends to maximize all these effects.

Recommendations:

- Use combined and cognitive training exercises that assist with balance and gait improvement and decrease fear of falling among elderly.
- Regular health education for senior people who are experiencing early-stage balance and gait problems.
- The relationship between enhancements in cognitive abilities and performance on

physical tasks among elderly should be examined in future study in this area.

- Periodic follow up for elderly people to assure understanding health information.
- Increase public awareness through health education about effect of combined and cognitive training exercises on balance, muscle strength, and activity of daily living through using effective teaching media as videos, role play and demonstration.

References:

Abd El Hamied Ibrahim El Saye, Mohamed T. Said ،Mohsen, O., Aziza M. Abozied4 and Mohamed Salama (2023): Falls and associated risk factors in a sample of old age population in Egyptian community Sec. Aging and Public Health. Rehabilitation International Scholars Conference, Volume 4 Issue 1, pp.62-82. https://doi.org/12.35994/7np1.955

Ahmad Ainuddin, H., Romli, M. H., Hamid, T. A., Salim, M. S., & Mackenzie, L. (2021): Stroke rehabilitation for falls and risk of falls in Southeast Asia: a scoping review with stakeholders' consultation. Frontiers in public health, 9, 611793.

Ambrose, A. F., Paul, G., and Hausdorff, J. M. (2013): Risk factors for falls among older adults: a review of the literature. Maturitas 75, 51–61. doi: 10.1016/j.maturitas.2013.02.009

Ameh, OI.;Cilliers, L.; Okpechi, IG. (2016): A practical approach to the nutritional management of chronic kidney disease patients in Cape Town, South Africa. BMC Nephrology. 17(68). P.p.1-8.

Anderson-Hanley, C., Stark, J., Wall, K. M., VanBrakle, M., Michel, M., Maloney, M., & Kramer, A. F. (2018): The interactive Physical and Cognitive Exercise System (PACES™): Effects of a 3-month in-home pilot clinical trial for mild cognitive impairment and caregivers. Clinical interventions in aging, vol. 1; 3. 1565-1577.

Arik, G., Varan, H. D., Yavuz, B. B., Karabulut, E., Kara, O., Kilic, M. K., &Cankurtaran, M. (2015): Validation of Katz index of independence in activities of daily living in Turkish older adults. Archives of gerontology and geriatrics, 61(3), 344-350.

Cho, S. H., Lee, H., Kim, M., Lee, J. Y., & Lee, W. (2021): Effect of combined cognitive-motor training on cognitive function, physical fitness, and muscle strength in older adults with mild cognitive impairment: a randomized controlled trial. Aging & Mental Health, 25(6), 1049-1058.

De Oliveira Silva, F., Ferreira, J. V., Plácido, J., Sant'Anna, P., Araújo, J., Marinho, V., &Deslandes, A. C. (2019): Three months of multimodal training contributes to mobility and executive function in elderly individuals with mild cognitive impairment, but not in those with Alzheimer's disease: a randomized controlled trial. Maturitas, vol 3;1. 126, 28-33.

Eggenberger, P.; Schumacher, V.; Angst, M.; Theill, N.; de Bruin, E.D.(2020): Does multicomponent physical exercise with simultaneous cognitive training boost cognitive performance in older adults? A 6-month randomized controlled trial with a 1-year follow-up. Int. J. Environ. Res. Public Health 17, 6079 11 of 12

Faria-Fortini, I., Polese, J. C., Faria, C. D., Scianni, A. A., Nascimento, L. R., & Teixeira-Salmela, L. F. (2021): Fall efficacy scale–international cut-off score discriminates fallers and non-fallers individuals who have had stroke. Journal of bodywork and movement therapies, 26, 167-173.

Fernando, P.F. (2019). Effect of Foot Exercise on Lower Limb Strength and Balance Among Elderly: Basis for a Health Education Program. Abstract Proceedings International Scholars Conference, Volume 7 Issue 1, October 2019, pp.255-287. https://doi.org/10.35974/isc.v7i1.955.

Ismail,G.M., Fahim, H.I., Bakr, I.M., Wassif, G.O., Hamza, S.A.(2018): Risk of falls and Effect of a Health Education Program in Prevention of Falls among Elderly in Geriatric Homes in Cairo, Egypt. EJGG. 5(2): 1-7.

Katz, S., (1970): A measure of primary sociobiological functions. International journal of health services, 6(3), 493-508.

Kim, H., Kim, M., & Hong, J. (2021): Effects of combined cognitive-motor training on muscle strength and balance in older adults. Journal of Exercise Rehabilitation, 17(4), 269-276. doi:10.12965/jer.2142366.113

Kwan, R. Y. C., Liu, J. Y. W., Fong, K. N. K., Qin, J., Leung, P. K. Y., Sin, O. S. K., & Lai, C. K. (2021): Feasibility and effects of virtual reality motor-cognitive training in community-dwelling older people with cognitive frailty: pilot randomized controlled trial. JMIR serious games, 9(3), e28400.

Lapierre, N., Din, N. U., Igout, M., Chevrier, J., &Belmin, J. (2021): Effects of a rehabilitation program using a patient-personalized exergame on fear of falling and risk of falls in vulnerable older adults: protocol for a randomized controlled group study. JMIR research protocols, 10(8), e24665.

Li, Y., Wu, Y., Zhai, L., Hu, Y., & Li, W. (2020): Effect of cognitive-motor dual-task training on cognitive function and lower limb muscle strength in older adults: A randomized controlled trial. Journal of Physical Therapy Science, 32(9), 598-603. doi:10.1589/jpts.32.598

Lee, Y. M., & Yoon, D. (2020): Effects of cognitive-motor dual-task training on balance, cognition, and dual-task performance in older adults: A randomized controlled trial. Journal of Physical Therapy Science, 32(9), 604-609. doi:10.1589/jpts.32.604

MacPherson, S. E. (2018): Definition: dual-tasking and multitasking. Cortex. 106, 313–314. doi: 10.1016/j.cortex.2018.06.009.

Marusic U., and Grosprêtre, S. (2018): Non-physical approaches to counteract age-related functional deterioration: Applications for rehabilitation and neural mechanisms. Eur. J. Sport Sci. 18, 639–649. doi: 10.1080/17461391.2018.1447018

Montero-Odasso, M., &Speechley, M. (2018): Falls in cognitively impaired older adults: implications for risk assessment and prevention. Journal of the American Geriatrics Society, 66(2), 367-375.

O'Neill, S., Jaszczak, S. L. T., Steffensen, A. K. S., & Debrabant, B. (2017): Using 4+ to grade near-normal muscle strength does not improve agreement. Chiropractic & manual therapies, 25(1), 1-9.

Okubo, Y., Schoene, D., Lord, S. R., & Sturnieks, D. L. (2021). Effects of cognitive-motor dual-task training on balance and mobility in healthy older adults: A systematic review and meta-analysis. Sports Medicine, 51(3), 565-577. doi:10.1007/s40279-020-01441-8

Patterson, K. K., Inness, E., McIlroy, W. E., & Mansfield, A. (2017): A retrospective analysis of post-stroke Berg Balance Scale scores: how should normal and at-risk scores be interpreted?. Physiotherapy Canada, 69(2), 142-149.

Phirom K., Kamnardsiri.T, Sungkarat S., (2020): Beneficial Effects of Interactive Physical-Cognitive Game-Based Training on Fall Risk and Cognitive Performance of Older Adults. International Journal of Environmental Research and Public Health 17, 6079; doi:10.3390/ijerph17176079 www.mdpi.com/journal/ijerph

Pizzorno, J. E., & Murray, M. T. (2020): Textbook of Natural Medicine-E-Book. Elsevier Health Sciences chapter 15th Pp 1023:1025.

Rieker, J. A., Reales, J. M., Muiños, M., & Ballesteros, S. (2022): The effects of combined cognitive-physical interventions on cognitive functioning in healthy older adults: A systematic review and multilevel meta-analysis. Frontiers in human neuroscience, 16,2. 112.

Rosentzweig, A. (2019). Montreal Cognitive Assessment (MoCA) test for dementia. Environmental Research and Public Health 10,2 Pp;60:79; www.mdpi.com/journal/ijerph

Schoene, D.; Lord, S.R.; Delbaere, K.; Severino, C.; Davies, T.A.; Smith, S.T. A., (2013): Randomized Controlled Pilot Study of Home-Based Step Training in Older People Using Videogame Technology. PLoS ONE 2013, 8.1, e57734.

Shatil, E. (2013): Does combined cognitive training and physical activity training enhance cognitive abilities more than either alone? A four-condition randomized controlled trial among healthy older adults. Front. Aging Neurosci, 5.2, Pp8:20.

Shirooka, H., Nishiguchi, S., Fukutani, N., Tashiro, Y., Nozaki, Y., & Aoyama, T. (2018): Subjective cognitive decline and fall risk in community-dwelling older adults with or without objective cognitive decline. Aging clinical and experimental research, 30,2. 457-462.

Silsupadol, P.; Shumway-Cook, A.; Lugade, V.; Van Donkelaar, P.; Chou, L.-S.; Mayr, Smith, L., & Argentina, V. (2020): The usability of physical activity and cognitive training applications in people with mild cognitive impairment. Research in Gerontological Nursing, 13(2), 64-72.

Spanò B , Lombardi M, De Tollis M., Maria A. Szczepanska M., Ricci C., Manzo A, Giuli S, Polidori L, Griffini I., Adriano F, Caltagirone C and Annicchiarico R., (2022): Effect of Dual-Task Motor-Cognitive Training in Preventing Falls in Vulnerable Elderly Cerebrovascular Patients: A Pilot Study. Brain Sci., 12, 168. https://doi.org/10.3390/brainsci1202016

Sousa, N., Mendes, R., Abrantes, C., Sampaio, J., & Oliveira, J. (2021): Effects of a combined cognitive-motor training program on physical and cognitive performance in institutionalized older adults. International Journal of Environmental Research and Public Health, 18(5), 2535.

Ten Brinke, L. F., Best, J. R., Chan, J. L., Ghag, C., Erickson, K. I., Handy, T. C., & Liu-Ambrose, T. (2020): The effects of computerized cognitive training with and without physical exercise on cognitive function in older adults: an 8-week randomized controlled trial. The Journals of Gerontology: Series A, 75(4), 755-763.

Teraz K ., Šlosar L., Paravlic´ A., Bruin E. and Marusic U., (2022): Impact of Motor-Cognitive Interventions on Selected Gait and Balance Outcomes in Older Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials Abstract Proceedings International Scholars Conference, Volume 1 Issue 1, Pp.101-118.

Thaiyanto, J., Sittichoke, C., Phirom, K., &Sungkarat, S. (2021): Effects of multicomponent exercise on cognitive performance and fall risk in older women with mild cognitive impairment. The journal of nutrition, health & aging, 25,4 160-164.

Tieri, G., Morone, G., Paolucci, S., &Iosa, M. (2018). Virtual reality in cognitive and motor rehabilitation: facts, fiction and fallacies. Expert review of medical devices, 15(2), 107-117.

Vaishya, R., & Vaish, A. (2020): Falls in older adults are serious. Indian journal of orthopaedics, 54,2 69-74.

Varela-Vásquez, L. A., Minobes-Molina, E., & Jerez-Roig, J. (2020): Dual-task exercises in older adults: A structured review of current literature. Journal of frailty, sarcopenia and falls, 5(2), 31. https://doi.org/10.3389/fpubh.2023.1068314

WHO (2019): Aging population statistics Available at: http://www.who.statistics.com

WHO. (2018). Falls Prevention in Older Age. World Health Organization. Retrieved from: http://www.who.int/ageing/projects/falls_prevention_older_age/en/

WHO. (2023) . Falls. Available online at: https://www.who.int/news-room/fact-sheets/detail/falls (accessed January 17, 2023).

Zhou, Q., Yang, H., Zhou, Q., & Pan, H. (2021). Effects of cognitive motor dual-task training on stroke patients: A RCT-based meta-analysis. Journal of Clinical Neuroscience, 92,3 175-182.