ORIGINAL ARTICLE

Effect of Qigong Exercise on Balance in Healthy Elderly

Juwita Kusumadewi[1], Endang Ambarwati[1], Tanti Ajoe Kesoema[1]

[1] Department of Physical Medicine and Rehabilitation, Diponegoro University, dr. Kariadi General Hospital Semarang, Indonesia

ABSTRACT

Introduction: The elderly experience various declines in life, which can cause a decrease in balance that will affect their quality of life. Balance can be measured using various assessment instruments, including Berg Balance Scale (BBS). Qigong exercise is not widely known among the elderly in Indonesia, although it has many benefits and is suitable for them. This study aimed to prove the Qigong exercise's effect on improving balance in the elderly.

Methods: This study was a randomized controlled trial with pre and post-test control group design. The consecutive sampling method was employed in this research. A total of 20 participants were put into an intervention group (n=10) and a control group (n=10). The participants in the intervention group performed Qigong exercises three times a week for eight weeks. Meanwhile, the control group received common elderly exercise three times a week. Balance was measured before and after the intervention using the Berg Balance Scale (BBS).

Results: There was an increase in BBS scores after treatment both in the elderly exercise group (p=0.003) and the Qigong group (p=0.004). The Berg Balance Scale value in the control group (44.30±0.68) was higher than the Qigong group (44.18±0.60) at the beginning of the study, but the difference was not significant (p=0.632). The Berg Balance Scale value in the control group (46.60±0.84) was lower than the Qigong group (48.45±1.13) at the end of the study, and the difference was significant (p<0.001).

Conclusion: Qigong exercise improves balance more than the common elderly exercise.

Keywords: functional balance, Berg Balance Scale, Qigong exercise, elderly exercise.

ABSTRAK

Latar belakang: Lansia mengalami berbagai penurunan kondisi yang mampu menurunkan keseimbangan fungsional tubuh sehingga berpengaruh terhadap kualitas hidup. Keseimbangan dapat dinilai menggunakan berbagai instrumen penilaian, salah satunya adalah *Berg Balance Scale* (BBS). Senam Qigong belum banyak dikenal di kalangan lansia di Indonesia meskipun senam tersebut memiliki banyak manfaat untuk lansia. Penelitian ini bertujuan membuktikan pengaruh senam Qigong terhadap peningkatan keseimbangan fungsional pada lansia.

Metode: Penelitian ini merupakan *randomized controlled trial* dengan *pre-test* and *post-test control group design*. Sampling dilakukan dengan metode *consecutive sampling*. Besar sampel sebesar 20 orang dan dibagi menjadi kelompok intervensi (n=10) dan kelompok kontrol (n=10). Partisipan pada kelompok intervensi melakukan senam Qigong sebanyak 3 kali seminggu selama 8 minggu. Kelompok kontrol melakukan senam lansia sebanyak 3 kali seminggu. Keseimbangan diukur sebelum dan setelah intervensi dengan menggunakan *Berg Balance Scale* (BBS).

Hasil: Terdapat peningkatan skor BBS sebelum dan sesudah perlakuan pada kelompok senam lansia (p=0,003), dan pada kelompok senam Qigong (p=0,004). Nilai Berg Balance Scale pada kelompok kontrol (44,30±0,68) lebih tinggi dibandingkan dengan kelompok Qigong (44,18±0,60) pada awal penelitian namun perbedaan tersebut tidak signifikan (p=0,632). Nilai *Berg Balance Scale* pada kelompok kontrol (46,60±0,84) lebih rendah dibandingkan dengan kelompok Qigong (48,45±1,13) pada akhir penelitian serta perbedaan tersebut signifikan (p<0,001).

Simpulan: Senam Qigong meningkatkan keseimbangan yang lebih baik dari pada senam lansia.

Kata kunci: keseimbangan fungsional, *Berg Balance Scale*, senam Qigong, senam lansia

Correspondent Detail:

Juwita Kusumadewi, MD

Department of Physical Medicine and Rehabilitation, dr. Kariadi General Hospital Faculty of Medicine Diponegoro University, Semarang Indonesia
Email: juwitakusumadewi@ymail.com

INTRODUCTION

The number of elderly is expected to increase. According to Statistics Indonesia (BPS), the percentage has approximately doubled during 50 years (1971-2019) and reached around 25 million people.[1] The Ministry of Health noted that the number of elderly is estimated to reach 48.2 million in 2035.[2]

The elderly will experience various declines in life, including health aspect, which affects their physiological function, body structure, productivity, and quality of life.[3,4] They will experience physical changes such as decreased muscle mass, joint stiffness, decreased range of motion (ROM), decreased mass, and bone density. Declining sensory function, which includes visual function, vestibular function in the ear, and somatosensory function, including touch, taste,

perception, and pain, may also be noted. They also may experience excessive anxiety that causes fear of falling. The body's functional balance in the elderly will also decrease significantly and disturb their daily activities.[4]

Balance can be assessed and measured using various assessment instruments, including the Berg Balance Scale (BBS).[5] Balance exercises can be an effort to improve body balance. They may help the elderly increase muscle strength and maintain a balanced posture, saving them from the risk of falling.[6] One of the balance exercises widely known in Indonesia is the common elderly exercise. Previous studies have noted several weaknesses of this exercise, such as; having numerous different movements; taking a long period to evaluate the impact itself, which may decrease the participation and motivation among older people. Despite its weakness, common elderly exercise still has numerous slow movements, which are easy to be done by the elderly[6,7,8]

Besides common elderly exercises, various types of balance exercises have relatively easier movements, such as Pilates, Tai Chi, and Qigong, but these are not widely known in Indonesia.[6,7,8] Qigong exercise is a branch of Traditional Chinese Medicine (TCM) and uses a combination of breathing exercises, meditation, and movements. The theory of Chinese traditional medicine proposes that the body is a small universe with a vital energy flow called "Qi". Disturbance of vital energy flow results in illness or occurs because of injuries or illness. Qigong exercise requires minimal musculoskeletal strain and less energy expenditure and benefits physical ability, physical function, balance, and psychological health. Thus, Qigong exercise may offer an excellent approach to promoting the health of adults with various levels of physical ability, physical function, and chronic illness.[9] It is believed that "Qigong" (Qi = flow of energy; gong = work or exercise) facilitates the movement of Qi throughout the body, thereby improving health.[10]

Qigong exercise has various movements, including the Eight-section brocades (Baduanjin). Compared with Tai Chi, this movement requires fewer physical and cognitive needs.[8] Several Qigong exercise benefits for the elderly include having slow, controlled, non-impact posture and movement changes and the ability to control the body's center of gravity. This alternative exercise is based on balancing vital energy, calm thoughts, and controlled emotions. This exercise also integrates deep breathing, meditation, movement, and posture. Based on previous research, Qigong exercise is safe for elderly individuals with depression, frailty syndrome, or chronic diseases. Qigong has been proven to significantly improve balance, physical abilities, functional health, psychological health, and spiritual well-being in the elderly.[7]

Qigong exercises require the individual to move to and away from a semi-squatting posture with coordinated concentric and eccentric knee-joint muscle control. The combination of concentric and eccentric contractions during training has been proven more effective for improving muscle strength than concentric training alone. Movements during Qigong practice also resemble those required in many daily activities (sit-to-stand, picking up objects from the floor, managing stairs, etc.), which may account for the improvement in FTSTT (5 Times Sit to Stand test).[10]

Looking through the numerous effects served by Qigong, this exercise still has to be announced

among the elderly in Indonesia.[7] Currently, many studies have suggested that physical exercise, as an alternative and complementary therapy, has a positive effect. Qigong exercise is an easily adaptable form of mind-body integrative exercise whose essential components include concentration, relaxation, meditation, breathing regulation, body posture, and gentle movement.[9] The research that specifically examines the effect of Qigong exercise among the elderly in Indonesia is still limited, especially in the functional balance aspect. Therefore, the purpose of this study is to examine the effect of Qigong exercise on functional balance in the elderly.

METHODS

This study was a randomized controlled trial pre-test and post-test control group designed to determine the effect of Qigong exercise on functional balance in elderly individuals living in "Panti Pelayanan Sosial Lanjut Usia", Pucang Gading, Semarang on June 2021– August 2021. The total sample was 22 participants recruited using consecutive sampling technique, and then simple randomization was carried out to divide the subjects into two groups, with 11 participants in each.

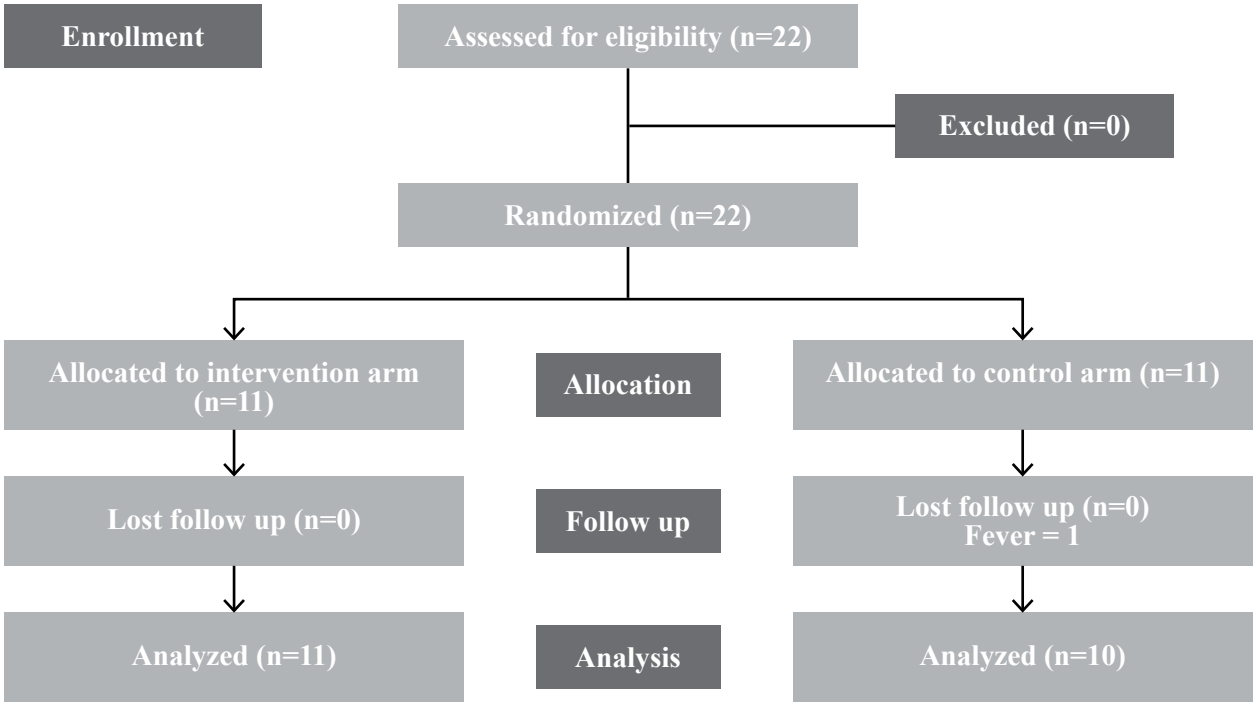

Figure 1. Consort Flowchart Diagram

Inclusion criteria included patients aged 60-75 years, who could walk without assistive devices, were cooperative and were willing to participate in the study by signing the informed consent.

Exclusion criteria consisted of patients with uncorrected visual and auditory disturbances resulting in the inability to follow instructions (cataracts, deafness), patients with proprioceptive disorders, having heart, lung, and nerve diseases

that result in limitations in participating in training, having a history of malignant hypertension (blood pressure 180/120mmHg), having musculoskeletal disorders (in the hip joint, knee joint, ankle joint and vertebral trunk) that result in limitations in following the exercise, having a score of MMSE < 24, having quadriceps muscle strength with MMT 4, having LLD >2 inches, having deformities of the lower extremities (varus or valgus in the knee joint, ankle joint), and having posture disorders such as scoliosis, kyphosis, lordosis.

This study also determined the drop-out criteria, including not coming to the Qigong exercise schedule twice or more in a row and not coming during the initial and final assessment of the study.

Subjects in the intervention group were given the Qigong exercise thrice a week for eight weeks. At the same time, the control group was given common elderly exercise three times a week.

Subjects who met the research criteria were involved in the elderly community. The participants were given an explanation of the objectives and benefits and the research protocol. Selected subjects who were willing to participate in the study were asked to sign an agreement. The subjects were randomized and divided into two groups, namely the intervention group and the control group; both were tested for BBS. The examination was carried out by the researchers. An exercise between the control and intervention groups was conducted in different locations. In the intervention group, participants performed Qigong exercises led by a certified trainer thrice a week. While in the control group, the participants got common elderly exercises thrice a week; and were given directions not to do other exercises other than those given by the researcher. BBS assessment was employed in both groups after participants completed Qigong exercises for eight weeks.

This study has passed the ethical clearance test by the Ethical Commission of the Faculty of Medicine, Diponegoro University/Dr. Kariadi General Hospital Semarang with ethical clearance number 147/EC/KEPK/FK-UNDIP/V/2021. The participant's data will be kept confidential and not published unless with the participant's permission.

Data were collected as collection sheets and coded, tabulated, and entered into the software. They were then analyzed using descriptive analysis and hypothesis testing. The normality test was performed using the Shapiro-Wilk test, and all data were normally distributed. To find out the difference in the BBS value before and after the intervention, a hypothesis test was carried out using paired t-test. The difference in the BBS value between the group was carried out by unpaired t-test. All data were processed with SPSS® software. The significance of this study was obtained if the p-value <0.05 was obtained with a 95% confidence interval.

RESULTS

A total of 22 elderly subjects met the inclusion and exclusion criteria and were willing to participate in the study. Subjects were randomly divided into two groups: the intervention (Qigong) group and the control group, with 11 subjects in each group. In the end, the total data analyzed were 21 subjects. A subject dropped out because he had a fever and could not participate in the exercise.

In both groups, most participants were women (72,7% in the Qigong group, 70% in the control group) and tended to have a non-sedentary lifestyle. The Qigong group consisted of the elderly, 69,64 ± 5,26, with a mean weight of 53,09 ± 5,17 kg and height of 153,00 ± 4,65. In comparison, the control group consisted of the elderly at 69,10 ± 6,42 with a mean weight of 54,90 ± 4,61 kg and height of 154,80 ± 5,37. No significant differences were observed between each group in baseline characteristics.

Table 1. Characteristics of subject

Variable	Group		P
	Qigong	Control	
Gender			
Men	3 (27,3%)	3 (30%)	1,000¥
Women	8 (72,7%)	7 (70%)	
Age	69,64 ± 5,26	69,10 ± 6,42	0,836¥
Weight	53,09 ± 5,17	54,90 ± 4,61	0,409¥
Height	153,00 ± 4,65	154,80 ± 5,37	0,420¥
BMI	22,69 ± 2,11	22,94 ± 1,90	0,573¥
Physical Activity Index			
Sedentary	0 (0%)	0 (0%)	
Non Sedentary	11 (100%)	10 (100%)	-

¥ p-value >0.05

Assessment of functional balance using the Berg Balance Scale (BBS) was performed in both groups. This test was conducted before the intervention started (pre-test) and at the end of week 8 of the study (post-test). The results of the Berg Balance Scale test measurements in the intervention and control groups are shown in Table 1.

Table 2. Differences of BBS pre-test, post-test and the differences of post and pre-test (delta).

BBS	Group		p
	Qigong	Control	
Pre-test	44,18 ± 0,60	44,30 ± 0,68	0,632†
Post-test	48,45 ± 1,13	46,60 ± 0,84	<0,001†*
P	0,003‡*	0,004‡*	
Delta	4,27 ± 1,01	2,30 ± 0,48	<0,001†*

*p value <0.05
† Unpaired sample t-test
‡ Paired sample t-test

The BBS I and II scores in both groups are shown in Table 2. In the control group, the BBS II scores increased compared to the BBS I scores, but it was not as high as in the intervention group. There was also a significant difference between BBS I and BBS II scores (p=0.004), indicating a substantial improvement in functional balance in the control group. In the intervention group, BBS II scores increased compared to BBS I scores. The statistical analysis showed a significant difference between BBS I and BBS II scores (p=0.003).

The data showed that the delta (mean change) of BBS scores before and at the end of week 8 in the Qigong group was higher than the control group. The BBS score in the control group (44.30±0.68) was higher than the Qigong group (44.18±0.60) at the beginning, but the difference was not significant (p = 0.632). This is different from the BBS score at the end of the study. The value of the Berg Balance Scale in the control group (46.60 ± 0.84) was lower than the Qigong group (48.45±1.13), and it was statistically significant (p < 0.001). The mean difference between the Qigong and the control groups was also significant (p<0.001). The statistical tests indicated a significant difference between BBS I and BBS II scores (p = 0.003). This shows that statistically, the Qigong exercise can improve functional balance better than the control group.

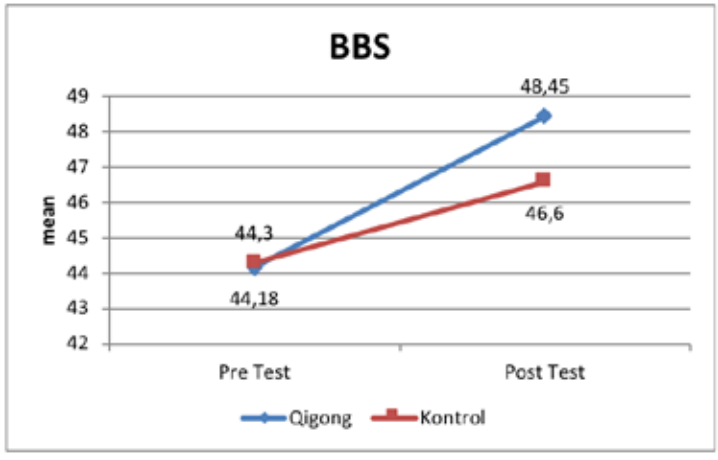

Figure 2. Berg Balance Scale Result

DISCUSSION

The characteristics of the research subjects, which included gender, age, weight, height, and BMI, showed that the subjects in the two groups were statistically not different. This can be interpreted that their characteristics were evenly distributed so that they did not affect the study results.

There were more female than male participants. Kado et al. and Takahashi et al. claim kyphosis exacerbation with age is becoming a more common problem for women. There was a difference in the mean age between the Qigong and the control groups in this study. The balance will decline in individuals over 60. A study published in 2018 found that one-legged standing time in the obese group was significantly shorter than in the normal-weight group of elderly women.[11]

There was also a slight difference in mean body weight between the Qigong and the control group. The mean weight of the Qigong group was lower than the control group in this study, and this result was also found in height and BMI. The taller a person's body is, the lower the functional ability will be. Functional ability is correlated with static and dynamic balance functions.[13-20] Physical activity is known to have many benefits and is recommended for reducing the risk of falling.[21,22] Among all subjects, both the Qigong and the control groups had non-sedentary levels of physical activity classification.

In this study, the subjects were divided into two groups. The Qigong group was given Qigong exercise thrice a week for eight weeks, and the control group was given common elderly exercise. The treatment that was given to the Qigong group showed an improvement in functional balance measured by the Berg Balance Scale test in this study.

If we look at the average test scores at the beginning of the study and the end of the 8th week, it was categorized as a low fall risk classification, and an improvement in the BBS value was found based on the difference between the two means. Research by Xiao et al. (2020) showed an improvement of 2 points in the group with the Qigong exercise compared to the control group in improving BBS with a p-value of 0.014.

There was a study conducted on elderly people with OA cases.[23–26] Based on the study by Chang et al. (2018) in the elderly, there was a 2-point change with a P value <0.01 in the moderate fall risk group, which was considered effective in improving balance function.[27]

Fraser et al. (2017) research on the elderly showed an improvement of 2 points in the low fall risk group with a P value of <0.001 which was considered to improve balance after doing Qigong exercises.11 In this study, there was a significant improvement of 4 points between the pre and post-Qigong exercise groups.

Qigong exercise improves the ability to utilize vestibular input, which is a component of intervention for people with stable central and peripheral vestibular disorders; thus, it may result in balance and sensory improvement. One randomized controlled trial in health and younger subjects found that Qigong exercise increased the kinetic sensitivity of the glenohumeral joint at an angle of 60°, and another non-randomized study reported that Qigong exercise improved arm control in older subjects. This beneficial movement is very similar to the heel lift exercise, which improves ankle strength and plantar flexor strength. Ankle flexibility and ankle plantar flexor strength significantly affect balance and functional health. This may explain why practicing Qigong can lead to better balance.[28]

Qigong exercises also increase the ability to utilize somatosensory and proprioceptive input, which provides information on body position to the environment.[27,28] Qigong exercises use the basic position of standing with your knees slightly bent. This position has the effect of increasing lower leg strength so that it will produce better balance when standing and walking. There is a reciprocal relationship between spinal mobility, the sagittal spine shape and impaired balance, which is caused by a shift in the center of gravity. An increase in the flexibility of the thoracolumbar spine and posture will increase the mobility of the spine, thereby may improving balance.[29]

In this study, the control group was given elderly exercise thrice a week and provided an increase in functional balance in the Berg Balance Scale test. The increasing value of the Berg Balance Scale test was not as high as the value found in the Qigong group. In this study, the classification of low fall risk was seen from the average Berg Balance Scale test value, and it was found that there was an improvement in the Berg Balance Scale value when compared to the beginning of the study with the end of week 8. A study by Stahl et al. (2020) stated by conducting the common elderly exercise, the value obtained in the pre-test Berg Balance Scale test was 39, and the post-test was 42.05 with a p-value <0.001. This indicates that elderly exercise can increase the balance score of the elderly from the moderate fall risk group to the low fall risk group. Elderly exercise also showed an improvement in functional balance in this study. Elderly exercise increases the number of muscle cells that contain myoglobin and mitochondria. This number of muscle cells will increase muscle strength, which affects maintaining body balance. Elderly with low physical activity and those who do not routinely perform the elderly exercise will result in declining body cell function. This will affect the balance organ system's function, thus increasing the risk of falling.[29]

In this study, the delta value of the Berg Balance Scale test before treatment and at the end of the 8th week in the Qigong group was higher than the elderly exercise group. This shows that Qigong Exercise can improve functional balance as measured by the Berg Balance Scale compared to the elderly group.

The improvement in BBS values after the Qigong exercise intervention was due to several underlying mechanisms. Balance exercises are carried out by strengthening weak muscles, repairing stiff joints, and training muscle coordination; thus elderly can control the risk of falling. Elderly exercise is effective in increasing flexibility and balance in the elderly, also reducing the risk of falling. Decreased balance may be improved by doing elderly exercise because it can maintain muscle function and posture. Flexibility may increase the strength of tendons and ligaments and maintain and strengthen muscles in all joints. Elderly exercise also increases the production of synovial fluid, therefore, may prevent injury.[30-32]

LIMITATIONS

Blinding was not done in this study, so measurement bias could have happened. Blinding does not allow the researchers to know the division of the intervention group or the control group. Experimental research/clinical trials with randomization techniques will create greater quality if the measurements are blinded. In addition, this study did not measure lower leg muscle strength at the beginning and end of the study.

CONCLUSION

Qigong exercise for eight weeks can improve balance in healthy elderly individuals. This exercise gives more significant results in improving balance compared to common elderly exercises.

REFERENCES

1. Badan Pusat Statistik. Statistik Penduduk Lanjut Usia. In: Badan Pusat Statistik; 2018.
2. Kementerian Kesehatan RI. Situasi Lanjut

Usia (Lansia) di Indonesia. Infodatin Pusat Data dan Informasi Kementerian Kesehatan Republik Indonesia; 2016.
3. Da Costa JP, Vitorino R, Silva GM, Vogel C, Duarte AC, Rocha-Santos T. A synopsis on aging—Theories, mechanisms and future prospects. Physiol Behav. 2017;176(1):139–48.
4. Departemen Kesehatan Republik Indonesia. Riset Kesehatan Dasar. Jakarta: Badan Penelitian dan pengembangan Kesehatan Kementerian Kesehatan RI; 2013.
5. Konrad HR, Girardi M, Helfert R. Balance and aging. In: Chiu BL, Pinto JM (eds). Aging in the United States, Otolaryngologic Clinics of North America; 2018.
6. Kaesler DS, Mellifont RB, Kelly PS, Taaffe DR. A novel balance exercise program for postural stability in older adults: A pilot study. In: Nepocatych S, Ketcham C, Vallabhajosula S, Balilionis G (eds). The effects of unstable surface balance training on postural sway, stability, functional ability and flexibility in women J Sports Med Phys Fitness; 2018. p. 27–34.
7. Davis CM. Qi Gong for Health and Healing. In: Complementary Therapies In Rehabilitation for Efficacy in Therapy, Prevention, and Wellness SLACK Incorporated; 2019. p. 53–60.
8. Chu DA. Tai Chi, Qi Gong and Reiki. Phys Med Rehabil Clin N Am. 2004;15(4):773–81.
9. Chang PS, Lu Y, Nguyen CM, Suh Y, Luciani M, Ofner S, et al. Effects of Qigong exercise on physical and psychological health among African Americans. West J Nurs Res. 2021 June ; 43(6): 551–562.
10. Yuen M, Ouyang XH, Miller T, Pang MY. Baduanjin Qigong Improves Balance, Leg Strength, and Mobility in Individuals With Chronic Stroke: A Randomized Controlled Study. Neurorehabilitation and Neural Repair. 2021, 35(5):444–456.
11. Puszczalowska-Lizis E, Bujas P, Jandzis S, Omorczyk J, Zak M. Inter-gender differences of balance indicators in persons 60-90 years of age. Clin Interv Aging. 2018 May 11;13:903-912.
12. Zhang FX, Ge SN, Dong YL, Shi J, Feng YP, Li Y, Li YQ, Li JL. Vesicular glutamate transporter isoforms: The essential players in the somatosensory systems. Prog Neurobiol. 2018 Dec;171:72-89.
13. Reimann H, Fettrow T, Thompson ED, Jeka JJ. Neural control of balance during walking. Front Physiol. 2018;9(SEP):1–13
14. Chengetanai S, Tadyanemhandu C, Chibhabha F, Kaseke F. The relationship between weight bearing asymmetry after stroke and functional standing balance. Int J Sci Res. 2016;6(11):52–9.
15. Bang DH, Cho HS. Effect of body awareness training on balance and walking ability in chronic stroke patients: A randomized controlled trial. J Phys Ther Sci. 2016;28(1):198–201.
16. Tsaklis P V., Grooten WJA, Franzén E. Effects of weight-shift training on balance control and weight distribution in chronic stroke: A pilot study. Top Stroke Rehabil. 2012;19(1):23–31.
17. Tamburella F, Scivoletto G, Molinari M. Somatosensory inputs by application of KinesioTaping: Effects on spasticity, balance, and gait in chronic spinal cord injury. Front Hum Neurosci. 2014;8(MAY):1–9.
18. Thibaut A, Chatelle C, Ziegler E, Bruno MA, Laureys S, Gosseries O. Spasticity after stroke: Physiology, assessment and treatment. Brain Inj. 2013;27(10):1093–105.

19. Arene N, Hidler J. Understanding motor impairment in the paretic lower limb after a stroke: A review of the literature. Top Stroke Rehabil. 2009;16(5):346–56.
20. Kenyon LK, Blackinton MT. Applying motor-control theory to physical therapy practice: A case report. Physiother Canada. 2011;63(3):345–54.
21. Safarpour M, Hosseini SR, Mohamadzade M, Bijani A, Fotouhi A. Predictors of Incidence of Fall in Elderly Women; A Six-Month Cohort Study. Bull Emerg Trauma. 2018 Jul;6(3):226-232.
22. Ehrari H, Larsen RT, Langberg H, Andersen HB. Effects of Playful Exercise of Older Adults on Balance and Physical Activity: a Randomized Controlled Trial. J. Popul. Ageing. 2020;13:207-222.
23. Chiu HL, Yeh TT, Lo YT, Liang PJ, Lee SC. The effects of the Otago Exercise Programme on actual and perceived balance in older adults: A meta-analysis. PLoS One. 2021 Aug 6;16(8):e0255780.
24. Izquierdo M, Merchant RA, Morley JE, Anker SD, Aprahamian I, Arai H, Aubertin-Leheudre M, Bernabei R, Cadore EL, Cesari M, Chen LK, de Souto Barreto P, Duque G, Ferrucci L, Fielding RA, García-Hermoso A, Gutiérrez-Robledo LM, Harridge SDR, Kirk B, Kritchevsky S, Landi F, Lazarus N, Martin FC, Marzetti E, Pahor M, Ramírez-Vélez R, Rodriguez-Mañas L, Rolland Y, Ruiz JG, Theou O, Villareal DT, Waters DL, Won Won C, Woo J, Vellas B, Fiatarone Singh M. International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. J Nutr Health Aging. 2021;25(7):824-853.
25. Rezaeipour M, Apanasenko G L. Acute Improvement of Postural Steadiness Through Neuromuscular and Proprioceptive Training in Sedentary Older Females, Middle East J Rehabil Health Stud. Online ahead of Print; 7(4):e104894.
26. Xiao C, Zhuang Y, Kang Y. Effects of Wu Qin xi Qigong exercise on physical functioning in elderly people with knee osteoarthritis: A randomized controlled trial. Geriatr Gerontol Int. 2020 Oct;20(10):899-903.
27. Fraser SA, Li KZ, Berryman N, Desjardins-Crépeau L, Lussier M, Vadaga K, Lehr L, Minh Vu TT, Bosquet L, Bherer L. Does Combined Physical and Cognitive Training Improve Dual-Task Balance and Gait Outcomes in Sedentary Older Adults? Front Hum Neurosci. 2017 Jan 18;10:688.
28. Xiao CM, Zhuang YC. Effect of health Baduanjin Qigong for mild to moderate Parkinson's disease. Geriatr Gerontol Int. 2016;16(8):911–9.
29. Gil EM, López-Arza MVG. Systematic review about the effects of Qigong therapeutic exercise on balance. Altern Integr Med. 2017;6(1):1000236.
30. Albert N. Pengaruh Senam Lansia terhadap Keseimbangan Tubuh Lansia di Panti Sosial Tresna Werdha Kasih Sayang Ibu Batusangkar Tahun 2018 (Doctoral dissertation, Universitas Andalas); 2019.
31. Martono H. Aspek Fisiologis dan Patologis Akibat Proses Menua. In: Martono H, Panarka K, editors. Geriatri (Ilmu Kesehatan Usia Lanjut). 4th ed; 2009. p. 56–74.
32. Suroto S. Buku Pegangan Kuliah: Pengertian Senam, Manfaat Senam, dan Urutan Gerakan. UPT Mata Kuliah Umum Olahraga UNDIP; 2004