Ergoterapi ve Rehabilitasyon Dergisi, 3(2) 2015, 87–94

Araştırma Makalesi

The Relationships Among Isolated Muscle Strengths And Ratio, Balance And Quality of Life in The Elderly

Yaşlı Bireylerde İzole Kas Kuvveti ve Oranı ile Denge ve Yaşam Kalitesi Arasındaki İlişkiler

Öznur BÜYÜKTURAN[1], Gamze EKİCİ[2], Necmiye Ün YILDIRIM[3]

[1] Ahi Evran University, School of Physiotherapy and Rehabilitation, Kirsehir, Turkey

[2] Hacettepe University, Faculty of Health Sciences, Department of Occupational Therapy, Ankara, Turkey

[3] Yıldırım Beyazıt University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Ankara, Turkey

ABSTRACT

Purpose: The aim of this study was to investigate the relationships between of Musculus Quadriceps Femoris (MQF) and Hamstring (HST) muscle strengths and ratios, balance, falling number and quality of life of elderly people. **Materials and Method:** Socio-demographic information were recorded. Muscle strength was assessed by isokinetic dynamometer. Static-dynamic balance tests were performed. Both muscle strength and balance tests were applied three times in following three weeks. Falling numbers during the last one year were recorded, too. Quality of life was determined by World Health Organization Quality of Life-Old module. **Results:** Eighty five men and 87 women elderly whose mean ages 68.84±4.26 years were included study. Significant correlations were found between static-dynamic balance, falling numbers and MQF-HST muscle strengths at 60º/sec and at 180º/sec angular velocity ($p<0.05$). Also, MQF and HST Ratio (QHR) was determined correlations with static-dynamic balance and number of falls at 60º/sec ($p<0.05$). At 180º/sec angular velocity, it wasn't found relationship between QHR and static balance ($p=0.778$), but correlation were found between QHR, dynamic balance and falling numbers ($p<0.05$). **Conclusion:** This study has indicated important relationships between MQF-HST muscle strength, QHR, falling number and balance problems in geriatrics. We may say that QHR, balance status and falling numbers, are predictors of fall. So, it is advisable that to improve balance, reduce falling numbers as a result to increase quality of life level, isolated MQF and HST strengths and their ratio should be evaluated in elderly people.

Key words: Elderly; Muscle strength; Balance; Falls; Quality of life

ÖZ

Amaç: Bu çalışmanın amacı, yaşlı bireylerin Musculus Quadriceps Femoris (MQF) ve Hamstring (HST) kas kuvvetleri ve oranlarının, denge, düşme sayısı ve yaşam kalitesi ile ilişkilerini incelemektir. **Gereç ve yöntem:** Yaşlı bireylerin sosyo-demografik özellikleri kaydedildi. Kas kuvvetleri izokinetik dinamometre ile değerlendirildi. Statik ve dinamik denge testleri yapıldı. Hem kas kuvveti hem de denge testleri birbirini takip eden üç hafta içinde tüm katılımcılara üç kez uygulandı. Son bir yıl içindeki düşme sayıları da kaydedildi. Yaşam kalitesi ise, Dünya Sağlık Örgütü Yaşam Kalitesi Anketi-Yaşlı Modülü ile belirlendi. **Sonuçlar:** Yaş ortalaması 68,84±4,26 yıl olan 85 erkek ve 87 kadın yaşlı birey çalışmaya dahil edilmiştir. Statik ve dinamik denge ile 60º/sn ve 180º/sn açısal hızlarda ölçülen MQF-HST kas kuvvetleri ve düşme sayıları ile anlamlı ilişkiler bulunmuştur ($p<0,05$). Ayrıca, 60º/sn açısal hızdaki MQF ve HST kas kuvvet oranları ile statik-dinamik denge ve düşme sayıları arasında ilişki tespit edilmiştir ($p<0,05$). 180º/sn açısal hızda, kas kuvvet oranları ile static denge arasında ilişki bulunmamışken ($p=0,778$), dinamik denge ile kas kuvvet oranları arasında ilişki bulunmuştur ($p<0,05$). **Tartışma:** Bu çalışma, yaşlı bireylerde MQF-HST kas kuvvetleri, kas kuvvet oranları, düşme sayısı ve denge problemleri arasında önemli ilişkileri göstermiştir. Kas kuvvet oranları, denge durumu ve düşme sayılarının düşme için belirleyici olduğunu söyleebiliriz. Bu yüzden, yaşlı bireylerde izole olarak MQF ve HST kaslarının ve oranlarının değerlendirilmesi, dengenin geliştirilmesi, düşme sayısının azaltılması sonucu yaşam kalitesinin arttırılması için önerilmektedir.

Anahtar Kelimeler: Yaşlı; Kas kuvveti; Denge; Düşmeler; Yaşam kalitesi

Sorumlu Yazar (Corresponding Author): Gamze EKİCİ, Doç.Dr., **e-mail:** fztgamze@yahoo.com

Geliş Tarihi (Received): 15.05.2015; Kabul Tarihi (Accepted): 20.05.2015

Ageing is defined by the World Health Organization as a gradual decrease in the capacity of generating reactions against internal and external stimulants. The age of 65 is regarded as the threshold of ageing (Kesioğlu, Bilgiç, Pıçakçıefe et al, 2001). Furthermore, ageing triggers several physiological and morphological changes, influencing numerous systems and organs (Tsunoda, Soma, Kitano et al, 2013). The musculoskeletal system is among these, which is critically affected in older persons. Ageing is also reported as a key factor in the reduction of muscle strength (Laughton, Slavin, Katdare et al, 2003). In connection with advancing age, muscle weakness becomes more conspicuous particularly in proximal and antigravity muscles. Between the ages of 30 and 80, there exists a 40%–weakness in leg and back muscles as well as a 30%–weakness in shoulder muscles. In geriatrics, there occurs an age–induced weakness in the strength of static and dynamic muscles of Musculus Quadriceps Femoris (MQF), which is a crucial structure for maintaining an independent life and mobility. This weakness may be followed by functional impairment in the posture, balance, and proprioception of the persons (Laughton et al, 2003; Scherder, Eggermont, Geuze et al, 2010).

Balance is achieved and becomes sustained when the spatial, visual, auditory, proprioceptive and kinesthetic data coming from internal or external stimulants are integrated into the upper centers. In older people, when this integration is constricted due to the weakening in the neural system, balance disorders become inevitable (de Araujo, de Oliveira, Martins et al, 2013). The balance disorders in elderly people can also lead to some problems that limit the quality of life. The patients with balance disorders are prone to the fear and risk of falling. As for the elderly people, they are more dependent on this risk and thus have a lower profile in terms of quality of life (Özcan, Donat, Gelecek et al, 2005). Indeed, their quality of life is further lowered by the problems emerging from anatomic and physiological changes. Overall, there exists a negative relationship between age and quality of life. Apart from age, quality of life is also dependent on gender, marital status, educational level, level of income, physical activity level, and level of perceived health (Maffiuletti, Jubeau, Munzinger et al, 2007).

The population is getting older in the whole world (Eser, Saatli, Eser et al, 2001). Therefore, quality of life of elderly is getting more important and it can be affected by balance and muscle strength. There are many studies about the correlation between quality of life, balance and muscle strength. But, these studies assessed the total extremity muscle strength (Özcan et al, 2005; Maffiuletti et al, 2007; Eser et al, 2001; Lustosa, Pacheso, Liu et al, 2010). According to our knowledge, there is no regarding isolated muscle strength in elderly. In addition, not only MQF muscle strength but also HST muscle strength and their ratio between these two muscles are important for elderly people. Also, young adults have been proven to suffer from knee injuries and balance disorders due to the loss of strength in the MQF and Hamstring (HST) muscles and imbalance between these muscles (Portes, Portes, Botelho et al, 2007), there is only scarce documentation of this relationship for older people. The aim of this study was to examine the relationship between MQF and HST muscle strengths, MQF and HST Ratio (QHR), balance, falling number and quality of life in elderly people.

MATERIALS AND METHOD

This study protocol was approved by the Ethics Committee of Clinical Researches Abant Izzet Baysal University (2011/32), Bolu, Turkey and was conducted in accordance with the rules of the Declaration of Helsinki. Written and oral information was given to all participants before testing. They also gave their informed and written consent for participation. The trial was conducted between 2011 and 2013.

The study was undertaken using the method of momentary change detection, which is a general type of single–scan methods. The participants were chosen depending on the availability (unbiased) sampling method. The individuals included 384 older people who were all over 65 years of age and were living in their family homes.

Demographic data including marital status, educational level, number of children, use of assisting devices, use and number of drugs a day, falling number in the last one year, social security, age, height, and total body weight were recorded.

The eligibility criteria required submitting a written consent, having adequate cognitive functions for communication, achieving a minimum score of 24 in Mini Mental State Examination and standing independently standing and walking (Wolf, Feys and Weerdt, 2001; Arnold and Faulkner, 2007).

As for the exclusion criteria, the participants having the illness in the acute stage, suffering from tension disorders, using 4 or more drugs a day, suffering from tachycardia, undergoing foot deformities, bearing endoprostheses or osteoarthritis in knees and/or hips, and experiencing serious problems with hearing and eyesight were not studied (Wolf et al, 2001; Arnold et al, 2007). So, 212 elderly were excluded from the present study, because of their health status (Figure 1).

The individuals were assessed in terms of muscle strength, balance, and quality of life, respectively. All the assessments were performed at room temperature under a silent atmosphere.

Assessments

Assessments were performed using various tools and methods: MQF and HST muscle strengths were assessed by a Biodex System 4–Pro dynamometer (Biodex, Inc., Shirley, New York), balance was tested using Biodex balance system (Biodex, Version 3.1, Biodex, Inc., Shirley New York), and quality of life was evaluated in line with the World Health Organization assessment of Quality of Life for Older Persons. Also, the falling numbers during the last one year were recorded.

Mental State

The Turkish version of Mini Mental State Examination that was standardized by Güngen *et al*. (Güngen, Ertan, Eker, et al, 2002) is a practical scale which can also provide information on the grade of cognitive impairment. The test comprises a number of sections including orientation, registration, attention–calculation–recall, language, and reconstruction while each question is worth one point. Top score is 30 points and high values indicate a good cognitive state.

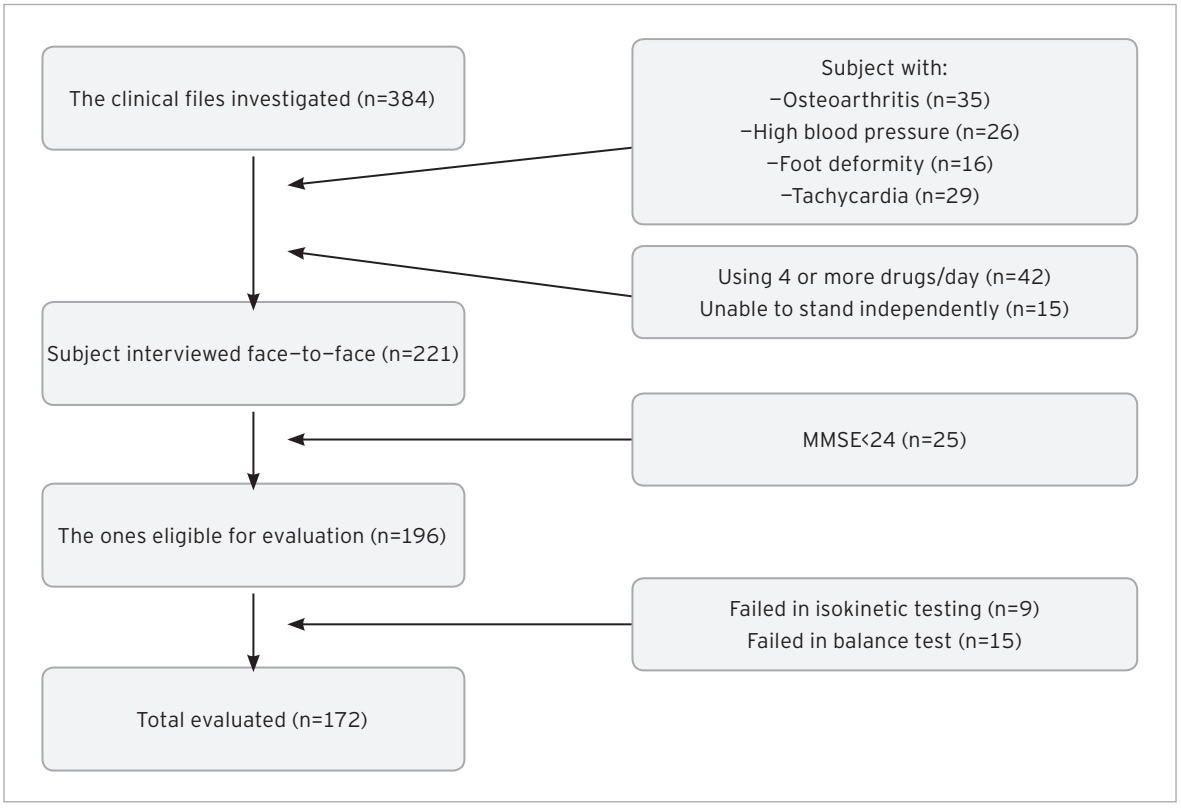

Figure 1. Flowchart of participants in study (n: number of participants).

Balance status

The balance system has a movable platform that provides up to 20° of surface tilt in a 360° range of motion. The levels of the platform range from 12 (most stable) to 1 (least stable), with 1 representing the greatest instability (Simoes, Dias, Marinho et al, 2001).

The participants stepped on the platform without foot wear and while they wore casual clothes. Once they were informed about the platform, they underwent adaptation training. During the test, they were asked to keep their balance while standing erect with the arms hanging freely at the sides and staring at the screen which was 50 cm away. To assess the Static Balance Scores (SBS), the platform was adjusted to the "static" level. SBS were assessed in the same posture with the platform being moved from the 6thlevel through the 2nd. The assessments included three 20−sec sessions with 30−sec breaks among each (de Rekeneire, Visser, Peila et al, 2003).

Muscle Strength

To elicit the dominant sides of the participants, several questions such as "Which of your hands do you use most?, Which of your feet do you use for kicking a ball?, Which of your sides do you use most while doing the housework?" were queried. Once all the participants were questioned, isokinetic testing was performed for the dominant lower extremities to assess the muscle strength of the MQF and HST group. The angular velocity was adjusted to 60°/sec and 180°/sec which are the most reliable speeds for elderly people (Lustosa et al, 2010; Ringsberg, Gerdhem, Johansson et al, 1999). Prior to assessments, each participant was informed by the researcher. Muscle strength testing included three sessions, the first being the adaptation training and the other two consisting of 3 tests for the assessments of muscle strengths:

1st session (adaptation): 3 repetitions at 60°/sec angular velocity,

2nd session: 5 repetitions at 60°/sec angular velocity,

3rd session: 10 repetitions at 180°/sec angular velocity (Lustosa et al 2010; Ringsberg et al, 1999). Among each session, the participants were allowed for 30−sec breaks.

Due to the geriatric participants were included the present study, balance and muscle strength measurements were performed three times in the following three weeks in the same day and same hour in order to minimalize the factor that may affect balance and muscle strength assessments. The resultant scores of muscle strength and balance comprised the mean average of the three tests. After the scores of balance and muscle strength were obtained, other assessments were applied to the participants.

Quality of Life

To assess the level of quality of life, the World Health Organization assessment of Quality of Life for Older Persons was used, which has a range between 0 and 120 and in which high values indicate a good level of quality of life (Lenk, Schuler and Adams, 2009).

SPSS 15.0 for Windows (SPSS Inc; Chicago, Illinois) was used for all statistical analyses. The results were expressed as frequency, and/or arithmetic mean±standard deviation (X±SD). All the data but the socio−demographic profiles were evaluated using the Pearson correlation analysis. A p value of $p<0.05$ was considered significant.

RESULTS

Table 1 presents the profiles of the 172 participants, including age, height, total body weight, body mass index, gender, number of drugs/day, falling number, and use of assisting devices.

According to Mini Mental State Examination results, the scores ranged from 25 to the highest 30, with a mean score of 26.18±3.19.

In Table 2, the participants' Dynamic Balance Score and Static Balance Score scores along with the MQF and HST strengths and QHR at the velocity of 60°/sec and 180°/sec are presented.

Table 3 provides the details portraying the relationship among the variables (falling number, muscle strengths, static and dynamic balances, and levels of quality of life). It is revealed that the MQF muscle strength correlates with the falling number and static and dynamic balance not only at the velocity of 60°/sec ($p<0.01$) but also at the velocity of 180°/sec ($p<0.05$).

Table 1. Participants' profiles (n=172)

	X±SD
Age (years)	68.84±4.26
Height (m)	1.62±10.35
Total body weight (kg)	82.49±15.21
BMI (kg/m+)	31.35±5.09
	n (%)
Gender (M/F)	85 (49.4) / 87 (50.6)
No of drugs (count/day)	
None	69 (40.1)
1	17 (9.9)
2	19 (11.0)
3	67 (39.0)
No of falls in the last one year	
0	118 (68.6)
1	14 (8.1)
≥ 2	40 (23.3)
Use of assisting devices	
No	160 (93.0)
Using inside home	5 (3.0)
Using outside home	7 (4.0)

m: meter, kg: kilogramme, BMI: Body Mass Index, M: Male, F: Female, n: number of participants

Table 2. Results on balance, muscle strength and levels of quality of life

Balance	X±SD (n=172)
DBS (%) sec	2.90±1.95
SBS (%) sec	1.60±0.85
Muscle Strength	
MQF at 60°/sec (N–M)	65.11±34.67
HST at 60°/sec (N–M)	41.83±22.03
QHR at 60°/sec (%)	73.87±34.41
MQF at 180°/sec (N–M)	36.29±21.62
HST at 180°/sec (N–M)	27.49±12.32
QHR at 180°/sec (%)	85.54±33.43
Quality of Life	
WHOQOL–OLD	88.09±9.12

DBS, Dynamic Balance Score; SBS, Static Balance Score; MQF at 60°/sec, M.Quadriceps Femoris muscle strength at 60°/sec angular velocity; HST at 60°/sec, Hamstring muscle strength at 60°/sec angular velocity; QHR at 60°/sec, M.Quadriceps Femoris and Hamstring ratio at 60°/sec angular velocity; MQF at 180°/sec, M.Quadriceps Femoris muscle strength at 180°/sec angular velocity; HST at 180°/sec, Hamstring muscle strength at 180°/sec angular velocity; QHR at 180°/sec, M.Quadriceps Femoris and Hamstring ratio at 180°/sec angular velocity; WHOQOL-Old, World Health Organization Quality of Life Instrument-Older Adults Module.

CONCLUSION

Ageing is known to cause losses in the mass and strength of muscles (Ringsberg et al, 1999; Wang and Bai, 2012). It is a common belief that as the muscles weaken, both dynamic and static balances in older people get impaired (Lustosa et al, 2010; Ringsberg et al, 1999; Wang et al, 2012). Moreover, it is believed that weakened muscles give rise to the risk of falling (Ringsberg et al;1999; Kimura, Obuchi, Arai et al, 2010). Accordingly, older persons are inflicted with the risk and fear of falling, which make them more dependent in their daily life activities and thus reduce their quality of life (Kimura et al, 2010). There are many studies reporting a significant correlation between balance and the total muscle strength of the lower extremity (Özcan et al, 2005; Maffiuletti et al, 2007; Lustosa et al, 2010). It is also reported that the MQF muscle strength is one of the factors in achieving and securing the balance and that it is badly affected by the muscle loss in older people (Hunt, McManus, Hinman et al, 2010). But, total extremity muscle strength were assessed in those studies. In this study, isolated muscle strength were assessed and examine the correlation between muscle strength, balance and quality of life. Also, in addition to total lower limb muscle strength, not only MQF muscle strength but also HST muscle strength and the muscle strength ratio between these two muscles are important for elderly people, too.

The present study verifies the common literature proving that there exists a significant relationship between the MQF strength–which is an antigravity muscle (Scherder et al, 2010) and dynamic and static balances (Hunt et al, 2010;

Table 3. Relationships among muscle strength, falling number, balance and levels of quality of life

		MQF at 60°/sec	MQF at 180°/sec	HST at 60°/sec	HST at 180°/sec	QHR at 60°/sec	QHR at 180°/sec	SBS	DBS	No of falls	WHOQOL-OLD
MQF at 60°/sec	r										
	p										
MQF at 180°/sec	r	**.790****									
	p	0.000									
HST at 60°/sec	r	**.746****	**.648****								
	p	0.000	0.000								
HST at 180°/sec	r	**.621****	**.756****	**.630****							
	p	0.000	0.000	0.000							
QHR at 60°/sec	r	**.542****	**−.320***	.140	**−.320***						
	p	0.000	0.011	0.567	0.011						
QHR at 180°/sec	r	**−.349****	**−.452****	−.155	**−.171**	**−.188**					
	p	0.005	0.000	0.230	0.184	0.144					
SBS	r	**−.413****	**−.298***	**−.407****	−.373**	.383**	−.036				
	p	0.001	0.018	0.001	0.003	0.005	0.778				
DBS	r	**−.357****	**−.391****	**−.335****	**−.384****	**.398****	**0.770****	**.819****			
	p	0.004	0.002	0.008	0.002	0.002	0.050	0.000			
No of falls	r	**−.343****	**−.156***	**−.246***	**−.182***	**.295****	**−.172***	**.810****	**.671***		
	p	0.006	0.050	0.045	0.032	0.002	0.050	0.000	0.000		
WHOQOL–Old	r	**.159***	.185	.165	**.831****	−.031	0.760	**−.932****	**−.882****	**−.701****	
	p	0.047	0.149	0.199	0.000	0.811	0.557	0.000	0.000	0.000	

MQF at 60°/sec, M.Quadriceps Femoris muscle strength at 60°/sec angular velocity; MQF at 180°/sec, M.Quadriceps Femoris muscle strength at 180°/sec angular velocity; HST at 60°/sec, Hamstring muscle strength at 60°/sec angular velocity; HST at 180°/sec, Hamstring muscle strength at 180°/sec angular velocity; QHR at 60°/sec, M.Quadriceps Femoris and Hamstring ratio at 60°/sec angular velocity; QHR at 180°/sec, M.Quadriceps Femoris and Hamstring ratio at 180°/sec angular velocity; SBS, Static Balance Score; DBS, Dynamic Balance Score; No of Falls, Falling number; WHOQOL-Old, World Health Organization Quality of Life Instrument-Older Adults Module
*p≤0.05, **p<0.01

Ki, Soo, Seung et al, 2011). For this reason, it is took into account that MQF muscle in older persons should be kept as strong as possible so as to reduce the risk factors regarding balance and falling. Indeed, it is well known that older people are inflicted with the fear and risk of falling as a result of balance disorders (Ki et al, 2011). Consequently, in order to reduce the risks of falling and balance disorders, it is suggested that in addition to lower limb muscle, MQF muscle in older people should be strengthened to the extent that its functionality is sustained at the maximum level.

There have been studies reporting a significant relationship between lower extremity total muscle strength and quality of life, though the number of studies investigating the relationship between MQF muscle strength and quality of life is scarce (Özcan et al, 2005; Brandt, Heilman, Slemenda et al, 2000). Nevertheless, in this study, there was a significant correlation between MQF and quality of life. This might be identified that the activities of older persons may be challenged by the loss in the MQF strength and thus the MQF strength is one of the factors both in enabling the geriatric persons to carry out their daily activities more independently and in reducing the risk of injury.

Hortobagyi et al. (Hortobagyi, Westerkamp, Beam et al, 2005) studied the QHR in osteoarthritic patients and concluded that the HST strength conveys the same importance as the MQF strength in keeping the knee joint loading at a normal level and securing the balance, and they

also suggested that the HST strength should be kept at an optimal level in treatment approaches. Yet, there is a scarcity in the number of studies looking into the QHR in healthy older people.

The present study has discovered that the MQF–HST muscle strength measured at 60°/sec correlates with the falling number, Dynamic Balance Score, and Static Balance Score. Yet, it was found that the MQF–HST muscle strength only correlates with the falling number when measured at 180°/sec. This difference is attributed to notion that the type II fibers, which present a higher profile of aerobic metabolism and contract more slowly, confront the sarcopenic mechanism earlier than the type I fibers, which use anaerobic metabolism and contract faster, and to the fact that the type I fibers remain stronger at advanced ages (Hortobagyi et al, 2005; Frontera, Suh, Krivickas et al, 2000).

Hawkins *et al.* (Hawkins, Musich, Ozminkowski et al, 2011) reported that the knee extensor strength is higher in the cases with no falls than in the cases with a history of falls. Moreover, some studies identified the notion of falling as a negative parameter affecting the quality of life (Özcan et al, 2005; Maffiuletti et al, 2007; Aoyama, Suzuki, Onishi et al, 2011). In the present study, the falling number during the last one year was found to be correlating with all isokinetic tests on muscle strength, balance tests, and quality of life.

The correlation between knee injuries, balance problems and QHR are important in young adults (Portes et al, 2007). But, there is no study about this correlation in older people. But this study has revealed a significant relationship between the QHR and balance and falling. So, in addition to muscle strengthening practices, the balance between MQF and HST strength may also a remarkable issue in geriatric rehabilitation programs.

The study did have some limitations worth noting in interpreting the results. First, in muscle strength assessments we didn't use the adaptation period for 180°/sec angular velocity. Furthermore, the participants might not be adapted at 180°/sec angular velocity. Second, because the sample size was small, it was difficult to generalize to whole elderly. So, the results might not extend to a wide range of all of the elderly. Finally, in addition to total extremity strength, isolated muscle strength could have been useful to detect the relationship between strength, falls and quality of life in elderly.

In conclusion, falling and balance disorders are major problems that have negative effects on older people's quality of life. In order to preclude these problems, further information about the relationship between muscle strength, ratio, falling number and quality of life should be known. Also, the examination of isolated muscle strength is advised in addition to assessing the total extremity muscle strength besides more specific and evidence–based methods should be employed for more correct results. We conclude that the isolated MQF and HST strengths is one of the predictors of falls and require more attention in geriatric physiotherapy and rehabilitation programs as well, concerning their relationship with quality of life and balance. Moreover, it is also recommended to assessing the QHR in physiotherapy and rehabilitation programs for older people owing to its correlation with balance and falling number. Further studies are needed to confirm these important findings about elderly.

REFERENCES

Aoyama, M., Suzuki, Y., Onishi, J., & Kuzuya, M. (2011). Physical and Functional Factors in Activities Of Daily Living That Predict Falls in Community–Dwelling Older Women. *Geriatr Gerontol Int,* 11, 348-357.

Arnold, C.M., & Faulkner, R. (2007). The History Of Falls and the Association of the Timed Up and Go Test to Falls and Near–Falls in Older Adults with Hip Osteoarthritis. *BMC Geriatr,* 4(7), 17.

Brandt, K.D., Heilman, D.K., Slemenda, C., Katz, B.P., Mazzuca, S., Braunstein, E.M., & Byrd, D.A. (2000). Comparison of Lower Extremity Muscle Strength, Obesity, and Depression Scores in Elderly Subjects with Knee Pain with and without Radiographic Evidence af Knee Osteoarthritis. *J Rheumatol,* 27(8), 1937–46.

De Araújo, T.B., De Oliveira, R.J., Martins, W.R., De Moura Pereira, M., Copetti, F., & Safons, M.P. (2013). Effects of Hippotherapy on Mobility, Strength and Balance in Elderly. *Arch Gerontol Geriatr,* 56(3),478–81.

De Rekeneire, N., Visser, M., Peila, R., Nevitt, M.C., Cauley, J.A., Tylavsky, F.A., Simonsick, E.M., & Harris, TB. (2003). Is A Fall Just A Fall: Correlates of Falling in

Healthy Older Persons. The Health, Aging and Body Composition Study. *J Am Geriatr Soc,* 51(6), 841–6.

Eser, S., Saatli, G., Eser, E., Baydur, H., & Fidaner, C. (2001). The Reliability and Validity Of The Turkish Version Of The World Health Organization Quality Of Life Instrument–Older Adults Module (WHOQOL–Old). *Turkish Journal Of Psychiatry*, 21(1), 37–48.

Frontera, W.R., Suh, D., Krivickas, L.S., Hughes, V.A., Goldstein, R., & Roubenoff, R. (2000). Skeletal Muscle Fiber Quality In Older Men and Women. *Am J Physiol Cell Physiol,* 279(3), 611–8.

Güngen, C., Ertan, T., Eker, E., Yasar, R., & Engin F. (2002). Reliability and Validity of The Standardized Mini Mental State Examination in the Diagnosis of Mild Dementia in Turkish Population.*Turkish Journal Of Psychiatry,* 13(4), 273–82.

Hawkins, K., Musich, S., Ozminkowski, R.J., Bai, M., Migliori, R.J., & Yeh, C.S. (2011). The Burden of Falling on the Quality of Life of Adults with Medicare Supplement Insurance. *J Gerontol Nurs,* 37(8), 36–47.

Hortobágyi, T., Westerkamp, L., Beam, S., Moody, J., Garry, J, Holbert, D., & De Vita, P. (2005). Altered Hamstring–Quadriceps Muscle Balance in Patients with Knee Osteoarthritis. *Clin Biomech,* 20(1), 97–104.

Hunt, M.A., Mcmanus, F.J., Hinman, R.S., & Bennell, K.L. (2010). Predictors of Single–Leg Standing Balance in Individuals with Medial Knee Osteoarthritis. *Arthritis Care Res*, 62(4), 496–500.

Kesioglu, P., Bilgiç, N., Pıçakçıefe, M., & Uçku, R. (2003). The Prevalence of the Chronic Disease and Disability in Elderly Population At Çamdibi–1 Health Center's Region In Izmir. *Turkish Journal Of Geriatrics*, 6(1), 27–30.

Ki, Y.O., Soo, A.K., Seung, Y.L., & Young, S.L. (2011). Comparison of Manual Balance and Balance Board Tests in Healthy Adults. *Ann Rehabil Med*, 35(6), 873–9.

Kimura, K., Obuchi, S., Arai, T., Nagasawa, H., Shiba, Y., Watanabe, S., & Kojima, M. (2010). The Influence of Short–Term Strength Training on Health–Related Quality of Life and Executive Cognitive Function. *J Physiol Anthropol*, 29(3), 95–101.

Laughton, C., Slavin, M., Katdare, K., Nolan, L., Bean, J., Kerrigan, C., Phillips, E., Lipsitz, L., & Collins, J. (2003). Aging, Muscle Activity, and Balance Control: Physiologic Changes Associated with Balance Impairment. *Gait And Posture*, 18(2), 101–8.

Lenk, K., Schuler, G., & Adams, V. (2009). Skeletal Muscle Wasting in Cachexia and Sarcopenia: Molecular Pathophysiology and Impact of Exercise Training. *J Cachexia Sarcopenia Muscle*, 1(1), 9–21.

Lustosa, L.P., Pacheso, M., Liu, A., Gonçalves, W.S., Silva, J.P., & Pereira, L. (2010). Impact of Static Stretching on The Gain in Knee–Extensor Strength of Community–Dwelling Older Women After A Training Program. *Rev Bras Fisioter,* 14(6), 497–502.

Maffiuletti, N.A., Jubeau, M., Munzinger, U., Bizzini, M., Agosti, F., De Col, A., Lafortuna, C.L.,& Sartorio, A. (2007). Differences in Quadriceps Muscle Strength and Fatigue Between Lean and Obese Subjects. *Eur J Appl Physiol,* 101, 51–9.

Özcan, A., Donat, H., Gelecek, N., Özdirenç, M., & Karadibak, D. (2005). The Relationship Between Risk Factors for Falling and Quality of Life in Older Adults. *BMC Public Health*, 5, 90–5.

Portes, E.M., Portes, L.A., Botelho, V.G., & Pinto, S.S. (2007). Isokinetic Torque Peak and Hamstrings/Quadriceps Ratios in Endurance Athletes with Anterior Cruciate Ligament Laxity. *Clinics,*62(2), 127–32.

Ringsberg, K., Gerdhem, P., Johansson, J., & Obrant, K.J. (1999). Is There A Relationship Between Balance, Gait Performance and Muscular Strength in 75–Year Old Women*?. Age Aging,* 28(3), 289–93.

Scherder, E., Eggermont, P., Geuze, H., & Verkerke, J. (2010). Quadriceps Strength and Executive Functions in Older Women. *Am J Phys Med Rehabil,* 89(6), 458–63.

Simoes, L.A., Dias, J., Marinho, K.C., Pinto, C., & Britto, R.R. (2010). Relationship Between Functional Capacity Assessed by Walking Test and Respiratory and Lower Limb Muscle Function in Community–Dwelling Elderly. *Rev Bras Fisioter,* 14(1), 24–30.

Tsunoda, K., Soma, Y., Kitano, N., Tsuji, T., Mitsuishi, Y., Yoon, J., & Okura, T. (2013). Age and Gender Differences in Correlations of Leisure–Time, Household, and Work–Related Physical Activity with Physical Performance in Older Japanese Adults. *Geriatr Gerontol Int,* 13, 919–27.

Wang C, & Bai L. (2012). Sarcopenia in the Elderly: Basic and Clinical Issues. *Geriatr Gerontl Int*, 12, 388–396.

Wolf, B., Feys, H., & Weerdt, W.D. (2001). Effect Of A Physical Therapeutic Intervention for Balance Problems in the Elderly: A Single–Blind, Randomized, Controlled Multicentre Trial. *Clin Rehabil*, 15(6), 624–36.