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Original Article

Age-related effects on lower extremities muscular strength, sit-to-stand, and functional reaching tests among community-dwelling elderly females

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Abstract
Ageing-related deterioration of the lower limb muscle strength could highly influence the functional performance of elderly adults, particularly females, which are more prone to injurious falls. Precise analyses on the effects of ageing on individual lower-limbs' muscle groups and their relationship with feeble functional performance could provide us with information that aid in designing preventive interventions. To this end, this study was designated to investigate the impacts of advancing age on lower limb muscles strength and consequently sit-to-stand and functional reaching performance among 34 community-dwellingelderly females (eighteen 60-69 years old and sixteen 70-79 years old). Results illustrated a significant decrease in produced relative peak torque (RPT) and power (RPP) values of ankle invertors, plantarflexors and knee extensor among 70-79 group, and their 5RSTS execution time significantly increased in comparison with 60-69 group ($p<0.05$). Outcomes also demonstrated that RPT and RPP values of ankle invertors and evertors have significant correlations with lateral reaching tests in both groups. Ankle plantarflexors, knee flexors and extensors are also shown a strong contribution in the decrement of 5RSTS duration in both groups, while ankle plantar flexors and knee extensors had also a significant correlation with FRT performance among them. The ankle and knee joints muscle strength, which has an undeniable contribution to human locomotion and balance status, underwent sharp attenuation by advancing age, consequently resulting in changing position impairments among elderly females. Findings of the current study might help in designing the interventional training programs, which could help community-dwelling elderly females in the prevention of fall-related risks of injuries.
Keywords: Isokinetic muscle contraction, 5RSTS, Torque, Power, Functional performance,

Introduction

Execution of daily tasks with highest possible efficiency and less injury risk is the main concern of elderly societies, particularly among females(Sarvestan, Kovacikova, Linduska, Gonosova, & Svoboda, 2020). Given the prevalence of various physical limitations and impairments caused by ageing, the demands for proper accomplishment in daily activities, including position changing from sitting to standing, secure stance, and reaching performances have been increasing within elderly adults (Pion et al., 2017). Along with this, a sharp increase in falling rate among elderly adults, which is the main reason of mortality in such susceptible group, adds up to the social concern regarding the elderly adults' healthcare (Wulf & Lewthwaite, 2016). Health-related problems, life quality decrement and healthcare-related expenses are mentioned as consequences of falling among elderly adults (Stevens, Corso, Finkelstein, & Miller, 2006). Due to which, the senile population increasingly lose functional independence in daily activities (Crişan, Oancea, Timar, Fira-Mladinescu, & Tudorache, 2015; Kovacikova et al., 2020), and lifespan shortens.

Of the reasons for control loss among elderly adults, intrinsic or person-related factors, such as disease, neuromuscular signalling weakness and ageing, are counted as vital determinants in durable stability during routine tasks (Liu et al., 2019; Orr, 2010). The central nervous system (CNS), as the main controller of internal parameters, smartly coordinates the information from the eyes, muscles, joints, and vestibules to maintain the vertical centre of mass (CoM)line in the shortest distance to the joints centre of rotation, preserve the centre of pressure (CoP) within the base of support and consequently, the body posture remains upright (Roman-Liu, 2018). It has been formerly hypothesized that advancing age weakening the CNS sensitivity, muscular strength decreases, and as a result, stability control faces infirmity (Roman-Liu, 2018; Sarvestan et al., 2020). Albeit the mentioned intrinsic factors are globally brought up to have an equally considerable contribution to the lack of equilibrium among elderly adults (Maritz & Silbernagel, 2016), it seems necessary to highlight that the muscular weakness is the principal element in balance instability and changing position dysfunction, where eventually, the result is falling.

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Reaching capacity and its close relationship to balance control and falling, has been gaining increasing attention in elderly-related studies (Demura & Yamada, 2007; Kováčiková, Janura, Sarvestan, Zemková, & Pecho, 2020). In order to control the forward and lateral reaching, higher coordination between sensorimotor and muscular organs is required (S.-I. Lin, Chen, Liao, & Chou, 2010). From the physical point of view, every upright structure tends to lose its shape to a more stable structure (Halliday, Resnick, & Walker, 2013). This means the tendency to fall is constantly threatens human body structure. To this end, eccentric contraction of muscles engaged in standing balance serves as maintenance of CoP inside the base of support and keep the structure upright(Kovacikova et al., 2020). This is how the contractile elements coordinately maintain the structural balance.

On the other hand, from a biomechanical point of view, changing position from sitting to standing includes four flexion-momentum, momentum-transfer, extension and stabilization phases (Dehail et al., 2007). The role of lower limbs muscles strength in all four mentioned phases are clear; as ankle dorsiflexors, knee extensors and hip flexors activate in a flexion-momentum phase, ankle dorsiflexors, knee and hip extensors during both momentum-transfer and extension phases and the eccentric activation of the entire lower limbs muscles during the stabilization phase. To this effect, any infirmity in lower limb muscular status could negatively influence these biomechanical aspects during sit to stand changing position (Bernardi et al., 2004). Evaluation of sit-to-stand and reaching capabilities could be quantified by two different methods: laboratory-based and physical performance-based measurements (M. R. Lin et al., 2004). Although both laboratory- and physical performance-based measures have some deficits in terms of reliability of data sampling and real-life condition measurement, the combination of both methods of measurement might vastly increase the rationale behind the performance-related defects under the real-life circumstances. Considering the fact that a large proportion of annual healthcare expenses are associated with falling-related injuries, this approach could significantly help in identification of elderly adults, those who are in falling risk and death spectrum and warns urgent medical or rehabilitation training (Duncan, Weiner, Chandler, & Studenski, 1990; Reider & Gaul, 2016).

Elderly females, in comparison with similarly aged males, are more susceptible to balance dysfunction and functional performance deficits due to loss of muscle strength (Kováčiková, Sarvestan, et al., 2020; Tiwari, Talley, Alsalaheen, & Goldberg, 2019). It has been formerly proved that elderly females execute the five times sit-to-stand test during a longer time compared with elderly males (McCarthy, Horvat, Holtsberg, & Wisenbaker, 2004). Furthermore, regarding the functional reaching capabilities, it has been brought up that elderly males are abler to reach further spaces in frontal reaching, in comparison with females (Duncan et al., 1990; Weiner, Bongiorni, Studenski, Duncan, & Kochersberger, 1993). Nevertheless, more scrutiny is still required to precisely understand the origin of function performance deficits among elderly females.

According to the literature discussed above, this study is designated to investigate the relationships between advancing age impacts on the ankle, knee and hip joints muscle groups' strength, sit to stand and functional reaching tests among 60-69 and 70-79 years old healthy elderly females without falling background. We hypothesized that (a) advancing age negatively affects lower limbs strength among elderly females, and (b) consequently deteriorates the sit to stand performance, and functional reaching capability.

Material and Methods

Participants

A total of 34 community-dwelling elderly females voluntarily participated in this study. They were divided into two groups of 60-69 years old (n=18, mean age: 64.78±3.65 years, mean height: 166.51±9.48 cm, mean weight: 73.41±13.8 Kg) and 70-79 years old (n=16, mean age: 74.31±4.53 years, mean height: 165.69±8.82 cm, mean weight: 74.69±16.23 Kg). The exclusion criteria for this study were: (a) a history of falls, (b) any musculoskeletal, neurological, orthopaedic, or cardiopulmonary disorder, (c) usage of any walking aids, and (d) total joint replacement. Falling was defined to include any fall where the participant could precisely distinguish the time, venue, and the mechanism of falling (Uiga, Capio, Ryu, Wilson, & Masters, 2018). The procedures complied with the 1964 Helsinki Declaration and its later amendments.

Instrumentation and Procedure

In the Functional Reach Tests (FRTs), participants were asked to raise their arms and forearms to shoulder-height. The metacarpal phalangeal (MCP) joint position was emblemed, and the participants were asked to perform the maximal forward and lateral reach, while keeping their posture balanced. The difference between the initial and final positions of the MCP joint was calculated as the individual reaching capacity, and the score was recorded in centimetres (Jenkins, Johnson, Holmes, Stephenson, & Spaulding, 2010). The FRTs were conducted in three directions: frontal functional reaching test (FRT), right side lateral reaching test (LRT_{right}), and left side lateral reaching test (LRT_{left}). The five repetition sit-to-stand (5RSTS) test, in which a participant rose from a chair, stood upright, and sat again, was executed five times; the total execution time was considered as the participant's performance (van Lummel et al., 2016).

For assessing the lower limb muscle quality, the subjects were made to participate in two identical measurement days, separated by a week. The first session was to familiarize the patient with the measurement procedure for the right leg, while the second session was for the assessment of both legs. Both sessions were carried out at the same time of the day (±30 minutes), and the evaluation was performed by the same researcher, in order to reduce the effects of investigator inconstancy and diurnal impacts (Dirnberger, Kösters, & Müller, 2012).Prior to the assessment, participants performed a 5-minute general warm-up on a stationary Kettler ergometer (Heinz Kettler GmbH and Co. KG, Ense-Parsit, Germany), with an exercise workload of 1.5 W/kgBW at a constant 70 rpm pedal rate (Roth, Donath, Kurz, Zahner, & Faude, 2017). This was followed by several stretching exercises of the lower extremity muscles; these exercises included: hip, knee, and ankle joints' internal and external rotation, anteroposterior ballistic agitations in the hip joint, squats, frontal and lateral lunge stretches, calf raises, ankle inversion and eversion, jumping jacks, and rope jump.

Immediately after the warm-up, participants were seated on the Iso-Med^{2000} adjustable chair (D&RFerstl, Hemnau, Germany) with the hip joint at 75˚ (0˚ = full extension, level 1 seat height) to perform the knee extension/flexion test (Dirnberger et al., 2012). The hip, shoulder, chest, and femur were fixed by adjustable pads and straps for the most isolated position possible (Roth et al., 2017). Participants were asked to keep their hands on their chest, to eliminate the effects of the hands' force on the torque produced. Using the mechanical axis of the dynamometer's head, the lateral femoral epicondyle was detected as the joint centre of rotation, and the dynamometer adaptor was set approximately 3 cm above the lateral malleolus. Mechanical stops were also fixed at two maximum flexion and extension ends to prevent any unwanted movement of the dynamometer adaptor and keep the test as safe as possible. The participants, as a warm-up to the test, were then permitted to execute the test three times with 50% of the maximal force, 75% of the maximal force, and the maximum possible force, respectively, with a 15-second rest after each time.

After this warm-up and prior to the test, gravity compensation for the weight of the tested leg was carried out using the integrated software. The maximal range of movement (ROM) was defined between 0˚ to 75˚ at an angular velocity of 60˚/s (Davies, Riemann, & Ellenbecker, 2018). The maximum strength of knee extensors and flexors was measured using four concentric contractions, separated by 15-second periods of rest. Furthermore, the ankle was ensured to be in a neutral position, in order to avert unwanted calf muscle cramps.

For the ankle inversion/eversion test, the participants were seated on a 60˚ back-inclined chair with a hip joint angle of 80˚ and made to flex their knee (to approximately 110˚) and place their feet on the adaptor. After three submaximal trials, the participants performed four concentric efforts initiated from 25˚ of ankle eversion to 20˚ of ankle inversion at an angular velocity of 30˚/s (Möller, Lind, Styf, & Karlsson, 2005). In the ankle dorsi/plantar flexion test, the participants were laid supine on the isokinetic dynamometer table with the hip and knee in full extension. Two Velcro straps firmly fixed the feet to the adaptor. The lateral malleolus was detected as the ankle centre of rotation by the mechanical axis, and after gravity compensation and training trials, four concentric contractions were executed from 10˚ of dorsiflexion to 35˚ of plantar flexion at an angular velocity of 30˚/s (0˚ = neutral position of the talocrural joint) (Möller et al., 2005). A 15-second rest was given to the participants between each contraction.

In the hip flexion/extension test, the participants were laid supine and the dynamometer adaptor was placed approximately 3 cm above the lateral femoral epicondyle (Figure 1 – d). The shoulders were fixed in the ventral-to-dorsal and cranial-to-caudal directions by shoulder straps and pads. After the training endeavour and gravity compensation, the participants executed four maximal concentric contractions from 10˚ to 100˚ at an angular velocity of 60˚/s (0°=full hip extension) (Johnson, Mille, Martinez, Crombie, & Rogers, 2004). For the hip abduction/adduction test, the participants were laid on their sides, and similarly, the dynamometer adaptor was placed approximately 3 cm above the lateral femoral epicondyle (Figure 1 – e). Four maximal concentric contractions from 0˚ to 50˚ at a rotational velocity of 60˚/s were performed after positioning, training efforts, and gravity compensation (0° = neutral position of the hip joint) (Johnson et al., 2004). Subsequently, the second lower limb was tested using the same procedure, during which the individual settings were automatically activated, rechecked, and adjusted if necessary. During the entire testing procedure, the participants were asked to maintain the maximum force throughout the entire ROM and visual feedbacks were given to them.

Data analysis

The IsoMed Analyze V.1.0.5 (D. & R. Ferstl GmbH, Hemau, Germany) was employed for data recording and reduction. Peak torque and peak power were the isokinetic variables extracted from the following individual tests: ankle internal rotators (AIN), external rotators (AEV), plantar flexors (APF), and dorsiflexor (ADF) tests; knee flexors (KFL), extensors (KEX); and hip flexors (HFL) and extensors (HEX) tests. All variables were then divided by the body mass, in order to calculate relative measures. Thereafter, the average values of relative peak torque (RPT) and relative peak power (RPP) of both the dominant and non-dominant legs were calculated as the general lower limb strength and used for further statistical analysis.

Statistical Analysis

The normality of data distribution was checked using the Kolmogorov-Smirnov test. Independent sample T-test was employed in order to investigate the difference between ankle and knee muscle groups, 5RSTS and functional reaching tests among both 60-69 and 70-79 years old groups. Using Pearson's productmoment correlation coefficient, the correlation between RPP and RPT of selected muscle groups with 5RSTS and functional reaching tests was evaluated. The magnitude of the correlations was determined using the modified scale by Hopkins et al. (Hopkins, Marshall, Batterham, & Hanin, 2009): r<0.1 trivial; >0.1–0.3 small; >0.3–0.5 moderate; >0.5–0.7 large; >0.7–0.9 very large; >0.9 nearly perfect; and 1 perfect. Significance level was also set at $p < 0.05$. The SPSS 23.0 statistical analysis package (IBM SPSS, Armonk, NY, USA) was used for all statistical analyses.

Results

Table 1 depicts the descriptive measures of relative peak torque and power produced by ankle invertors, evertors, plantar flexors, dorsiflexors and knee extensors and flexors in both 60-69 and 70-79 groups. As it is demonstrated, produced measures of relative power and torque encountered a significant decrement by increasing age in ankle invertors (≈30%), plantar flexors (≈28%), knee extensors (≈23%) hip extensors (≈24%). Nevertheless, no significant difference was observed in both ankle evertors and dorsiflexors, knee flexors and hip flexors due to advancing age. Overall, it could be observed that the relative measures of RPT and RPP of the entire muscle groups, except ADF, were lower in 70-79 group, either significant or not.

Table 1. Descriptive measures of ankle invertors, evertors, plantar flexors and dorsiflexors and the differences between 60-69 and 70-79 groups.

Muscle Group		60-69years	70-79years	t	Sig. (2-tailed)
AIN	RPT	0.24±0.06	0.17±0.05	-3.27	0.00‡
	RPP	0.13±0.03	0.09±0.02	-3.28	0.00‡
AEV	RPT	0.21±0.05	0.17±0.07	-1.46	0.15
	RPP	0.11±0.03	0.09±0.04	-1.46	0.16
APF	RPT	1.07±0.23	0.77±0.28	-3.35	0.00‡
	RPP	0.57±0.12	0.41±0.15	-3.34	0.00‡
ADF	RPT	0.33±0.07	0.32±0.09	-0.02	0.98
	RPP	0.17±0.04	0.17±0.05	-0.03	0.97
KFL	RPT	0.83±0.18	0.74±0.18	1.48	0.14
	RPP	0.88±0.19	0.79±0.18	1.51	0.14
KEX	RPT	1.49±0.26	1.14±0.28	1.89	0.04†
	RPP	1.57±0.28	1.20±0.30	1.91	0.04†
HFL	RPT	1.03±0.22	0.95±0.25	1.55	0.07
	RPP	1.04±0.29	0.93±0.33	1.62	0.06
HEX	RPT	1.58±0.59	1.21±0.54	2.18	0.03†
	RPP	1.63±0.55	1.25±0.61	2.23	0.02†

AIN = Ankle invertors, AEV = Ankle evertors, APF = Ankle plantar flexors, ADF = Ankle dorsiflexors, KFL = Knee flexors, KEX = Knee extensors, HFL = Hip flexors, HEX = Hip extensors, RPT = Relative peak torque, RPP = Relative peak power.
† significant at $\alpha<0.05$
‡ significant at $\alpha<0.01$

Descriptive measures of 5 times sit to stand, right-side, left-side and frontal reaching tests, and the differences between 60-69 and 70-79 groups are illustrated in table 2. Sit to stand execution time was the sole test that faced a meaningful increase as a result of age increase (≈18%), while both left- and right-side lateral reaching test measures experienced decrease for 1.22cm and 1.34cm, respectively.

More interestingly, not only frontal reaching values did not decrease by advancing age, but also 70-79 group reached further spaces for almost 1.23cm. Although statistical analysis failed to show a significant difference in frontal reaching test between both groups, figure 2 portrays that over than 80% of 70-79 group were able to have access to further spaces regarding their age norm defined by Duncan et al. (1990)for females, which is way higher in comparison with 60-69 group (≈28%).

Table 2. Descriptive measures of 5 times sit to stand, right-side, left-side and frontal reaching tests, and the differences between 60-69 and 70-79 groups.

Test	60-69years	70-79years	t	Sig. (2-tailed)
5RSTS (s)	10.46±2.12	12.68±2.69	-2.21	0.03†
LRT_{left}(cm)	19.09±6.88	17.87±6.98	0.69	0.49
LRT_{right}(cm)	20.01±6.87	18.67±4.65	0.42	0.53
FRT(cm)	28.87±7.83	30.10±6.19	-0.60	0.55

5RSTS = 5 times sit to stand, LRT_{left} = left-side reaching test, LRT_{right} = right-side reaching test, FRT = frontal reaching test.
† significant at $\alpha<0.05$
‡ significant at $\alpha<0.01$

Table 3. Correlation between RPT and RPP values of selected muscle groups with 5RSTS and functional reaching tests among 60-69 years and 70-79 years groups.

Muscle Group		60-69 years				70-79 years			
		5RSTS	LRT	RRT	FRT	5RSTS	LRT	RRT	FRT
AIN	RPT	0.12	0.58*	0.62⁑	0.31	0.35	0.69⁑	0.65⁑	0.19
	RPP	0.14	0.52*	0.54*	0.24	0.32	0.61⁑	0.60*	0.18
AEV	RPT	0.25	0.53*	0.51*	0.09	0.25	0.55*	0.53*	0.26
	RPP	0.29	0.50*	0.57*	0.12	0.23	0.54*	0.50*	0.31
APF	RPT	-0.68⁑	0.41	0.32	0.71⁑	-0.78⁑	0.18	0.11	0.69⁑
	RPP	-0.66⁑	0.40	0.36	0.74⁑	-0.75⁑	0.21	0.10	0.72⁑
ADF	RPT	0.24	0.07	0.13	0.38	0.21	0.30	0.43	0.09
	RPP	0.21	0.03	0.15	0.33	0.24	0.27	0.41	0.06
KFL	RPT	-0.52*	0.08	0.02	0.38	-0.59*	0.35	0.24	0.31
	RPP	-0.55*	0.09	0.05	0.41	-0.57*	0.33	0.29	0.28
KEX	RPT	-0.79⁑	0.19	0.15	0.52*	-0.87⁑	0.08	0.14	0.59*
	RPP	-0.82⁑	0.22	0.12	0.51*	-0.84⁑	0.02	0.13	0.54*
HFL	RPT	0.66⁑	0.38	0.24	0.18	0.58*	0.05	0.17	0.21
	RPP	0.65⁑	0.42	0.27	0.14	0.61⁑	0.09	0.17	0.22
HEX	RPT	0.79⁑	0.15	0.33	0.69⁑	0.72⁑	0.36	0.45	0.52*
	RPP	0.82⁑	0.09	0.28	0.72⁑	0.69⁑	0.31	0.39	0.55*

5RSTS = 5 times sit to stand, LRT $_{left}$ = left-side reaching test, LRT $_{right}$ = right-side reaching test, FRT = frontal reaching test. AIN = Ankle invertors, AEV = Ankle evertors, APF = Ankle plantar flexors, ADF = Ankle dorsiflexors, KFL = Knee flexors, KEX = Knee extensors, HFL = Hip flexors, HEX = Hip extensors, RPT = Relative peak torque, RPP = Relative peak power.
* significant at $\alpha<0.05$
⁑ significant at $\alpha<0.01$

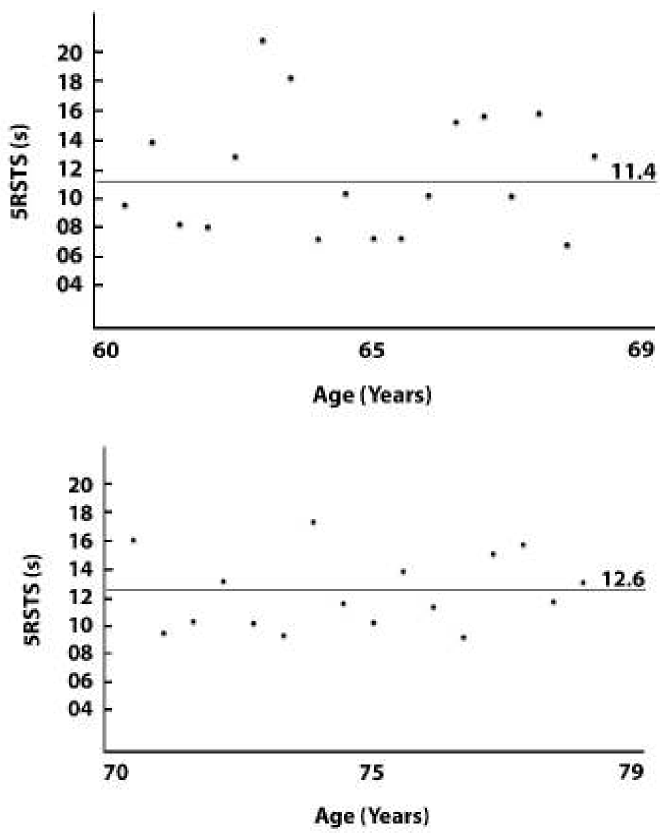

Fig. 1. *5RSTS critical values for each age group and the recorded times by individual participants. According to Bohannon et al. (Bohannon, 2006), the critical value for 5RSTS test is 11.4s for 60-69 elderly adults and 12.6cm for 70-79 elderly adults.*

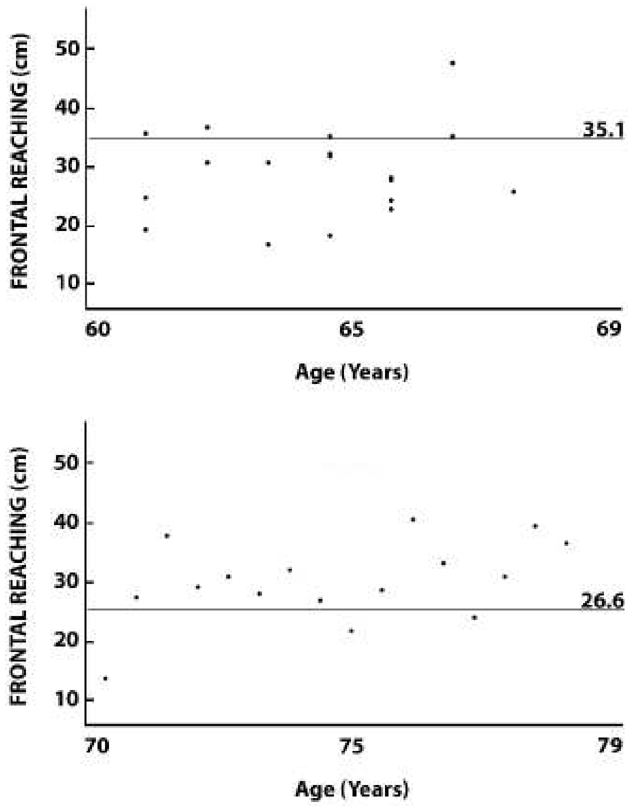

Fig. 2. *Frontal reaching test critical values for each age group and the recorded times by individual participants. According to Duncan et al. (Duncan et al., 1990), the critical value for frontal reaching test is 35.1cm for 41-69 adults and 26.6cm for 70-87 adults.*

The correlations between RPT and RPP values of selected muscle groups with 5RSTS and functional reaching tests are illustrated in table 3. As it is portrayed, RPT and RPP values of AIN and AEV have significant correlations with LRT and RRT in both 60-69 and 70-79 years old groups. APF, KFX, KEX, HFL and HEX are also shown a strong contribution in the decrement of 5RSTS duration in both groups, while APF, KEX and HEX had also a significant correlation with FRT performance among them. Nevertheless, ADF showed no significant correlation with the outcomes of evaluated tests.

Discussion

This study was designed to investigate the impacts of ageing on the ankle and knee joints muscle strength and the subsequent effects on routine tasks, such as 5 repetition sit-to-stand (5RSTS) motion and functional reaching among the two groups of 60-69 and 70-79 years old elderly females. Of the main findings of this study was that with increasing age, the muscle strength of the AINs, APFs, KFXs, HFLs and HEXs significantly decreased, and 5RSTS execution time meaningfully increased. Correlation analysis, besides, demonstrated that RPT and RPP values of AINs and AEVs have significant correlations with LRT_{left} and LRT_{right} in both groups. APFs, KFXs, KEXs, HFLs and HEXs are also shown a strong contribution in the decrement of 5RSTS duration.

Risk of fall, particularly among elderly adults, has been recognized to have a linear proportion with balance dysfunction (Goldberg, Chavis, Watkins, & Wilson, 2012; Lord & Dayhew, 2001; Lord, Murray, Chapman, Munro, & Tiedemann, 2002). In line with this statement, it has been investigated that elderly adults, those suffering from balance impairments, are meaningfully slower in 5RSTS performance (Goldberg et al., 2012). As the results portray, the 70-79 elderly females executed the 5RSTS in a significantly longer duration, compared with 60-69 group, which is in agreement with former studies (Goldberg et al., 2012; van Lummel, Evers, Niessen, Beek, & van Dieën, 2018; Whitney et al., 2005). Nevertheless, this question arises as to whether the balance dysfunction is the origin of 5RSTS deficits among older adults or muscle weakness? From a biomechanical perspective, the sit-to-stand action is the process of changing the body status from balanced condition to imbalanced one and again balanced. More precisely, during the flexion-momentum phase, the hip flexors produce momentum to transfer the CoM line from the chair-feet base of support (complete sitting) into feet based-of-support (complete standing). This transfer moves the structure toward the imbalanced condition, in which the CoM is still outside of the feet based-of-support. Weaker HFLs ends up in longer transferring duration and individuals remain in the imbalanced condition for a longer time. This condition, during the transfer-momentum phase, puts the KEXs under a higher pressure to eccentrically prevent the structure from falling and concentrically extend the knee joint and help in standing. Simultaneously and followed by extension phase, the HEXs concentrically extend the trunk to prevent further movement of CoM and keep it inside the feet base of support during stance. During the stabilization phase, the role of APFs, KEXs, and HEXs becomes more highlighted, where they must eccentrically keep the CoM line close to the joint centre of rotation, reduce the momentum arm around each joint and maintain the CoM inside the base of support. During the sitting action, the CoM reversely transfers from feet based-of-support to the chair-feet base of support, in which the KFLs and HFLs concentrically contract to produce momentum and imbalance the body, and KEXs eccentrically slow down the downward locomotion of the body in order to prevent falling on the chair in a controlled movement. Among the mentioned muscles, which have a contribution to 5RSTS performance of elderly females, the APFs, KEXs and HEXs faced a significant decrease in strength measures by advancing age, and KFLs and HFLs, rather insignificant, had a meaningful strength decrease. To this effect, it could be claimed that lower limb strength, which is negatively influenced by advancing age, have a vital contribution in 5RSTS, and strengthening of these muscle groups could highly enhance the sit-to-stand performance of elderly females.

On the other hand, the reaching capability of elderly females is mentioned to deteriorates by advancing age (Duncan et al., 1990; Weiner et al., 1993). The results of this study, despite the mentioned studies, illustrated no significant deterioration in LRT_{left} andLRT_{right} by advancing age, and more interesting, the FRT performance was better in 70-79 group compared with 60-69 group; although the entire muscles that had a significant contribution in these performances faced strength decrease by age increment. Furthermore, it is observed that individual FRT was significantly better in 70-79 group given the critical norm set by Duncan et al. (Duncan et al., 1990), as over than 80% of the participants could reach to higher values of 26.6cm. Due to which, it is still unclear if the muscle strength is in charge of balance impairment or not? Similar to the standing part of 5RSTS, during the reaching performance, whether frontal or lateral, the structure tends to lose its equilibrium and the CoM falls out of the base of support (Maki, Holliday, & Topper, 1994). Hereupon, the CNS sends the imbalance-threshold signals to the muscles and they eccentrically maintain the CoM line inside the feet base of support. Therefore, although the concentric strength of AINs, AEVs, APFs, KEXs and HEXs had a significant correlation with the functional reaching tests among elderly females, it is the eccentric strength that can provide the structure with proper balance, which is in contribution with CNS. These findings also demonstrate that the CNS signalling and its contribution to skeletal muscle activity did not encounter impairment from 60-69 group to 70-79 group. Overall, form the outcomes of this study, it could result that eccentric contraction of lower limbs muscle strength and their contribution with the CNS faces no significant deterioration by advancing age; however, it is the concentric contraction weakness that cause an impairment in 5RSTS and ends up with longer execution time.

Of the limitations of this study involves not measuring the eccentric strength of lower extremities muscles. Due to prolonged two-phase testing of concentric strength and the limitations dealing with eccentric activity among the elderly females, we were only able to evaluate the concentric strength. For this reason, further analysis of eccentric strength of lower extremities muscles and their impact on 5RSTS and functional reaching could be investigated in future research studies.

Conclusion

Findings of this study confirmed that the muscle groups acting around the ankle, knee and hip joints underwent a weakness (knowing as atrophy) by advancing age among elderly females, and as a consequence, the sit-to-stand execution time increases since these muscle groups cannot contract faster and control the smoothnessof movement. Furthermore, the sit-to-stand duration increment could be due to the fact that the lower limbs muscles could not properly maintain the structure balance while the elderly females are in the standing position. Nevertheless, the reaching performance faced no significant deterioration by increasing age among elderly females.

Conflict of interest statement

The authors of this study declare no conflict of interest.

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