JBACHS
Journal of Basic and Clinical Health Sciences

J Basic Clin Health Sci 2020; 4:140-144
https://doi.org/10.30621/jbachs.2020.978

Original investigation

The Examination of the Relationship Between Flexibility and Stability of Trunk in Older Adults

Mehmet Duray[2], Şule Şimşek[1], Nesrin Yağcı[3], Hande Şenol[4]

[1]Pamukkale University, Sarayköy Vacational School, Denizli, Turkey
[2]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Süleyman Demirel University, Isparta, Turkey
[3]Pamukkale University, School of Physical Therapy and Rehabilitation, Denizli, Turkey
[4]Pamukkale University, Medicice Faculty/Department of Biostatistics, Denizli, Turkey

Address for Correspondence: Mehmet Duray, **E-mail:** mehmet_duray@hotmail.com
Received: 25.04.2019; **Accepted:** 11.03.2020; **Available Online Date:** 15.05.2020

Cite this article as: Duray M, Şimşek Ş, Yağcı N, Şenol H. The Examination of the Relationship Between Flexibility and Stability of Trunk in Older Adults J Basic Clin Health Sci 2020; 4:140-144.

ABSTRACT

Purpose: This study was planned to examine the relationship between body flexibility and stability in the elderly and to compare it with adults.

Methods: People over 40-year-of-age had no musculoskeletal problems in the spine, had good cognitive functions, and could walk independently were included in this cross-sectional study. 156 participants were grouped as the young (n: 65) and the elderly group (n: 91). Flexibility assessment included Sit and Reach Test (SRT), Back Extension Test (BET) and Side Bending Test (SBT). Antero-posterior stability of body was measured by Functional Reach Test (FRT).

Results: The flexibility of trunk in four directions and stability were better in young group than elderly group ($p<0.001$). In both groups, flexibility measurements except SRT showed a positive and medium significant correlation with FRT. There was also a negative correlation was found between age and body flexibility (SRT, BET, SBT) measurement scores in elderly group ($p=0.001$), but neither all flexibility measurements nor stability were associated with age in young group ($p>0.05$).

Conclusion: Loss of flexibility is a more important risk factor than aging for balance and stability impairment. So it is suggested that treatment protocols should include approaches increasing body flexibility to increase body stability.

Key words: Flexibility, stability, elderly

INTRODUCTION

Flexibility refers to the ability of a muscle to lengthen, the range of motion of one or more joints, and is an essential component of normal biomechanical function (1). Along with the normal aging process, changes in the collagenous tissue result in reduced flexibility and loss of range of motion (2). The relative contributions of soft tissue to total resistance encountered in a joint are as follows: the joint capsule, 47% ; muscle and fascia, 41% ; tendon and ligaments, 10% and skin 2% (3). According to Goldspink, collagen solubility and cross-linking, within muscle increase with age which results in decreased joint range of motion. Inactivity or activity limitation increases collagen turnover and accumulation within ligaments, shortens muscle fibers and reduces muscle mass and flexibility (4). It was thought that studies about flexibility are inadequate, and there was no consensus on the recommendation of flexibility assessment and approach for the elderly in the 'Guide to Exercise and Physical Activity for the Elderly published in the American College of Sports Medicine in 2009 (5). Goldsprink has suggested that exercise can help to reduce age-related fibrosis and preserve declining flexibility with aging (4). Loss of upper and lower body flexibility has negative effects on activities such as getting dressed, reaching for objects, maintaining normal walking patterns, bending and reaching (6, 7). Because the thoracic region usually tends to be kyphotic and the upper cervical region tends to become flexed with aging (8), the center of gravity slides forward and the lower extremity becomes more difficult to extend. Balance and gait disorders due to this abnormal posture are one of the main causes of falling. Progressive stability problems are seen in 30% of people older than 65 years old, who fall because of inability to keep balance (9). According to studies; changes in main gait parameters such as speed and stride length have been associated with the risk of falls, including decreased lower extremity muscle strength, slower reaction time, increased postural oscillations, and peripheral sensory impairment (10). However, relation between flexibility and stability has not been investigated much in this population.

This study was planned to examine the relationship between body flexibility and stability in the elderly and to compare it with adults.

METHODS

Participants

As a result of the power analysis, it is calculated that when 40 people are included for each group, 90% power will be obtained with 95% confidence. This cross-sectional study was conducted in 156 participants living in Asmalıevler Quarter of Denizli between the years 2016–2017. Ethics committee approval for the study was obtained from Ethics Committee of Clinical Research Pamukkale University. All participants received information regarding the aim and methods of the study and provided their informed consent.

Study design

Volunteer participants, aged over 40, were living in their own home, had no musculoskeletal problems in the spine, had good cognitive functions, and could walk independently were included in the study. Volunteers with acute pain; neurological disease and congenital anomalies and pregnant were excluded. Data were collected by two physiotherapists. Socio-demographic data included age, gender, educational level, medical information and exercise habit. One hundred and fifty-six participants were divided into two groups according to their age. Age of 65 was our cut-off score to divide the subjects into two groups as the young group (group I, n=65, between 40–64 years) and the elderly group (group II, n=91, 65 and over) (Figure 1).

Measurements

Flexibility Assessment

Flexibility of trunk for all directions was evaluated by Sit and Reach Test (SRT), Back Extension Test (BET), Side Bending Test (SBT).

SRT was used to evaluate the flexibility of hamstring and flexor muscles of the trunk. For the test, participant sat on the floor with legs stretched out straight ahead. The soles of the feet were placed flat against the box with both knees locked and pressed to the floor. The participant reached forward along the box as far as possible. While hands were at the same level, the participant reached out and held that position for one-two seconds. The distance between edge of the box and fingers was recorded as cm. After three measurements, the highest score was recorded (11, 12).

BET was used as a measure of extension flexibility of trunk. The participants stood against the wall while upper extremities are near the body. The pelvis and trunk contacted with the wall. First, the distance between incisura jugularis and wall was measured and recorded. The participants were then asked to extend their trunk while the therapist was immobilizing pelvis to the wall and the distance between incisura jugularis and wall was measured and recorded again. The difference between two measurements was calculated (11, 12).

Lateral flexibility of the trunk was evaluated with bilateral SBT. The participants stood in front of the wall while upper extremities were

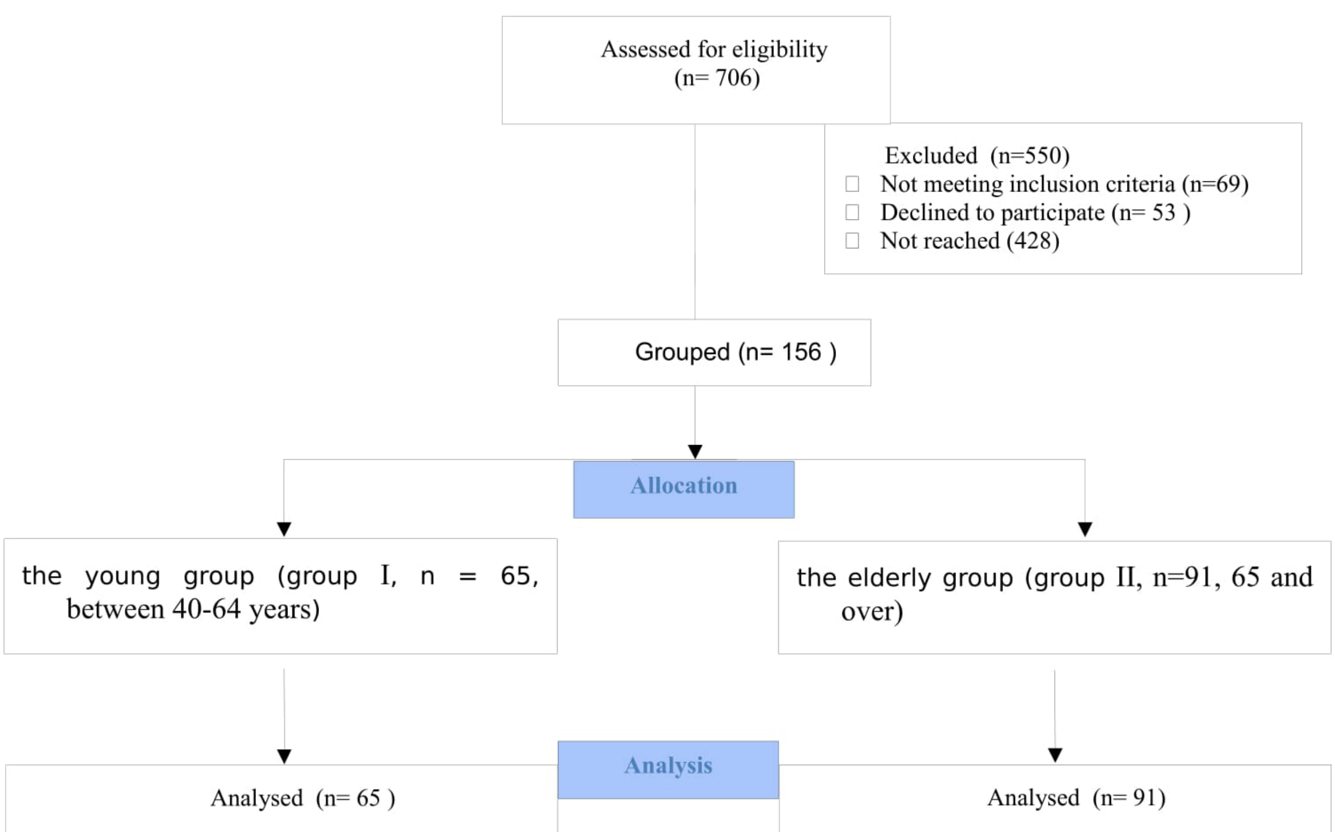

Figure 1. Participant flow and retention.

near the body. There was no contact between the subjects' body and the wall. The distal end of third finger of right hand placed on the femur was marked and then they were asked to flex their trunks to right side. The distal end of third finger of right hand placed on the femur was marked again. The distance between two points was recorded. Same measurement was applied for the other side (12, 13).

Stability Assessment

Antero-posterior stability of body was measured by Functional Reach Test (FRT). The participant was instructed to stands close to the wall. His arm that closer the wall was held at 90° of shoulder flexion. The third metacarpal head is marked on the wall; the patient was asked "reach as far as he can forward without taking a step". The location of the 3rd metacarpal was recorded, again. The distance between two points was measured and recorded as cm (13, 14).

Statistical Analysis

Statistical analyzes were conducted using SPSS for Windows version 20.0 (SPSS, Inc., Chicago, IL, USA). All continuous variables were evaluated for normality using Kolmogorov-Smirnov test. Frequencies were calculated for all variables, and data were presented as frequencies and percentages or mean and standard deviation after flexibility and stability measurement results of groups were compared via Independent Sample t Test and Mann-Whitney U Test, Pearson Correlation Test was used to examine the relationship between physical fitness, balance, falling risk and FOF in both groups. *P* values <0.05 were considered significant.

RESULTS

Descriptive statistics for age, body size and functional capacities of older adults were summarized by age groups in Table 1. Significant differences were found between the groups in terms of number of medication and activity level in favor of the young group (p=0.001).

Table 1. Socio-demographic data of the sample

Variables	Totally (n=156) Mean ± SD	Group I (n=65) Mean ± SD	Group II (n=91) Mean ± SD	p
Age (yr)*	63.78±12.16	51.64±6.93	72.45±6.34	0.0001
BMI (kg/m^2)*	29.19±4.56	28.75±4.47	29.51±4.61	NS
	n(%)	n(%)	n(%)	
Gender**				NS
Female	118 (75,6	46(70,8)	72(79,1)	
Male	38 (24,4)	19(29,2)	19(20,9)	
Education Level**				
Illiterate	9(5.8)	4(6.1)	5(5.5)	NS
≤8years	123(78.8)	49(75.4)	74(81.3)	
>8 years	24(15.4)	12(18.5)	12(13.2)	
Usage of Medicine**				
Yes	82(52.6)	23(35.4)	59(64.9)	0.0001
No	74(47.4)	42(64.6)	32(35.1)	
Exercise habit**				
Yes	74(47.4)	21(32.3)	53(58.2)	0.001
No	82(52.6)	44(67.7)	38(41.8)	

BMI: body mass index; **SD:** standard deviation; ***:** two independence sample t-test; ****:** chi-square test (Mc Nemar); **NS:** not significant.

Table 2 provides the comparisons of groups' across all measurement domains. The flexibility of trunk in four directions and stability were better in the young group than the elderly group (p<0.001).

Table 2. Comparison of flexibility and stability of trunk between groups

Variables	Group I Mean ± SD	Group 2 Mean ± SD	p*
FRT score	30.28±10.94	26.43±3.01	0.006
SRT score	4.53±8.12	0.48±10.17	0.009
BET score	20.29±9.75	13.97±6.93	0.001
SBT score	13.74±4.63	11.12±3.14	0.001

FRT: functional reach test; **SRT:** sit and reach test; **BET:** back extension test; **SBT:** side bending test; **SD:** standard deviation; ***:** two independence sample t-test.

The relationship between age, flexibility and stability in younger and older subjects were presented in Table 3. In the elderly group, a negative correlation was found between age and body flexibility (SRT, BET, SBT) measurement scores (*r*=-0.233, p=0.001; *r*=-0.273, p=0.001; *r*=-0.264, p=0.001, respectively). In contrast, neither all flexibility measurements nor stability were associated with age in young group (p>0.05). There was also a positive correlation between trunk stability and flexibility measurements (BET, SBT) in the elderly group (*r*=0.463 p=0.001; *r*=0.354 p=0.001, respectively). Similarly, in the young group there were significant, positive correlations between trunk stability (FRT score) and both BET score and SBT score (*r*=0.431 p=0.001; *r*=0.437 p=0.001, respectively).

Table 3. Bivariate Pearson's correlations between age, flexibility and stability of trunk in both groups

Group I	Age	FRT	SRT	BET	SBT
Age	-				
FRT	0.008	-			
SRT	0.123	0.192	-		
BET	-0.036	0.431**	0.014	-	
SBT	-0.202	0.437**	0.254*	0.041	-
Group II					
Age	-				
FRT	0.121	-			
SRT	-0.233*	0.152	-		
BET	-0.273**	0.463**	0.172	-	
SBT	-0.264*	0.354**	0.293**	0.286**	-

FRT: functional reach test; **SRT:** sit and reach test; **BET:** back extension test; **SBT:** side bending test; ***:** p<0.05; ****:** p<0.001.

DISCUSSION

The general findings from this study suggest both flexibility and stability of trunk decrease with aging. In the analyzes we have done to find out whether the reduction in stability is due to aging or reduction in flexibility, the young group's stability was significantly better because there was no significant change in flexibility in the directions of extension and lateral flexion between ages 40–65. However, the main reason for the loss of stability was determined to be the loss in flexibility of extension and lateral flexion after 65 years of age.

The amount of connective tissue in muscle increases, however the flexibility decreases gradually due to decreased number of cross-bridges and volume of the connective tissue with aging (15, 16). While it is reported that flexibility decreases between 20% and 30% between the ages of 30–70 (17), current study showed that flexibility did not change much between the ages of 40–65. It is known that decrease in flexibility of trunk flexion is about 1.5% (18) and range of hip flexion related with lower body flexibility decreases 1.16 degrees for males and 0.66 degrees for females per year over the age of 71 in both gender (7). In contrast, Adamo et al. reported that trends for flexibility were equivocal in people aged over 60 (19). The results obtained from the intergroup comparisons in our study support the view that structural changes in the musculoskeletal system reduce flexibility. According to Mc Culloch et al., reduction in flexibility of trunk flexion assessed by SRT was most between the ages of 65 and 75 (20). In parallel with Mc Culloch et al, our results showed that the 65-year-old can be considered a limit to define the reduction in forward, backward, and lateral flexibility of the body.

As previously stated due to neurodegenerative changes and deterioration in activation of many physiological systems contributing to postural control (21), the greatest reduction of flexibility (about 50%) which results in moving of the center of gravity is seen in body extensors muscles after the age of 70. A number of studies caution against reduced flexibility and strength which also decreases the ability to adapt quickly to external perturbations in elderly (18, 22). Similarly, we observed the most important reduction was in the flexibility of trunk extension in all the flexibility evaluations made. Depending on the deficiency of trunk motion in the direction of extension, it was found that the FRT score, which is a measure of center of gravity, decreases after 65 years of age. However, kyphotic and rigid posture resulting from decreasing flexibility with aging causes muscle imbalance and the deficiencies in postural adjustments, these deformities are directly related to balance and falling parameters [22, 23]. The results of our study revealed that flexibility of trunk extension and lateral flexion, which improves stability before 65 years of age, decreases markedly after 65 years of age, which leads to instability. So, we think that the loss of stability is mainly caused by the decrease in flexibility of trunk extension and lateral flexion rather than aging.

These linear relationships between trunk flexibility in various directions and stability may seem sensible from a biomechanical or/and physiological point of view. However, since decrease in the flexibility of trunk flexion might prevent the center of gravity from moving out of the support surface, it can be a protective mechanism developed to compensate for the risk of falling forward.

In conclusion, loss of flexibility is a more important risk factor than aging for balance and stability impairment. So it is suggested that treatment protocols should include approaches increasing body flexibility to increase body stability.

This study has some limitations that should be acknowledged; the data have been derived from cross-sectional study so the results do not indicate causality; in addition, the use of computer systems such as dynamic posturography for evaluations could provide more objective results. Despite limitations, the strength of our study is; being one of the premise studies that examines the effect of trunk flexibility on stability. It is hoped that these results will be addressed in ongoing studies. According to our results; adding flexibility exercises in patients who have stability problems will be a guide for physiotherapists. Future large-scale trials are warranted to investigate the effects of the flexibility and age on stability using sensitive measure parameters.

Informed Consent: All participants received information regarding the aim and methods of the study and provided their informed consent.

Compliance with Ethical Standards: The research was carried out after approval from the Pamukkale University Non-Interventional Clinical Research Ethics Committee (No:14, Date:19.07.2016)

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - MD; Design - MD, NY; Supervision - NY; Fundings - ŞŞ; Materials - MD; Data Collection and/or Processing - MD, NY, ŞŞ; Analysis and/or Interpretation - HŞ; Literature Search - MD, ŞŞ; Writing Manuscript - MD, ŞŞ; Critical Review - NY

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

Presented In congress: 14th EUGMS 2018, Berlin

REFERENCES

1. Yıldırım MS, Ozyurek S, Tosun OÇ, Uzer S, Gelecek N. Comparison of effects of static, proprioceptive neuromuscular facilitation and Mulligan stretching on hip flexion range of motion: a randomized controlled trial. Biol Sport 2016;33:89–94. [CrossRef]
2. Paterson DH, Warburton DE. Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines. Int J Behav Nutr Phys Act 2010;7:38. [CrossRef]
3. Johns RJ, Wright V. Relative importance of various tissues in joint stiffness. J Appl Physiol 1962;17:824–828. [CrossRef]
4. Goldspink G, Harridge S. Cellular and molecular aspects of adaptation in skeletal muscle. In: Komi PV, editor. Strength and Power in Sport, 2nd ed. Boston, MA: Blackwell Science Ltd.; 2003. pp.231–251. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.455.6598&rep=rep1&type=pdf
5. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. Exercise and physical activity for older adult. Med Sci Sports Exerc 2009;41:1510–1530. [CrossRef]
6. Daley MJ, Spinks WL. Exercise, mobility and aging. Sports Med 2000;29:1–12. [CrossRef]
7. Stathokostas L, McDonald MW, Little RM, Paterson DH. Flexibility of older adults aged 55–86 years and the influence of physical activity. J Aging Res 2013;2013:743–843. [CrossRef]
8. Katzman WB, Wanek L, Shepherd JA, Sellmeyer DE. Age-related hyperkyphosis: its causes, consequences, and management. J Orthop Sports Phys Ther 2010;40:352–360. [CrossRef]
9. Wijlhuizen GJ, Chorus AMJ, Hopman-Rock M. Fragility, fear of falling, physical activity and falls among older persons: some theoretical considerations to interpret mediation. Prev Med 2008;46:612–614. [CrossRef]

10. Day L. Fall and injury risk; In: Lord SR, Sherrington C, Menz HB, editors. Falls in Older People: Risk Factors and Strategies for Prevention. Port Melbourne: Cambridge University Press; 2007. pp.17–40.

11. Tomchuk D, editor. Companion Guide to Measurement and Evaluation for Kinesiology. London: Jones & Bartlett Publishers; 2011. pp.23–43.

12. Suni JH, Oja P, Miilunpalo SI, Pasanen ME, Vuori IM, Bös K. Health-related fitness test battery for adults: associations with perceived health, mobility and back function and symptoms. Arch Phys Med Rehabil 1998;79:559–569. [CrossRef]

13. Kwak CJ, Kim YL, Lee SM. Effects of elastic-band resistance exercise on balance, mobility and gait function, flexibility and fall efficacy in elderly people. J Phys Ther Sci 2016;28:3189–3196. [CrossRef]

14. Williams B, Allen B, Hu Z, et al. Real-time fall risk assessment using functional reach test. Int J Telemed Appl 2017;2017;1–8. [CrossRef] https://doi.org/10.1155/2017/2042974

15. Martinez-Lopez Emilio EJ, Hita-Contreras F, Jimenez-Lara PM, Latorre-Roman P, Martinez-Amat A. The association of flexibility, balance, and lumbar strength with balance ability: risk of falls in older adults. J Sports Sci Med 2014;13:349–357. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3990889/

16. Williams GN, Higgins MJ, Lewek MD. Aging skeletal muscle: physiologic changes and the effects of training. Phys Ther 2002;82:62–68. [CrossRef]

17. Adams K, O'Shea P, O'Shea KL. Aging: Its effects on strength, power, flexibility, and bone density. Natl Strength Cond Assoc J 1999;21:65–77. [CrossRef]

18. Einkauf DK, Gohdes ML, Jensen GM, Jewel MJ. Changes in spinal mobility with increasing age in women. Phys Ther 1957;67:370–375. [CrossRef]

19. Adamo DE, Talley SA, Goldberg A. Age and task differences in functional tests in older women: comparisons with senior fitness test normative and criterion-referenced data. J Aging Phys Act 2015;23:47–54. [CrossRef]

20. McCulloch RG, Clark DG, Pike I, Slobodian YM. Gender specific trends in fitness anthropometric parameters in a selected Saskatchewan sample, aged 65–75 years. Can J Aging 1994;13:30–40. [CrossRef]

21. Blaszczyk JW, Micholski A. Aging and postural instability. Studies in Physical Culture and Tourism 2006;13:11–14. https://pdfs.semanticscholar.org/1d8a/9b06baed1b66234af1283ee976d5d52c9b7c.pdf

22. Chiacchiero M, Dresely B, Silva U, DeLosReyes R, Vorik B. The relationship between range of movement, flexibility, and balance in the elderly. Top Geriatr Rehabil 2010;26:148–155. [CrossRef]

23. Suri P, Kiely DK, Leveille SG, Frontera WR, Bean JF. Trunk muscle attributes are associated with balance and mobility in older adults: a pilot study. PM R 2009;1:916–924. [CrossRef]