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Balance Comparison between Iranian Elderly with and without Knee Range of Motion Limitations

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ABSTRACT

This study compares the static eye movement (eyes open and eyes closed) and dynamic balance amongst Iranian elderly with and without knee range of motion (ROM) limitations. The method used was a quasi-experimental before/after study. The participants consisted of 30 older Iranian adults, aged 60 or more (10 females and 20 males across two groups of 15 in each group) who were evaluated using the Sharpened Romberg (SR), Timed Up and Go (TUG) tests. An independent t-test was used to compare the descriptive characteristics of the two groups of the elderly. The findings showed substantial alterations in all the measured components between the subjects. The static balance with an open eye ($p = 0.028$) and closed eye ($p = 0.021$), as well as the dynamic balance ($p = 0.009$) between the elderly with and without the limitation of knee ROM, was substantially different. Moving forward, the findings of this study suggested that the balance of the elderly was directly linked to knee ROM, as the elderly without limitations of knee ROM displayed greater stability than the elderly with limitations of knee ROM. Health care practitioners should also understand the ROM of the knee, as individuals with ROM limitations of the knee are more likely to fall due to underlying disorders associated with their balance.

Keywords: Dynamic balance, elderly, falls, knee range of motion (rom), static balance

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INTRODUCTION

The COVID-19 pandemic is an unprecedented health crisis, as the aging population has been asked to self-isolate and live in home-confinement for several

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weeks to months. This, in itself, represents a physiological challenge with significant health risks. These unprecedented conditions can reduce neuromuscular functions, muscle mass, strength, endurance, and joint range of motion (ROM) amongst older people (Barzegari et al., 2019). Research has shown that aging induces changes in the musculoskeletal system, leading to substantial changes in the motor skills required for the performance of functional tasks, such as balance and posture due to the COVID-19 outbreak. These changes and their consequences have been strongly associated with an increase in the risk of falling (Concha-cisternas, 2019).

Given that the aging population contributes to the personal and socioeconomic toll attributed to accidental falls, it is fitting that over the last 30 years, a considerable amount of research has been devoted to the issue (Rubenstein, 2006). Due to the high morbidity, falls are now one of the leading public health concerns amongst older adults, which costs money and mortality concerns for the family and the community.

Falling is one of the biggest problems affecting the health of older people. The majority of falls amongst the elderly arise from irregular processes of balance functions. Falls and injuries are critical issues that impact older individuals. Studies have shown that about one-third of people over 65 experience one or more falls per year (Sgarbieri & Pacheco, 2017). Approximately 24 percent of people who fall suffer a severe injury that needs medical treatment, or results in a limitation of fracture or operation (Hornbrook et al., 1996). The effect of falling for the loss of the elderly cause of independence and financial burden and psychological, social, and economic effects, which have a significant impact on the community's health system. It is one of the most severe problems for the health of the elderly because of the significant complications and associated risk factors posed to the elderly (Akbari Kamrani et al., 2006).

Balance and the production of muscle force are directly linked to age-related muscular changes (Kamalden, & Gasibat, 2020). Studies on the prevention of falls have concentrated on different group training and individualized strength training. There is, however, a lack of evidence on strengthening critical muscles required to maintain balance and postural stability (MacCulloch et al., 2007; Safikhani, et al., 2011). Studies have shown that impaired functions of sensorimotor factors are responsible for balance or postural stability, shown in elderly subjects who have had falls (Spink et al., 2008). Inactive lifestyle and aging-related physiological changes characterized by a gradual decrease in muscle power, joint motion range, reaction time, and sensory systems, contribute to the decreased physical ability and increased risks of falling (Borah et al., 2007; Howe et al., 2011; Lang et al., 2010).

According to the Iranian Centre of Aging, falls are the most common complication that older people face, which imposes burdens such as massive hospital costs, medical treatment, and rehabilitation on the family, the elderly, and society as well (Manoochehry & Rasouli, 2017). Low balance is a significant factor in decreasing age-related mobility and increased risk of falls in the elderly. Some deficiencies in fitness factors cause falls. For example, a deficiency in balance, a weakness in the knee, and a decrease in the reaction tend to cause falls, resulting in consequences such as changes in the walking sequence (Ravindran, 2017).

ROM's limitation is known as a condition that involves the changes of articular cartilage, particularly in weight-bearing joints, e.g., the knee. It is the most common type of lower limb restriction amongst the elderly. It interferes with independent functions. It is estimated that 80% of the population over 55 have changes consistent with knee ROM. Researchers have found that people with Limitation of Knee ROM exhibit balance deficits relative to their age, mass, and gender-matched control subjects (Manetta et al., 2002). Due to the severe complications and threats that were falling and its associated risk factors have for the health of the elderly, it is one of the most severe issues facing the elderly population, particularly in Iran, because Iran is experiencing a rapidly aging demographic shift (Afshar et al., 2016; Sheykhi, 2004; Sotoudeh et al., 2018). Most previous studies ignored the serious complications and threats that were falling and the related risk factors for the health of the elderly, especially in a country with a rapidly ageing population such as Iran.

The outcome of this study will tell the difference between the static and dynamic balance between the elderly with and without knee ROM limitation. It also determines what parameter needs to be improved based on the comparison of knee ROM limitations between two groups so that the knee-limited group can perform better. Qiao et al. (2018) found that knee joint variability during walking was balance dependent, with required step-to-step adjustments. The study results showed that through the improvement of knee ROM limitation, the participants developed positive changes toward their balance. Therefore, this study aimed to compare the static and dynamic balance amongst the elderly, with and without knee ROM limitations in Iran.

LITERATURE REVIEW

Balance is an essential requirement for daily activities and plays a vital role in static and dynamic activities. Research on the elderly showed that aging significantly impacts balance types (Justine et al.,2010; Norheim et al., 2020). According to previous studies, the imbalance has been one of the main reasons for falling amongst the elderly (Hsu et al., 2014). Researchers paid attention to the phenomenon of balance in this age group. Falls have a high prevalence and have become a significant public health problem due to the high economic and functional costs amongst the elderly. To avoid these events, it is essential to know that the anatomy of the physiological changes associated with aging and plan health strategies where bone, muscle, somatosensory (proprioceptive), and cognitive stimulation are incorporated is needed to avoid functional impairment and disability (Concha-cisternas, 2019).

Furthermore, physical and psychological consequences of falls, such as impaired mobility, depressive symptoms, and the decline in the functional ability for various daily living (ADL), are expected. This leads to disability amongst older adults. Fear of falling compounds the problem and may lead to a reluctance to participate in physical activities, less confidence, depression, social isolation, and, consequently, more need for long-term care facilities (Sotoudeh et al., 2018). The prevalence of balance deficits increases with age and is associated with an increased incidence of falls seen in the elderly population; these falls are associated with significant morbidity and mortality. Balance is an essential consideration in the health of elderly subjects. It is estimated that 13% of adults self-report imbalance from ages 65 to 69, and this proportion increased to 46% amongst those aged 85 years and older (Osoba et al., 2019).

The progressive decline in older people's physiological function that usually occurs over decades is associated with difficulties arising from a seated position and balancing themselves. Some physiological changes inevitably occur with age; however, it seems that by improving the quality of life (QOL) and examining physical status, the effects of aging may be reduced. Therefore, preventive strategies adopted even at an early age can help improve older people's living conditions (Mcphee et al., 2016).

Balance is defined as maintaining optimal posture in both static and dynamic positions. Previous studies have shown that imbalance in most situations leads to falls, which is one of the most common and severe problems of old age and has physical (pelvic fracture, disability, loss of physical ability, and death), psychological (loss of confidence and self-esteem and decline in life expectancy) and financial consequences. Older adults usually fall several times a year, resulting in fractures, soft tissue injuries, immobility, and eventually, long-term disability and immobility, or even death (Barzegari et al., 2019).

Balance is a skill and ability for the central nervous system learned through the use of different body systems, including all of the muscular sensory systems and different parts of the brain, to maintain balance. The body must be stable and strive to hold the center of gravity (COG) on the footrest. These three systems are involved in balancing work together and are all critical in maintaining a well-coordinated situation. Balance, a basic requirement for daily activities, plays an essential role in static and dynamic activities (Anderson & Behm, 2005).

The balance function is the ability to maintain the center of mass (COM) at the support base. The interaction between the sensory inputs from proprioception, visual and vestibular systems, motor systems (such as muscle strength and muscle activity), and cognitive components. Reduced balance function is associated with an increased risk of falling, which is one of the leading causes of hospital admissions amongst older adults, and could lead to other consequences such as fracture, joint dislocation, soft-tissue injury, loss of independence, and mortality (Liu et al., 2017). Damage to any of the balance regulation levels influences the postural system's output, resulting in an increased risk of postural instability and fall, which could generate dramatic consequences amongst the elderly. Knee ROM limitation is seen as one of the most prevalent joint disorders and affects many different joint areas in the body, causing pain, stiffness, decreased function, and health status. The knee is the most frequently affected joint of the lower limb, and it has become a widely used joint alteration model in studies on balance control, for both muscular and joint proprioceptive differences, and in motor efferences (Gauchard et al., 2010).

Balance and its Types

Balance is the maintenance of the body's resting state, even if force is exerted on it. All forces quickly state the aspect of balance in terms of equal size and opposite direction. Balance is classified into three categories:

1. Static balance
2. Dynamic balance
3. Neutral balance (Whittle et al., 2012).

Static Balance

The body maintains its resting state even when a force tends to disturb its balance. This is called static or stable balance. In general, when the support level is higher, and COG is lower the balance increases. (Whittle et al., 2012).

Dynamic Balance

The minimum force needed to disturb the balance of the object is called dynamic or unstable balance. The object will have little balance when the support surface is low, and the COG is high (Whittle et al., 2012).

Neutral Balance

In the neutral balance, despite the object's movement in the body, there is no change in the COG of the object (Okubo et al., 2019).

Level of Reliance in Balance during Walking

The high COG, two legs, and the low level of human reliance distinguish it from others. Although this condition facilitates displacement, maintaining the static and dynamic balance is more complicated and increases muscle function and pressure on the bones and ligaments. The head, arms, and trunk (HAT) are carried with the lower limb's alternating movements. HAT consists of 75% of the total body weight (head and hands 25% and trunk 50%). In a standing position, the HAT weight is borne by the legs, but while walking, the weight of the HAT and the lower limbs of the swinging body are also carried on the other foot, which is the weight-bearing leg. It changes periodically with time. Therefore, one should be not only able to withstand the weight of HAT while standing in balance on two legs, but also be able to keep the weight of the swinging leg in balance in addition to the weight of the head, arms, and trunk, by keeping one foot on the ground, and lifting one leg above the ground to the other. One has to do this alternately without disturbing the balance. Performing this complex activity requires coordination, balance, the health of the deep and motor senses, and healthy muscles and joints (Qiao et al., 2018; Soh et al., 2018).

Range of Motion (ROM)

The muscles can produce an internal force for the body, and an external force, which is applied manually or mechanically. Moving a joint is changing the angle of that joint. The angles in which the movements are made are called ROM. If the soft tissue around a joint is healthy, ROM of the joint can be optimal. Any alteration and disruption of the soft tissue can affect the ROM in the joint. Generally, in joints with movement limitation, ROM is typically lower than in normal joints, and vice-versa. ROM can be measured using a goniometer (Soh et al., 2003).

Limitation of Knee Range of Motion (ROM)

It is determined that a normal knee should ideally be able to flex between 133 and 153 degrees and extend to 180 degrees. A reduction in the normal range of motion in the knee joint is known as limited ROM in the knee. It is the most common form of the lower limb's limitation related to the elderly and involves changes in the knee joint (Liikavainio, 2010).

Types of ROM: Active and Passive

Active ROM. ROM that can be created in a joint only with the help of the individual and without any external force. In general, the active ROM in a joint with movement limitation will be less.

Passive ROM. ROM is created by an external force that is naturally more than the active ROM. In little joints, the passive ROM is a much more active ROM because of the shortened structures pulled by passive forces, which are not possible with active forces. ROM varies from one joint to another (Whittle et al., 2012). For a better understanding of study variables, see Figure 1.

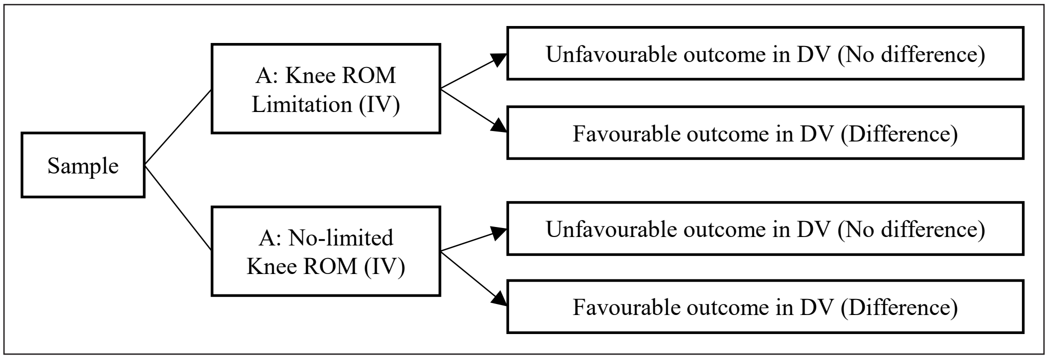

Figure 1. Conceptual framework

METHOD

Research Design

Research design is an integral part of the research. It is a basic structure covering the overall strategy regarding the method to be used in the study. Selecting a correct research design that tallies with the objectives helps obtain an authentic result (Haegele & Hodge, 2015). In the medical informatics literature, quasi-experimental research designs, also defined as nonrandomized, and pre-post intervention studies, are common (Harris et al., 2006).

This study used a quasi-experimental approach to determine the balance parameter's differences between the elderly and knee ROM limitations. This study's primary instrument was the Goniometer MSD (Whittle et al., 2012) in evaluating the knee flexion/extension ROM. This study measured the static balance of older people with their eyes kept open, the static balance of the older people with their eyes closed, and the older people's dynamic balance. This evaluation was based on the changes in the limitation of the knee ROM as an independent variable. The comparison in this study was then used to compare the elderly with and without knee ROM limitations. The relationship between independent and dependent variables is vital to determine the elderly's balance to be improvised or changed to an optimal situation with various interventions.

Population and Sample

The 2011 census observed a significant demographic change in Iran's elderly population (the proportion of the elderly population rose from 7.27 percent to 8.20 percent from 2006 to 2011, and 8.65 percent in 2016). In 2025, the aging population is expected to increase to 10.5 percent, and in 2050 to 21.7 percent (Manoochehry & Rasouli, 2017). In this study, the target research population was the elderly in the age group above 60, in Tehran, Iran. The research sample consisted of 37 seniors who were non-randomly selected from the Norast Yara Elderly Centre in Tehran, Iran. This sample was selected because they were much more at the risk of falling in their age group. They consisted of 25 males and 12 females. They were subjected to various tests and were instructed to perform the test accurately.

To select the test samples, the research plan was described first, and then the orthopedic and neuromuscular disease records of the study participants were assessed using the questionnaire. Those with practice surgery on the lower limb joints were also excluded from the study and those with poor performance according to the protocol. To ensure the subjects' health and their ability to participate and complete the test, a medical questionnaire and simple tests, such as walking 0.2 km, were used. Finally, of the 37 individuals who were evaluated, 30 (Male=20 and Female=10) met the eligibility criteria, completed the tests correctly, and used the associated data for statistical analysis.

Instrumentation

In this study, three parameters for comparison needed to be evaluated to identify the differences between the elderly with and without knee ROM limitation. The three parameters were static balance with open eyes, static balance with closed eyes, and dynamic balance. The instruments used in this study were the Sharpened Romberg test (Reliability: 0.90- 0.91 for open eyes and 0.76- 0.77 for closed eyes) to measure static balance. The Timed Up-and-Go test (TUG) (Reliability: 0.99) was used to measure the dynamic balance (Barry et al., 2014). The knee flexion/extension ROM was measured with a standard tool using the Goniometer MSD (Whittle et al., 2012).

Procedures

The researchers provided a complete explanation regarding the purpose of the research, how it was to be conducted, and the confidentiality of the information obtained before obtaining the subjects' consent. The current study data collection followed the Ministry of Health principals of patients' rights and regulations (Islamic Republic of Iran, Ministry of Health and Medical Education, 2001).

All subjects signed the consent form to participate in the research tests and were then briefed on how to perform the tests. In order to perform the tests, the subjects were coordinated in two groups, and the tests were carried out as follows:

1. The person sits on the edge of the bench, and with their hands grasping the flat edge until the hip is fixed, and leans back to reduce the hamstring muscle tension. This is carried out because of pain and discomfort in these muscles inhibit knee extension. Then we asked the person to keep their knee straight. ROM measurement was performed on the sagittal plane so that the Goniometer axis was positioned on the outer condylar of the femur. Those with knee extensions less than 180 degrees were identified as individuals with knee joint limitations (Whittle, 2012), which resulted in the subjects being divided into two groups, with and without knee ROM limitation. Of the 30 subjects, 15 were fell into the knee-limited group, and 15 in the non-knee-limited group.
2. The height and weight of each subject were measured using the standard metal height scale.
3. Static Balance with Open and Closed Eyes: Sharpened Roomberg test was used to measure the static balance (Gras et al., 2017). The test was performed on the subject under barefoot conditions, so that one of the legs (the dominant leg) was positioned ahead of the other, and the arms were placed crosswise on the chest. Each subject's length of time could maintain this position with eyes open and closed was illustrated as the test score (Gras et al., 2017). To get acquainted with the test, the subjects practiced it

three times. Then, each test was performed three times with open eyes, and three times with closed eyes. Each subject was able to maintain this position with their eyes open and closed was scored, and the average of these three tests was then recorded.

Dynamic Balance. Timed Up-and-Go test (TUG) was used to measure the dynamic equilibrium (Gras et al., 2017). Activities such as walking and getting up from a chair were necessary motor activities and extremely important in independent daily living (Yuksel et al., 2017). Performing this test required that each subject arose from a chair without a handle, using a three-meter path, and then to sit on the chair again (Gras et al., 2017; Kashiani & Geok, 2019). Subjects were asked to complete this task as quickly as possible without running, and the total test time was recorded. To get acquainted with the test, the subjects practiced this practice three times before recording the tests. Time recording began with the person leaving the seat and being seated again. The subject's back needed to be in contact with the back of the seat before and after getting up. This test was repeated three times, and the mean of the three tests was recorded as a record for each individual. The TUG test involved standing from a seated position, walking around a cone placed 3 meters away, and returning to a seated position on the original chair. Healthy men and women completed the task within 7 seconds (Bijlsma et al., 2013), and frail people took 10 seconds longer (Kashiani et al., 2020; Turner & Clegg, 2014), suggesting that a score between 7–10 seconds was indicative of pre-frailty.

Ethical Considerations

Ethical considerations can be defined as one of the most significant components of the analysis. Study participants should not be harmed in any way, whatsoever. It is necessary to prioritize respect for the dignity of the research participants. Before the study, full consent was obtained from the participants (Connelly, 2014). Ethical considerations for the current study are as follows:

1. Informed consent (Moore & Savage, 2002) was obtained from all study subjects.
2. Full and adequate supervision by the researcher and an assistant anticipated full and adequate supervision and adequate supervision during the tests to prevent any injuries or falls. In the case of falling fall, a doctor was present during the tests in the center.
3. The researcher protected the personal information of the subjects (Caudill & Kaplan, 2005).
4. The study subjects were free to discard themselves at any stage of the research at their discretion, for any reason, or even without any particular reason.
5. In case of any severe illness or disability, the researcher was ready

to coordinate and follow up on the treatment and rehabilitation of the studied elderly.

DATA ANALYSIS

In this study, after collecting data, the mean, standard deviation, and percentile rank in the descriptive statistics and the normality of the data distribution were evaluated using the Kolmogorov-Smirnov normality the equality of variance using Levine's test. Inferential analysis was used to compare the biomechanical properties of the two groups. The tests were field type, and data were analyzed using SPSS version 25 (The Statistical Package for Social Science). Descriptive statistics were used to calculate the mean and standard deviation of the subject's age, height, weight, and report the results of each group's measurements. An independent t-test was used to compare the two groups with a significance level of $P \geq 0.05$ (Nekooei, et al., 2016; Soh et al., 2006, 2009).

FINDINGS

Descriptive Statistics

Mean and Standard Deviation (*SD*) for continuous variables were used in the descriptive statistics to summarise the participants' baseline characteristics. The results discussed the contents of this study. The data were analyzed using an independent t-test. All statistical analyses were performed using the Statistical Package for Social Sciences for Windows (SPSS) software version 25 with a significance level of 0.05. Table 1 shows the mean and standard deviation ($M \pm SD$) of the individual characteristics across the two groups of the elderly, with and without knee ROM limitations.

Balance Findings

Table 2 shows the mean and standard deviation ($M \pm SD$) of the static balance with the eyes open, the static balance with the eyes closed, and the dynamic balance across the two groups of the elderly with and without knee ROM limitations. The group without the knee ROM limitation recorded a higher mean score per second in the static balance category with open and closed eyes. The group's dynamic balance with the knee ROM limitation was lower, which demonstrated a higher mean of balance time during the tests.

Table 1

Mean and standard deviation ($M \pm SD$) of individual characteristics (N=30)

	The group with knee ROM Limitation (N=15)	**The group without knee ROM Limitation (N=15)**
Age (years)	66.78 ± 4.98	65.56 ± 5.33
Weight (kg)	67.10 ± 9.80	66.98 ± 5.11
Height (cm)	171.94 ± 10.40	170.54 ± 7.69

Note. M = mean, *SD* = standard deviation.

Table 2

Mean and standard deviation (*M* ± *SD*) *of balance (N=30)*

	Group with knee ROM Limitation (N=15)	**Group without knee ROM Limitation (N=15)**
Static Balance with open eyes (seconds)	28.90± 7.60	4.44 ± 35.54
Static Balance with close eyes (seconds)	9.65± 2.12	3.75± 13.81
Dynamic Balance (seconds)	11.68 2.29±	1.91 ±15.30

Note. M = mean, SD = standard deviation

Table 3

Comparison of static balance with open eyes in the elderly with and without limitation of knee ROM

	(M ± SD)	**t**	**Df**	**Sig.**	**Mean Difference**	**Result**
With Limitation of Knee ROM	28.907.06±	2.765	28	0.028	6.64	Reject H_0
Without Limitation of Knee ROM	35.54±4.44					

Note. M = mean, SD = standard deviation

Furthermore, the results of the independent t-test presented in Table 3 displayed a significant difference in the static balance with open eyes between the elderly with and without limitations of the knee ROM. Studies showed that through increased age due to disorders across various systems of the body, particularly for ROM limitations in the knee, "the ability of the elderly to maintain static balance with their eyes open" decreased (Rose & Gamble, 2006). In another study, reduced knee ROM had been found to correlate with decreased static balance with the eyes open, and subsequently, an increased risk of falls. These findings were consistent with this research work and suggested that knee joint ROM limitations were one of the significant risk factors of falling amongst older people. Improvements in the ROM of the lower limb joints, following an exercise intervention, had been found to correspond with improvements in the balance stability (Lord et al., 2014).

This study's findings in Table 4 showed a significant difference in the static balance with the eyes closed between the elderly with and without limitations of knee ROM. This study revealed that the knee's ROM associated with static balance performance with the eyes closed amongst older adults with lower limb's deformities resulted in performing less forceful movements due to the weakness and hypermobility of certain joints. The results showed the limitations in ROM as an essential factor influencing the changes in the elderly's balance (Justine et al., 2010).

Lastly, the independent t-test presented in Table 5 displayed a significant difference in the dynamic balance between the elderly and without limitation of knee ROM. In a previous study, Qiao et al. (2018) found that knee joint variability impacted both static

Table 4
Comparison of static balance with close eyes in the elderly with and without limitation of knee ROM

	(M ± SD)	**t**	**Df**	**Sig.**	**Mean Difference**	**Result**
With Limitation of Knee ROM	9.65±2.12	2.943	28	0.021	4.16	Reject H_0
Without Limitation of Knee ROM	13.81±3.75					

Note. M = mean, SD = standard deviation

Table 5
Comparison of dynamic balance in the elderly with and without limitation of knee ROM

	(M ± SD)	**t**	**Df**	**Sig.**	**Mean Difference**	**Result**
With Limitation of Knee ROM	11.68±2.29	3.341	28	0.009	3.62	Reject H_0
Without Limitation of Knee ROM	15.30±1.91					

Note. M = mean, SD = standard deviation

and dynamic balance, and the perturbations elicited more massive and more pervasive increases in the knee joint ROM outcome measured amongst the elderly. The authors found that the knee joint variability did vary in the knee joint kinematics, occurring predominantly during dynamic balance. As a result, aging increased the susceptibility of the knee joint angle variability of balance with larger and more pervasive effects in the elderly. Qiao et al. (2018) also reported that the reduced ROM, especially around the knee joint, was one of the leading causes of falls, mainly due to the effects of thigh stiffness on the lower extremities' dynamics during walking, which could affect the dynamic balance.

DISCUSSIONS

Various studies have shown that with increasing age, "the ability of older people to maintain balance" decreases due to disorders in various systems of the body, especially due to physical and mobility limitations (Cuevas-trisan, 2017). In this study, a significant relationship was established between balance types and knee ROM limitations. The results of this study showed that the balance of the elderly was directly related to the ROM of the knee, as older people without limitation of the knee ROM demonstrated much better stability than those with knee ROM limitations. These findings are in line with the previous studies such as Chiacchiero et al. (2010) and Cao et al. (2007) that the presence of limitations in the knee ROM could affect the balance amongst older adults.

This study showed that the balance of the elderly was directly related to the ROM of the knee. This is also consistent with the previous studies that older people without limitation of the knee ROM demonstrated much better stability than elders with knee limitations (e.g., Vaillant et al., 2009). Therefore, the loss of motion amplitude and limitation in the knee ROM could affect balance amongst older persons. The physical activity and flexibility significantly influenced the motion's amplitude in the training exercise, which can be considered a therapeutic strategy across many older subjects who suffer from reduced cognitive and physical performance. (Lauretani et al., 2018). The need for a good range of motion of joints is measured while walking. In fact, by increasing the joints of the ROM in subjects with limitations, it may be possible to eliminate some of the motor disorders of the lower extremities amongst the elderly. Lower limb weakness, especially knee extensor weakness, is a condition that alters the average balance, and this condition may result in decreased stability when carrying out daily tasks (Rafiaei et al., 2016).

Various studies have shown that with increasing age, "the ability of older people to maintain balance" decreases due to disorders in various systems of the body, mainly due to physical and mobility limitations (Cuevas-Trisan, 2017). Macrae et al. (2013) believed that muscle weakness in the hip abductors, extensors and knee flexors, and the ankle flexor's dorsal muscles were associated with risk of movement, maintaining balance, and walking.

Chan et al. (2018) also reported that reduced ROM around joints in lower limbs was one of the leading causes of falls, mainly due to the effects of knee limitation on the dynamics of the lower extremities during walking, affecting the balance. Another study revealed that ROM of the lower limb joints associated with balance performance in older adults with lower limb deformities resulted in less forceful movements due to the weakness of mobility across certain joints. The results cite restriction in ROM as an essential factor influencing the changes in balance amongst the elderly (Justine et al., 2010).

According to the results from previous research works, the current study results also showed that the lack of restriction in ROM was associated with improved balance amongst the elderly. Therefore, due to the function of 'muscle strength' and optimum ROM of the lower extremity joints, it is recommended to minimize changes in the balance caused by aging, for example when performing sports activities, particularly strength and stretching exercises, to improve the strength, flexibility, and the ROM between the joints amongst the elderly.

CONCLUSIONS

Researcher found out that this research has successfully achieved all the objectives set. All of the information obtained from this study should be used to improve elderly's balance so that it can benefit both society and the elderly. The results highlighted exercise training interventions can improve gait pattern of the elderly with knee ROM limitation and increase the strength of the legs and balance of the elderly. This result emphasizes the improvement of flexibility and increase ROM of the joints, especially the knee in the elderly.

Furthermore, the results of this study showed that the balance of the elderly is directly related to the strength of the leg muscles and ROM of the knee as elder people without limitation of knee ROM. The results demonstrated a better stability than the elders with knee limitation. Therefore, the loss of muscle strength and presence of restriction in knee ROM could affect balance in older persons. Specific trainings can be implemented to enhance the elderly's ability to maintain static and dynamic balance, which can improve physical function, and decrease risk of falls.

LIMITATIONS AND SUGGESTIONS FOR FUTURE STUDIES

The population in this study consisted of only of the elderly in the stated center in Tehran, Iran, where only these persons in the centre had access to the researchers with restricted data and records, including the age of the subjects (people over 60) and the decision with regards to the sampling methodology. Purposeful sampling, therefore, limited the generalizability of the results, and did not generalize it to all older people in this sample. In the study, healthy subjects were used, but the investigator was not aware of the existence of underlying conditions in the system related to balance control. This was because, when conducting experiments and the exhaustion procedure, this research was unable to monitor the mental state of the participants.

The following points provide two recommendations for future study guidelines. The advice to further this research is to test the balance of older adult. In order to determine how to improve the balance pattern amongst the elderly which can enable them to be much more efficient in terms of the physical activities which leads to a better QOL, future research should be carried out. Firstly, it is crucial to analyze the simultaneous effects of hip ROM, knee and ankle joints on the elderly's balance parameters. Adding more variables to fit the balance parameters in the future analysis to see if there is a substantial difference between two elderly groups with and without limitation, is also advantageous. Secondly, the kinetic aspects of the dynamic balance amongst the elderly with knee ROM limitations should also be used in future analysis, so that similar goals can be used to assess the variations in the balance parameters amongst the elderly with, and without knee ROM limitations.

IMPLICATIONS

Theoretical Implications

Therefore, providing training programs with the necessary principles to strengthen muscles and also to achieve optimal ROM amongst the elderly is one of the strategies which can be used to drive the benefits in the life of the elderly, and reduce imbalances and falls. Additional studies are required in the field of maintaining of balance amongst the elderly. Furthermore, to achieve the proper balance, the results of this study can help the elderly care centres develop health, which brings significant changes to the QOL in the elderly community. Moreover, to better understand physiological and psychological contributions, it may be helpful to use an inter-disciplinary approach to discuss the balance across a different population. Across a broader sample, a similar analysis can be applied, and also for a more extended period, a related study can be carried out. Finally, a correlational analysis across multiple variables can be conducted specifically on the balance amongst the elderly.

Practical Implications

Specific strength training programmes, vibration exercises, massage therapies and Pilates will be helpful to increase the ROM of the knee joint, particularly amongst those with restricted mobility in this joint. It can help to improve the imbalance conditions amongst the elderly with limitations in the knee ROM, ranging from from weakness in the leg muscles, low physical health of the lower extremities, and limited range of motion in the knee. Therefore, one of the techniques which can be used to benefit from the positive effects and successes in the lives of the elderly, and to minimize imbalances and falls in the elderly, is to provide fitness programmes with the requisite concepts to strengthen muscles and also to achieve optimum ROM amongst the elderly. In addition, the findings of this study will enable the elderly care centres to improve fitness, in order to achieve the right balance, bringing about major improvements to the QOL amongst the elderly population.

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REFERENCES

Afshar, P. F., Asgari, P., Shiri, M., & Bahramnezhad, F. (2016). A review of the Iran's elderly status according to the census records. *Galen Medical Journal*, *5*(1), 1–6.

Akbari Kamrani, A., Azadi, F., Foroughi, M., Siadat, S., & Keldi, A. (2006). Characteristics nursing home falls in nursing home residents. *Iranian Journal of Ageing*, *1*(2), 101–105.

Anderson, K., & Behm, D. G. (2005). The impact of instability resistance training on balance and stability. *Sports Medicine*, *35*(1), 43–53. doi:10.2165/00007256-200535010-00004

Barry, G., Galna, B., & Rochester, L. (2014). The role of exergaming in Parkinson's disease rehabilitation: A systematic review of the evidence. *Journal of Neuroengineering and Rehabilitation*, *11*(1), 33. doi: 10.1186/1743-0003-11-33

Barzegari, M., Shojaedin, S. S., Tork, M. B., & Training, B. (2019). Research paper: The effect of 8-week strength training, balance training and combined training on the dynamic and static balance of the elderly inactive men. *Physical Treatments-Specific Physical Therapy Journal, 9*(1), 15–22. doi:10.32598/ptj.9.1.15

Bijlsma, A. Y., Meskers, C. G. M., Ling, C. H. Y., Narici, M., Kurrle, S. E., Cameron, I. D., Westendorp, R. G. J., & Maier, A. B. (2013). Defining sarcopenia: The impact of different diagnostic criteria on the prevalence of sarcopenia in a large middle aged cohort. *Age*, *35*(3), 871–881. doi: 10.1007/s11357-012-9384-z

Cao, Z. B., Maeda, A., Shima, N., Kurata, H., & Nishizono, H. (2007). The effect of a 12-week combined exercise intervention program on physical performance and gait kinematics in community-dwelling elderly women. *Journal of Physiological Anthropology*, *26*(3), 325–332.

Caudill, O. B., & Kaplan, A. I. (2005). Protecting privacy and confidentiality. *Journal of Aggression, Maltreatment & Trauma*, *11*(1–2), 117–134.

Chan, A. C., Jehu, D. A., & Pang, M. Y. (2018). Falls after total knee arthroplasty: Frequency, circumstances, and associated factors—a prospective cohort study. *Physical Therapy*, *98*(9), 767–778. doi: 10.1093/ptj/pzy071

Chiacchiero, M., Dresely, B., Silva, U., DeLosReyes, R., & Vorik, B. (2010). The relationship between range of movement, flexibility, and balance in the elderly. *Topics in Geriatric Rehabilitation*, *26*(2), 148–155. doi:10.1097/tgr.0b013e3181e854bc

Concha-cisternas, Y. (2019). Aging of balance and risk of falls in elderly. *MOJ Gerontol, 4*(6), 255–257. doi: 10.15406/mojgg.2019.04.00216

Connelly, L. M. (2014). Ethical considerations in research studies. *Medsurg Nursing*, *23*(1), 54–56.

Cuevas-Trisan, R. (2017). Balance problems and fall risks in the elderly. *Physical Medicine and Rehabilitation Clinics*, *28*(4), 727–737. doi: 10.1016/j.pmr.2017.06.006

Gauchard, C., Vanc, G., Meyer, P., Mainard, D., Perrin, P. P., & Poincare, H. (2010). On the role of knee joint in balance control and postural strategies: Effects of total knee replacement in elderly subjects with knee osteoarthritis. *Gait & posture, 32*(2), 155–160. https://doi.org/10.1016/j.gaitpost.2010.04.002

Gras, L. Z., Pohl, P. S., Epidy, J., Godin, B., & Hoessle, N. (2017). Use of the Sharpened Romberg as a screening for fall risk. *Topics in Geriatric Rehabilitation*, *33*(2), 113–117. doi: 10.1097/tgr.0000000000000145

Haegele, J. A., & Hodge, S. R. (2015). Quantitative methodology: A guide for emerging physical education and adapted physical education researchers. *The Physical Educator*, *72*(5), 59–75. doi:10.18666/tpe-2015-v72-i5-6133

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association*, *13*(1), 16–23. doi: 10.1197/jamia.m1749

Hornbrook, M. C., Stevens, V. J., Wingfield, D. J., Hollis, J. F., Greenlick, M. R., & Ory, M. G. (1996). Preventing falls among community-dwelling older persons: Results from a randomized trial. *Journal of Safety Research*, *2*(27), 134–151. doi: 10.1016/0022-4375(96)86983-0

Howe, T. E., Rochester, L., Neil, F., Skelton, D. A., & Ballinger, C. (2011). *Exercise for improving balance in older people* (Cochrane database of systematic reviews No. CD004963). John Wiley & Sons, Ltd.

Hsu, W. L., Chen, C. Y., Tsauo, J. Y., & Yang, R. S. (2014). Balance control in elderly people with osteoporosis. *Journal of the Formosan Medical Association*, *113*(6), 334–339. doi:10.1016/j.jfma.2014.02.006

Islamic Republic of Iran, Ministry of Health and Medical Education. (2001). *Iranian patients' bill of rights*. Ministry of Health and Medical Education.

Justine, M., Hamid, T. A., Kamalden, T. F. T., & Ahmad, Z. (2010). A multicomponent exercise program's effects on health-related quality of life of institutionalized elderly. *Topics in Geriatric Rehabilitation, 26*(1), 70-79. doi:10.1097/TGR.0b013e3181cd6949

Kamalden, T. F. T., & Gasibat, Q. (2020). Muscle imbalance in badminton athletes: Preventive training programmes need to be designed. *Sport Sciences for Health,* 1-2. doi:10.1007/s11332-020-00700-z

Kashiani, A. B., & Geok, S. K. (2019). Effects of 8 weeks single set versus multiple-set resistance training on upper and lower body muscular strength among untrained males in Iran. *Malaysian Journal of Movement, Health & Exercise*, *8*(2), 153–163.

Kashiani, A. B., Geok, S. K., Soh, K. L., Ong, S. L., & Kittichottipanich, B. (2020). Comparison between two methods of variable resistance training on body composition, muscular strength and functional capacity among untrained males. *Malaysian Journal of Movement, Health & Exercise*, *9*(1), 45–66.

Lang, T., Streeper, T., Cawthon, P., Baldwin, K., Taaffe, D. R., & Harris, T. B. (2010). Sarcopenia: Etiology, clinical consequences, intervention, and assessment. *Osteoporosis International*, *21*(4), 543–559.

Lauretani, F., Maggio, M., Ticinesi, A., Tana, C., Prati, B., Gionti, L., Nouvenne, A., & Meschi, T. (2018). Muscle weakness, cognitive impairment and their interaction on altered balance in elderly outpatients: Results from the TRIP observational study. *Clinical interventions in aging, 13*, 1437–1443. doi: 10.2147/cia.s165085

Liikavainio, T. (2010). *Biomechanics of gait and physical function in patients with knee osteoarthritis* [Doctoral dissertation, University of Eastern]. Publication of the Universıty of Eastern. https://erepo.uef.fi/bitstream/handle/123456789/9579/urn_isbn_978-952-61-0119-4.pdf?sequence=1

Liu, C., Wan, Q., Zhou, W., Feng, X., & Shang, S. (2017). Factors associated with balance function in patients with knee osteoarthritis: An integrative review. *International Journal of Nursing Sciences*, *4*(4), 402–409. doi: 10.1016/j.ijnss.2017.09.002

MacCulloch, P. A., Gardner, T., & Bonner, A. (2007). Comprehensive fall prevention programs across settings: A review of the literature. *Geriatric Nursing*, *28*(5), 306–311. doi: 10.1016/j.gerinurse.2007.03.001

Macrae, P. R., Jones, R. D., Myall, D. J., Melzer, T. R., & Huckabee, M. L. (2013). Cross-sectional area of the anterior belly of the digastric muscle: Comparison of MRI and ultrasound measures. *Dysphagia*, *28*(3), 375–380. doi: 10.1007/s00455-012-9443-8

Manetta, J., Franz, L. H., Moon, C., Perell, K. L., & Fang, M. (2002). Comparison of hip and knee muscle moments in subjects with and without knee pain. *Gait & posture, 16*(3), 249-254. doi: 10.1016/s0966-6362(02)00009-7

Manoochehry, S., & Rasouli, H. R. (2017). Iranian population policy and aging: New health concerns. *International Journal of Travel Medicine and Global Health*, *5*(2), 70–71. doi: 10.15171/ijtmgh.2017.14

Mcphee, J. S., French, D. P., Jackson, D., Nazroo, J., Pendleton, N., & Degens, H. (2016). Physical activity in older age: Perspectives for healthy ageing and frailty. *Biogerontology*, *17*(3), 567–580. doi: 10.1007/s10522-016-9641-0

Moore, L., & Savage, J. (2002). Participant observation, informed consent and ethical approval. *Nurse Researcher*, *9*(4), 58–69. doi: 10.7748/nr2002.07.9.4.58.c6198

Norheim, K. L., Samani, A., Bønløkke, J. H., Omland, Ø., & Madeleine, P. (2020). On the role of ageing and musculoskeletal pain on dynamic balance in manual workers. *Journal of Electromyography and Kinesiology*, *50*, 102374. doi:10.1016/j.jelekin.2019.102374

Nekooei, P., Majlesi, S., Sharifi, G., Kamalden, T. F. T., & Nekouei, P. (2016). Comparison of anthropometric parameters among Iranian and spanish water polo players. *Russian Open Medical Journal, 5(*2), e0204. doi:10.15275/rusomj.2016.0204

Okubo, Y., Sturnieks, D. L., Brodie, M. A., Duran, L., & Lord, S. R. (2019). Effect of reactive balance training involving repeated slips and trips on balance recovery among older adults: A blinded randomized controlled trial. *The Journals of Gerontology: Series A*, *74*(9), 1489–1496. doi: 10.1093/gerona/glz021

Osoba, M. Y., Rao, A. K., Agrawal, S. K., & Lalwani, A. K. (2019). Balance and gait in the elderly: A contemporary review. *Laryngoscope Investigative Otolaryngology, 4*(1), 143-153. doi: 10.1002/lio2.252

Qiao, M., Feld, J. A., & Franz, J. R. (2018). Aging effects on leg joint variability during walking with balance perturbations. *Gait and Posture*, *62*, 27–33. doi: 10.1016/j.gaitpost.2018.02.020

Rafiaei, M., Bahramizadeh, M., Arazpour, M., Samadian, M., Hutchins, S. W., Farahmand, F., & Mardani, M. A. (2016). The gait and energy efficiency of stance control knee – ankle – foot orthoses: A literature review. *Prosthetics and Orthotics International, 40*(2), 202-214. doi:10.1177/0309364615588346

Ravindran, R. M. (2017). *The risk, risk factors and immediate consequences of falls among older persons in their home environment in Thiruvananthapuram.* [Unpublished Doctoral dissertation]. The Sree Chitra Tirunal Institute for Medical Sciences And Technology, TRIVANDRUM Thiruvananthapuram.

Rose, J., & Gamble, G. J. (2006). *Kinetics of normal walking; energetics of walking. Human walking*. Lippincott Williams & Wilkins.

Rubenstein, L. Z. (2006). Falls in older people: Epidemiology, risk factors and strategies for prevention. *Age and Ageing*, *35*(suppl_2), 37–41.

Sgarbieri, V. C., & Pacheco, M. T. B. (2017). Healthy human aging: Intrinsic and environmental factors. *Brazilian Journal of Food Technology*, *20*, 1–23. doi:10.1590/1981-6723.00717

Safikhani, H., Kamalden, T. F. B. T., Amri, S. B., & Megat Ahmad, M. M. H. (2011). Ground reaction force during walking with and without counterbalance load system. *Australian Journal of Basic and Applied Sciences, 5*(12), 2704-2708.

Sheykhi, M. T. (2004). A study of the elderly people living in nursing homes in Iran with a specific focus on Tehran. *African and Asian Studies*, *3*(2), 103–118. doi:10.1163/1569209041641822

Soh, K. G., Ruby, H., & Zaliha, O. (2003). Leg strength per body mass ratio among lite Malaysian netball players. *Australian Council for Health, Physical Education and Recreation (ACHPER) Healthy Lifestyles Journal*, *50*(2), 27-29.

Soh, K. G., Japar, S., Ong, S. L., & Soh, K. L. (2018). Physical activity and health promoting lifestyle among bachelor of nursing students in Malaysia. *Research Journal of Pharmacy and Technology*, *11*(7), 2906–2910.

Soh, K. G., Ruby, H., & Soh, K. L. (2006). Body fat comparison between basketball and netball players in Malaysia. *Journal of Health and Translational Medicine, 9*(1), 20-22. doi:10.22452/jummec.vol9no1.5

Soh, K. G., Ruby, H., Soh, K. L., Sofian, M., & Marjohan, J. (2009). Physical profile comparison between basketball and netball players in Malaysia based on performance and playing position. *Journal of Health and Translational Medicine, 12*(1), 22-26. doi:10.22452/jummec.vol12no1.4

Sotoudeh, G. R., Mohammadi, R., Mosallanezhad, Z., & Viitasara, E. (2018). The prevalence, circumstances and consequences of unintentional falls among elderly Iranians: A population study. *Archives of Gerontology and Geriatrics*, *79*(May), 123–130. doi:10.1016/j.archger.2018.08.001

Spink, M. J., Menz, H. B., & Lord, S. R. (2008). Efficacy of a multifaceted podiatry intervention to improve balance and prevent falls in older people: Study protocol for a randomised trial. *BMC Geriatrics*, *8*(1), 1–16. doi:10.1186/1471-2318-8-30

Turner, G., & Clegg, A. (2014). Best practice guidelines for the management of frailty: A British Geriatrics Society, Age UK and Royal College of General Practitioners report. *Age and Ageing*, *43*(6), 744–747. doi:10.1093/ageing/afu138

Vaillant, J., Rouland, A., Martigné, P., Braujou, R., Nissen, M. J., Caillat-Miousse, J. L., Vuillerme, N., Nougier, V., & Juvin, R. (2009). Massage and mobilization of the feet and ankles in elderly adults: Effect on clinical balance performance. *Manual Therapy*, *14*(6), 661–664. doi:10.1016/j.math.2009.03.004

Whittle, A. J., Carobbio, S., Martins, L., Slawik, M., Hondares, E., Vázquez, M. J., Morgan, D., Csikasz, R. I., Gallego, R., & Rodriguez-Cuenca, S., Dale, M., Virtue, S., Villarroya, F., Cannon, B., Rahmouni, K., Lopez, M., & Vidal-Puig, A. (2012). BMP8B increases brown adipose tissue thermogenesis through both central and peripheral actions. *Cell*, *149*(4), 871–885. doi:10.1016/j.cell.2012.02.066

Yuksel, E., Kalkan, S., Cekmece, S., Unver, B., & Karatosun, V. (2017). Assessing minimal detectable changes and test-retest reliability of the timed up and go test and the 2-minute walk test in patients with total knee arthroplasty. *The Journal of Arthroplasty*, *32*(2), 426–430. doi:10.1016/j.arth.2016.07.031