Original Article

Effects of Physiotherapy Prescribed Exercises among Elderly Persons in a Selected Geriatric Home in Rwanda: A before-and-after Study

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Abstract

Background
Prescribed physiotherapy based exercise interventions are substantial in fall prevention, reduced risk of falls and improve quality of life in the elderly.

Objective
The aim of the study was to determine the effects of physiotherapy-prescribed exercises among elderly adults on coordination and balance performance and quality of life.

Methods
A before and after study design was used at Soeurs Saint Vincent de Paul (SSVP) geriatric home in Kigali Rwanda that hosts 45 people, where a sample of 40 elderly persons was followed up for 4 weeks. A physiotherapy-based exercise adapted from Johns Hopkins Hospital's Fall prevention programme was adopted. We measured balance and physical performance using Berg Balance Scale assssment, Timed Up and Go tests respectively as well as and quality of life domains using WHO quality of life questionnaire.

Results
The findings indicate that physiotherapy-based exercises had excellent outcomes related to performance, quality of life and reduced risk of falls where TUG performance dropped from 18 seconds to 11 seconds. The Pre-test scores of BBS were 28 ± 8 and after intervention BBS scores changed significantly to 43 ± 6. The quality of life after intervention was improved significantly in all domains where the physical domain improved from 41% to 53%.

Conclusion
The study results show that exercises that improve coordination and balance have the potential to remarkably reduce the risk of falls among elderly persons.

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Keywords: Falls, Elderly persons, Physiotherapy

Introduction

Falls are a leading cause of morbidity and mortality in older adults.[1] Globally falls are the second leading cause of unintentional injury leading to death, after road traffic injuries.[2] Approximately one in three community-dwelling people aged 65 years or older will fall at least once per year, and the risk of falling increases with age. Falls impose a significant social and economic burden on individuals, their families, community health services and the economy.[3]

The American Geriatrics Society and British Geriatrics Society in 2017 showed that 37.5% of fallers responded that they required medical treatment or activity restriction and about 3 million emergency department visits annually, and 25% of the falls cause serious injuries such as fractures and traumatic brain injury which is fatal too.[4] The prevention of falls is therefore an urgent public health challenge. National health bodies and international guidelines are promoting the implementation of appropriately designed intervention programs that are known to prevent falls in older people.[3,4,5,6]

Globally, falls are a major public health problem. An estimated number of 684,000 fatal falls occur each year, making it the second leading cause of unintentional injury death, after road traffic injuries. Though not fatal, yearly, more than 37 million falls are severe enough to require medical attention. In addition, falls are also responsible for over 38 million DALYs (disability-adjusted life years) lost each year and result in more years lived with disability than transport injury, drowning, burns and poisoning combined. In addition, those individuals who fall and suffer a disability, particularly older people, are at a major risk for subsequent long-term care and institutionalization.[7]
There are many risk factors for falls, some of which are modifiable; the strongest modifiable risk factors are balance impairment, gait impairment, muscle weakness, and medication use.

Fear of falling can result in a downward cascade of events leading to social isolation and loss of function, as well as more falls. Approximately 60% of falls are the result of multiple factors.[4]

Physical activity is identified by the World Health Organization (WHO), as a part of the solution to the challenge of population ageing and the associated need for global action to ensure health and wellbeing is maintained into later life. The recent Cochrane review of interventions to prevent falls in community dwelling older people concluded that exercise could reduce the risk and rate of falls in older people by between 15 and 32%, depending on the type of programme and measures used to assess effectiveness.[8] Furthermore, there is clear evidence that specific exercise programmes that challenge balance are most effective in preventing falls.[9]

Single interventions like exercises are cost-effective in preventing falls. Among other ways to prevent falls there is home safety modification for people who have previously fallen,[10] other multifaceted interventions may help but are not cost friendly. Therefore, when there are no contraindications, exercises should be considered as a core prevention of falls among older people.
In sub-Saharan Africa, many countries are experiencing demographic transitions, including Rwanda. Rwanda has made rapid and significant improvements in life expectancy and total fertility through healthcare system investments and poverty reductions, but the consequent growth in the number of elderly people may present challenges, including the lack of physical activity participation.[11]

With improved community-based interventions to prevent falls, the burden of the disease is minimized or prevented. For instance, exercise-based interventions among elderly persons that were designed from different corners of the globe have demonstrated a significant impact on the prevention of such accidents and therefore

reduce all burdens associated with falls, such as physical, emotional, and socioeconomic challenges/problems.

However, in most countries, including Rwanda, physiotherapy-based exercises in the prevention of falls among elderly persons are rarely practiced even though exercising is believed to be key in the prevention of falls among elderly persons. Therefore, including health-enhancing exercises or physical activity in the management of falls should be given a thought. Even considering the statistics and development partners, data about health metrics are nonexistent in national reporting.[12,13] In addition to that, there is very little or no published study, assessing the impact of physiotherapy-based exercises in the prevention of falls among elderly persons in Rwanda. This means, there is an absolute need to conduct this study.

Our study aimed to determine the effects of physiotherapy-based exercises on coordination, balance and quality of life among elderly persons living in Soeurs de Saint Vincent de Paul (SSVP) Geriatric Home.

Methods

Study design

We used a before-and-after methods study design in which participants were identified and then followed up for a period of four weeks.

Study setting

We conducted the study in the City of Kigali at Saint Vincent de Paul Geriatric Home. It was chosen because it is one of the known Geriatric homes that hosts elderly people of different demographics in Rwanda, located in Kigali City. The place is large with a total of 45 elderly persons residing in the facility, which is a big number compared to other places in Kigali City.

Population, sample, and sampling

The researchers considered all elderly residing in SSVP geriatric homes aged 65 years old and above who were willing to participate in the study and who were able to stand and walk independently.

The participants were excluded when they had reported during pre-test screening uncontrolled hypertension in the previous month who had systolic blood pressure (BP) > 200mmHg and diastolic BP > 100 mmHg and heart rate exceeding 140 beats per minute, reported dizziness associated with activity/ exercise, good mental cognition unable to follow exercise instructions. We also excluded those who completed the TUG Test for more than 20 seconds and scores on BBS less than 20/56 score.We used a census to recruit all participants who met inclusion criteria 40 out of 45 elderly persons were considered as our population of the study.

Intervention

After meeting the inclusion criteria, the participants were followed for four weeks receiving physiotherapy-based exercise intervention that included four components namely strengthening, aerobic, coordination and balance exercises. Home/community-based exercises were recorded as video tutorials and given to the participants where they performed them once per day for at least 30 minutes per day. Exercises were adapted from John Hopkin's Hospital Fall prevention exercise programme.[14]

All exercises performed were light to moderate intensity as all participants were at high risk of falling. The protective measures included the use of a chair as a support in case there is a loss of movement control which may result in a fall.

Prescribed exercises included Toe raises, Seated marching, Heel rise, Ankle pumps, Chair sit to stand, High knee walk, Back ward pedals, Arm raises, Standing jacks, Declined climb, Arm seal jacks, Free body squats, Thread the needle and Single leg standing. Each exercise was prescribed for 10 – 12 repetitions and they had to repeat every single exercise in three sets. They were given to perform exercises seven days per week from Monday to Sunday.

Study outcomes

Our primary outcomes were risk of falls using physical or fitness and balance performances on Timed Up and Go (TUG) test and the Berg Balance Scale (BBS) respectively. The TUG test is standardized clinical and physical performance test popularly used to predict performance in adults with high risk of fall, it is also poplularly utilized in interventions tracking risk of falls issues in the elderly and population at risk. On the other hand, BBS is used to determine the body balance status therefore estimating the risk of fall. Both TUG and BBS, are standardized clinical tools used to predict the risk of falls and measure changes related to falls in all people with different neuro-musculoskeletal disorders especially in the elderly. The tools were given to the participants at the beginning and the end of the trial.[15,16,17] While the WHO Quality of Life questionnaire is a standardized tool popularly used to assess quality of life.[2, 6]

Secondly to determine changes in quality of life among participants using the WHO Quality of Life Questionnaire (WHOQOL Bref questionnaire) that has 4 main sections. The tool assesses four domains of the quality of life including firstly, Physical domain of life quality of life where participants report how their physical performance changed over time; secondly, the psychological domain where questions related to mental health status; thirdly, the Environmental section where they report how they are able to cope with their environment and lastly their Social Relationships where they respond on how their social life changed or improved. Cardio-vascular measurements were considered namely blood pressure and heart rate as they were taken in selecting participants in selection and changes in those variables also were considered as secondary outcomes for the study. They were measured using OMRON Blood Pressue upper arm cuff machine.

Intervention delivery and outcome assessment

Physiotherapy prescribed exercise programme made up of 14 exercises was given for four weeks. The exercises were designed in categories of muscle strength, cardiovascular endurance, coordination and balance performed on all joints from toe to head on a regular basis. They developed and contextualized to suit the Rwandan community and explained in Kinyarwanda based on the exercise complexity and exercise equipment availability. All exercises used were light to moderate intensity exercises addressing Strength, Endurance, Flexibility, Balance and coordination parameters and were recorded in a video and narrated in Kinyarwanda by experts in movement science and physiotherapy.

The performance tests (BBS and TUG) were administered to participants as screening functional capacity tests/ performance tests and those who were not able to complete the tests were excluded in the study. Two examiners scored performance for each participants and had to have a common consensus of the final score on BBS and TUG test as an average score near the close second for TUG.

The WHO QoL Questionnaire was administered to participants. Participants were explained on hown to fill the questionnaire and whenever assistant was required was given. The same procedure to collect data was repeated at the end of four weeks of exercise intervention.

Participants who reported symptoms of fatigue, dizziness, poor vision, and confusion were advised to stop exercising and report them to the researchers.

Data analysis

Data was entered in Microsoft Excel, Windows 10.0 then transferred to SPSS 25.0 version for analysis. Means and standard deviation were used in the analysis. Paired t-tests were used to compare the changes before and after the intervention at a 95% confidence limit ($p < 0.05$). The results are presented in Table 1.

Ethical approval

Ethical clearance with Ref: CMHS/IRB/04/2022 was obtained from the College of Medicine and Health Sciences Institutional Review Board, and the request letter for data collection and intervention implementation at SSVP Geriatric Home was granted. Information related to the study was explained to the participants and their participation was absolutely voluntary. Participants had the right to withdraw from the study without affecting their relationship with researchers and their caregivers. An informed consent was given and signed by every participant who agreed to participate in the study. The information regarding their identity was kept confidential by using the codes instead of names. Researchers collected the baseline information of the elderly persons on physical performance using Performance assessment tools (Berg Balance Scale and TUG respectively). The World Health Organization Quality of Life Questionnaire was administered to the participants to assess their quality of life. The same assessment procedure was repeated after four weeks precisely at the end of the 4th Week of the trial to assess the changes.

Results

Demographic details

A total of 40 participants participated in the study, where the mean age of the participants was 73 ± 8 years old, with the minimum and maximum ages being 66 and 102 years respectively. Males (21) were more represented than females (19).

Table 1. Comparison of the participants' outcomes between pre and post intervention

	Pre-intervention		Post-intervention				
	Mean	**SD**	**Mean**	**SD**	**Mean difference**	**SD**	**p value**
Vital signs							
Systolic blood pressure, mmHg	134.00	10.000	129.00	9.000	5.00	5.00	<0.001
Diastolic blood pressure, mmHg	87.00	8.000	82.00	7.000	4.00	5.00	<0.001
Heart rate (bpm)	79.00	7.000	76.00	5.000	3.000	4.000	<0.001
Performance tests							
Timed Up and Go Test (seconds)	18.00	7.00	11.00	4.04	7.00	4.00	<0.001
Berg balance scale	28.00	8.000	43.00	6.000	-15.00	6.00	<0.001
Quality of life (%)							
Physical health	41.1563	11.96503	53.4990	11.08228	-12.34275	7.19778	<0.001
Psychological	36.4590	11.58502	51.7703	11.35742	-15.31125	9.21524	<0.001
Social relationship	21.4583	10.98648	35.5210	11.74650	-14.06275	11.19191	<0.001
Environment	35.6023	11.38696	53.2710	13.40119	-17.66875	9.97223	<0.001

Abbreviations: bpm, beats per minute; mmHg, millimetres Mercury; SD, Standard Deviation

The findings from this study (Table 1) indicate positive statistically significant effect ($p < 0.001$) of the interventional physiotherapy prescribed exercises on vital variables including systolic/diastolic blood pressures and heart rate. Systolic BP reduced from 134 ±10 mmHg to 129 ± 9 mmHg; and Diastolic BP reduced from 87 ± 8 mmHg to 82 ± 7 mmHg. The heart rate readings changed from 79 ± 7 bpm to 76 ± 5 bpm.

The ability to stand and go improved significantly whereby participants were able to complete the test from 18 ± 7 seconds (high risk of fall) to 11 ± 4 seconds (low risk of fall). The balance scores also improved on the 56 score scale from 28 ± 8 scores (high risk of fall) to 43 ± 6 scores (very low risk of fall).

Regarding the quality of life, outcomes indicated that physiotherapy prescribed exercises had a statistically significant impact on quality of life in all 4 components ($P < 0.001$). Physical health improved from 41.15 ± 11.96% to 53.49 ± 11.08%, psychological quality of life 36.45 ± 11.5 to 51.77 ± 11.35%, and social relationship from 21.45 ± 10 to 35.52 11.74%. The environmental quality of life improved from 35.60 ± 11.38% to 53.27 ±13.40%.

Discussion

The findings from this study show that physiotherapy-based exercises have a significant effect on reduced fall risks and balance among the elderly due to changes in regular physical activity participation.
The changes in blood pressure and heart rate also are reportedly as secondary outcomes in the present study. Secondly, the results also showed that there was an overall improved quality of life among the elderly persons who participated in therapeutic exercises prescribed in a four-week period of this intervention. Similar effects have been observed and reported by the American Society of Geriatrics,[4] confirming the importance of the recommendation of physical activity for all by WHO, which supported that appropriate physical activities or exercises be undertaken to improve strength, balance, and flexibility in the elderly.[2] Physical activities or exercises are reported to reduce risk of fall and contributing to quality of life because they are one of the most feasible and cost-effective strategies to prevent falls among older adults in the community and can be followed with ease, as they can be self-monitored.[2]

Blood pressure and heart rate considerably improved at the end of the four-week intervention, whereby there was a substantial decline in systolic and diastolic pressures, with moderate-intensity exercises suggesting that continuing participation in any regular exercise is a predictor of the change in systolic and diastolic blood pressure. A reduction in SBP by as low as 5 mmHg can result in a decline of acute myocardial infarction, stroke, and cardiovascular mortality by 10%.[27]

The study conducted by Lovato et al. showed that there is a possibility of physiological responses of the heart rate and blood pressure in response to physical exercise, where a decrease in values is expected as a physiological response.[20] However, another study reported that there is no clear difference in the blood pressure changes due to exercise intervention, as they were unable to confirm that the effects observed were due to exercise alone or after the whole session combining different types of exercise intervention.[21] Unlike what we observed in the present study, another study asserted that during an exercise session, contracting muscles help pump blood back to the heart which may tend to result in lowered blood pressure and heart rate.[21] Another research on effect of exercises in the elderly,[22] reported that training for three to five times per week, 30–60 minutes per session may help in reducing blood pressure in hypertensive patients.[22]

On performance side, the present finding of TUG test shows a significant improvement by a reduced risk of fall from high risk to lower risk levels as observed in one study that TUG performance testing with less duration to complete the test had an association with lowered fall risk.[16] As it was observed in the present study, a systematic review,[17] reported that the pooled mean difference in time taken to complete the TUG between fallers and non-fallers depended on the baseline functional status of the cohort of patients under investigation as they found that those who completed the test in less duration were considered as non-fallers or low fall risk.[17]

In the study conducted by Sun et al,[23] it was estimated that the majority of community-dwelling elderly women who performed the TUG test in less than 12 seconds were to be categorized as low risk people compared to those who were at high fall risk that completed the test over 15 seconds. They found that only 9% of institution-dwelling elderly women who performed the TUG test in less than 12 seconds were low risk elderly.[23]

According to a study comparing the functional balance of 96 elders of the community, equally divided into three groups according to the history of falls (without history of falls, with one fall and with recurrent falls), it was revealed that old people with a history of falls (including one or more) took longer to complete the TUG test than old people without a history of falls, and this difference was statistically significant.[24] In the present study, the participants who improved their balance on the Berg Balance Scale made substantial progress from a high level to a low level of risk of fall after participating in physiotherapy prescribed exercises consisting of strengthening, stretching and balance. This is consistent with a study,[24] which reported that specific exercise program for the elderly imparts significant improvement in balance performance and hence a reduced fall risk. The observed effects in both studies are due to similarity of research methods including the use of the same outcome measures, recruitment of geriatric population and interventions.

The present finding is consistent with ones of Maneeprom and his colleagues,[25] who reported that exercise program interventions resulted in improvement in balance after 6 months of intervention. Another similar study that tested balance exercise intervention in elderly individuals confirmed significant improvement balance of elderly and reduction in risk of fall as a result of participating in interventions aiming at preventing falls in geriatric population.[18]

The quality of life for elderly persons who participated changed positively according to the WHO QoL BREF, which was used in this study. The scores showed momentous change from low quality of life to medium quality of life in all domains, which are physical health, psychological, social relationships, and environment. This might be due to the decreased number of falls and fall injuries. The maintenance of functional abilities and social activities by decreasing fall injuries had a positive effect on QOL.

Lastly, the quality of life improvement was observed in physical, psychological, social relation and environmental dimensions. This aligned with the study in Brazil, in which the elderly who participated in exercise programs for fall prevention gained greater quality of life and that participating for longer duration was associated with a positive change in all four domains of the quality of life.[26] A cohort study could contribute to a better understanding of this association.

Although the findings from this study are interesting, some limitations were observed including the fact that the follow-up did not have a comparison group to confirm the effects observed. In addition, the participants were followed for a short period of time, hence the need for conducting a longitudinal randomized controlled trials with long term follow up.

Conclusions and Recommendations

Based on the study findings, it is concluded that physiotherapy-based exercises can contribute to reduced fall risk in geriatric population as demonstrated by improved exercise performance, balance and quality of life. Furthermore, hysiological changes including blood pressure and heart rate values remarkably reduce to lower values implying improvement in cardiovascular performance. Thus, exercise interventions designed by healthcare professionals contribute to overall well-being and quality of life in the elderly.

The recommendations from this study are that health institutions should take into account the role of physiotherapy-based exercises in improving the quality of life. These minimizes the incidents of falls in elderly persons by establishing or adopting already made protocols. Likewise, the Rwanda Biomedical Center and and Ministry of Health and its programs and initiative implementation partners such as NCDs Alliance should design initiatives to improve wellness and health of the elderly including fall prevention through existing programs such as car-free day, Friday sports, Umuganda, just to name few.

Teaching institutions specifically university of Rwanda, needs to introduce specific educational programs in gerontology and conduct research on exercise in adults as life expectancy is increasing and expect to have more elderly in near future.The elderly persons must be encouraged to regularly undertake specific physical activity and exercise programs customized to their abilities and health conditions to promote wellness and longevity.

Futuremore, researchers should investigate about fall prevention in the elderly country-wide and to conduct comparative large scale study on physiotherapy-based exercises and other fall preventions interventions in their communities and raise awareness on fall in the elderly which is becoming a health threat in that category of the population.

The private sector including investors in sports and exercise centers, and rehabilitation clinics are encouraged to focus on geriatrics to increase access.

Authors' contribution

The authors NCC and ML designed a set of exercises. The remaining four authors (BBG, MJB, NM and TKH) reviewed and delivered the exercises to the participants using a recorded video with the SoeursSaint Vincent de Paul recreational TV screen.

Conflict of interest declaration

The authors declare no conflict of interest for this study

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References

1. James SL, Lucchesi LR, Bisignano C, Castle CD, Dingels ZV, Fox JT, Hamilton EB, Henry NJ, Krohn KJ, Liu Z, McCracken D, Nixon MR, Roberts NLS, Sylte DO, Adsuar JC, Arora A, Briggs AM, Collado-Mateo D, Cooper C, Dandona L, Dandona R, Ellingsen CL, Fereshtehnejad SM, Gill TK, Haagsma JA, Hendrie D, Jürisson M, Kumar GA, Lopez AD, Miazgowski T, Miller TR, Mini GK, Mirrakhimov EM, Mohamadi E, Olivares PR, Rahim F, Riera LS, Villafaina S, Yano Y, Hay SI, Lim SS, Mokdad AH, Naghavi M, Murray CJL. The global burden of falls: global, regional and national estimates of morbidity and mortality from the Global Burden of Disease Study 2017. *Inj Prev.* 2020. https://doi/org/10.1136/injuryprev-2019-043286.
2. WHO. WHO Global Report on Falls Prevention in Older Age WHO Global Report on Falls Prevention in Older Age. *Who website.* 2007. ISBN 9789241563536. https://iris.who.int/bitstream/handle/10665/43811/9789241563536 _eng.pdf?sequence=1. Accessed 03 Jan 2025

3. Sherrington C, Tiedemann A, Fairhall N, Close JC, Lord SR. Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *N S W Public Health Bull.* 2011 Jun;22(3-4):78-83. https://doi.org/10.1071/NB10056.
4. Moncada LVV, Mire LG. Preventing falls in older Persons. *Am Fam Physician.* 2017. 96(4):240-247.
5. Krieg H, Eller T, Kies L. Verbreitung und Ökologie der Vaucheria-Arten (Tribophyceae) des Elbe-Ästuars und der angrenzenden Küste. *Helgoländer Meeresuntersuchungen.* 1988;42:613–36.
6. WHO. Strategies for preventing and managing falls across the life-course. *Who website.* 2021. https://www.who.int/publications/i/item/978924002191-4 Accessed 03 Jan 2025
7. Sherrington C, Tiedemann A. Physiotherapy in the prevention of falls in older people. *J Physiother.* 2015 Apr;61(2):54-60. https://doi.org/10.1016/j.jphys.2015.02.011.
8. Clemson L, Stark S, Pighills AC, Torgerson DJ, Sherrington C, Lamb SE. Environmental interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev.* 2019. https://doi.org/10.1002/14651858.CD013258. .
9. Sherrington C, Tiedemann A, Fairhall N, Close JC, Lord SR. Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *Public Heal Bull.* 2011. 22(3-4):78–83. https://doi.org/10.1071/NB10056
10. Tiedemann A, Lord SR. The role of exercise for fall prevention in older age. *Motriz: rev. educ. fis.* 2013. 541–547. https://doi.org/10.1590/S1980-65742013000300002
11. Martina Aboderin I, Bayisenge J, Irambeshya A. Population Ageing in Rwanda: Current Needs, Future Projections, and Implications for Policy. *DFID.* 2018. 1–77. https://assets.publishing.service.gov.uk/media/5b6c063440f0b640a5370011/Implications_of_Demographic_Change_in_Rwanda_FULL_REPORT.pdf
12. National Institute of Statistics of Rwanda (NISR). Rwanda - Rwanda Population and Housing Census. *NISR.* 2012. Available at https://www.statistics.gov.rw/datasource/42 . Accessed 03 Jan 2025
13. Brief P. Unlocking Rwanda ' s Potential to Reap the Demographic Dividend. *African Instutute for Development Policy.*2017. https://www.statistics.gov.rw/sites/default/files/documents/2025-05/21.05.2018-Rwanda-DD-Report_Final-For-Print-2.pdf. Accessed 03 Jan 2025
14. Stutzman L. Fall Prevention: Balance and Strength Exercises for Older Adults. *Johns Hopkins Medicine.* 2022. https://www.hopkinsmedicine.org/health/wellness-and-prevention/fall-prevention-exercises . Accessed 03 Jan 2025
15. Berg K.; Wood-Dauphine S.L.; Wiliams JL. Berg Balance Tests and Rating Scale. *Can J Public Health.* 1992. Greene BR, O'Donovan A, Romero-Ortuno R, Cogan L, Scanaill CN, Kenny RA. Quantitative falls risk assessment using the timed up and go test. *IEEE Trans Biomed Eng.* 2010. 57(12):2918-26. https://doi.org/10.1109/TBME.2010.2083659.
16. Barry, E., Galvin, R., Keogh, C. et al. Is the Timed Up and Go test a useful predictor of risk of falls in community dwelling older adults: a systematic review and meta- analysis. *BMC Geriatr.* 2014. 4(4). https://doi.org/10.1186/1471-2318-14-14.
17. Khot A, Hande D. Effect of conventional balance exercises and electronic balance board on elderly individuals. *Int J Multidiscip Res Dev.* 2017.4:505–8. ISSN: 2349-5979.
18. Sunita, Mahajan AS, Jain A, Singh N, Mishra T. Heart rate and blood pressure response to exercise and recovery in subclinical hypothyroid patients. *Int J Appl Basic Med Res.* 2013. (2):106-10. https://doi.org/10.4103/2229-516X.117076.

20. Lovato NS, Polito MD, Polito MD, Londrina UE De, Celso R, Cid G. Blood Pressure And Heart Rate Variability After Aerobic And Weight Exercises. *Rev Bras Med Esporte.* 2012. 18(1);25:28.
21. Forjaz CL, Matsudaira Y, Rodrigues FB, Nunes N, Negrão CE. Post-exercise changes in blood pressure, heart rate and rate pressure product at different exercise intensities in normotensive humans. *Braz J Med Biol Res*. 1998. 31(10):1247-55. https://doi.org/10.1590/s0100-879x1998001000003.
22. Salles GF, Reboldi G, Fagard RH, Cardoso CR, Pierdomenico SD, Verdecchia P, Eguchi K, Kario K, Hoshide S, Polonia J, de la Sierra A, Hermida RC, Dolan E, O'Brien E, Roush GC; ABC-H Investigators. Prognostic Effect of the Nocturnal Blood Pressure Fall in Hypertensive Patients: The Ambulatory Blood Pressure Collaboration in Patients With Hypertension (ABC-H) Meta-Analysis. *Hypertension.* 2016. 67(4):693-700. https://doi.org/10.1161/hypertensionaha.115.06981.
23. Sun M, Min L, Xu N, Huang L, Li X. The Effect of Exercise Intervention on Reducing the Fall Risk in Older Adults: A Meta-Analysis of Randomized Controlled Trials. *Int J Environ Res Public Health.* 2021. 18(23):12562. https://doi.org/10.3390/ijerph182312562.
24. Mohamed AA, El-shamaa ET, Mohamed JAE. Assess the Effect of Exercises program on balance and prevention of recurrent falling among Elderly People. *Min Sci J*. 2019. 6(1)1: 63-70. https://doi.org/10.21608/msnj.2019.187802.
25. Maneeprom N, Taneepanichskul S, Panza A, Suputtitada A. Effectiveness of robotics fall prevention program among elderly in senior housings, Bangkok, Thailand: a quasi-experimental study. *Clin Interv Aging*. 2019. 18(14):335-346. https://doi.org/10.2147/CIA.S182336.
26. Da Fonte E, Feitosa PH, de Oliveira Neto LT, de Araújo CL, Figueiroa JN, Alves JG. Effects of a physical activity program on the quality of life among elderly people in Brazil. *J Family Med Prim Care.* 2016. 5(1):139-42. https://doi.org/10.4103/2249-4863.184639.
27. Bosco, E., Hsueh, L., McConeghy, K.W., Gravenstein, S., & Saade, E. Major adverse cardiovascular event definitions used in observational analysis of administrative databases: a systematic review. *BMC Med Res Methodol*. 2021. https://doi.org/10.1186/s12874-021-01440-5