T.C.

YEDITEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF PHYSIOTHERAPY &
REHABILITATION

THE RELATIONSHIP BETWEEN BODY AWARENESS, BALANCE CONTROL AND PROPRIOCEPTION AMONG ELDERLY

MASTER THESIS

BARDHA AGUSHI, PT

ISTANBUL–2019

BARDHA AGUSHI DEPARTMENT OF PHYSIOTHERAPY & REHABILITATION MASTER THESIS ISTANBUL-2019

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun 31./12./2019... tarih ve 2019/20-36..... sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ
Sağlık Bilimleri Enstitüsü Müdürü

DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

Date

Signature

Name and Surname

DEDICATION

I am dedicating this thesis to all beloved people of my life, firstly to my parents, Raim and Imrane Agushi, to my source of inspiration who supported me endlessly to reach this day, secondly to my brother and sister, whose words of encouragement made me stay strong all this time, and to all other family members.

I also want to dedicate this thesis to my fiancé, who never stopped telling that I give all it needs to take to finish everything which I started, my emotional support of all time.

Finally, I want to dedicate this thesis to all my friends, the ones that were all the time with me, for their contribution and support in every situation, for giving me strength to move on, overcome hardship and for the help they gave to accomplish this work.

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LIST OF SYMBOLS AND ABREVIATIONS

BESTest	Balance Evaluation Systems Test
TUG	Timed Up and Go
UGS	Usual Gait Speed
GTO	Golgi Tendon Organs
JPS	Joint Position Sense
TTDPM	Threshold To Detection of Passive Motion
CE	Constant Error
VE	Variable Error
AE	Absolute Error
MMSE	Mini Mental State Examination
BAQ	Body Awareness Questionnaire
BAS	Body Awareness Scale
BAS-H	Body Awareness Scale-Health
BARS	Body Awareness Rating Scale
VFA	Vücut Farkındalık Anketi
DIPJ	Distal Inter Phalangeal Joint
PIPJ	Proximal Inter Phalangeal Joint
MTPJ	Meta Tarso Phalangeal Joint

TCJ	Talo Crural Joint
DIPR	Distal Inter Phalangeal Right
DIPL	Distal Inter Phalangeal Left
PIPR	Proximal Inter Phalangeal Right
PIPL	Proximal Inter Phalangeal Left
MTPR	Meta Tarso Phalangeal Right
MTPL	Meta Tarso Phalangeal Left
TCR	Talo Crural Right
TCL	Talo Crural Left
AnklePlantAAE.R	Ankle Plantarflexion Absolute Angle Error Right
AnklePlantAAE.L	Ankle Plantarflexion Absolute Angle Error Left
KneeExtAAE.R	Knee Extension Absolute Angle Error Right
KneeExtAAE.L	Knee Extension Absolute Angle Error Left
HipFlexAAE.R	Hip Flexion Absolute Angle Error Right
HipFlexAAE.L	Hip Flexion Absolute Angle Error Left
BMI	Body Mass Index
AAE	Absolute Angle Error
TUGT	Timed Up and Go Test

ABSTRACT

Agushi B. (2019) The relationship between body awareness, balance control and proprioception among elderly. Yeditepe University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, MSc thesis, Istanbul.

Body awareness is the process of understanding the various states of the body, processes and reactions that are supposed to derive from sensory, interoceptive and proprioceptive paths and that a person has the ability to be attentive of. Balance is a rapid synergistic cooperation between different physiologic and cognitive factors that allow fast and precise feedback to a perturbation. Proprioception is a sense that analyses position, motion and equilibrium from the combination of physical and neurological stimuli. The purpose of this study is to figure out the relationship for the key factors within elderly population including body awareness, balance control and proprioception at the same time. 48 participants were included in the study (40 females, 8 males, mean age ±69.08). Body Awareness Questionnaire (BAQ) was used for body awareness evaluation and Mini-BESTest for balance control assessment. For proprioception, joint position sense, motion sense and Romberg test were measured. BAQ did not show any significance relationship with age, balance control and proprioception ($p>0.05$). Strong relationship was found in the correlation of balance and the age of participants, showing that when age was increasing, balance score was decreasing ($p<0.05$). Between balance and proprioception correlation, meaningful relationship was found only in the joint position sense assessment, in one direction of the measured joints. No meaningful relationship was found between age of participants and proprioception, except with one direction in joint position sense ($p<0.05$). Within the measurements of joint position sense, meaningful relationships between joint scores was present in both assessed legs. ($p<0.05$) Despite the mentioned results, we conclude that ageing affects balance control in elderly, and proprioception could be affected by age and balance control either.

Keywords: Body awareness, balance, proprioception, elderly

ÖZET

Agushi B. (2019) Yaşlılar arasında vücut farkındalık, denge kontrolü ve propriyosepsiyon ilişkisi. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü̈, Fizyoterapi ve Rehabilitasyon Bölümü, Yüksek Lisans Tezi. İstanbul.

Vücut farkındalığı, duyusal, interoseptif ve proprioseptif yollardan türemesi gereken ve kişinin dikkatli olma yeteneğine sahip olduğu vücudun çeşitli durumlarını, süreçleri ve reaksiyonları anlama sürecidir. Denge, farklı fizyolojik ve bilişsel faktörler arasında hızlı bir sinerjik iş birliğidir ve bu da bir tedirginlik için hızlı ve kesin geri bildirim sağlar. Propriyosepsiyon, pozisyon, hareket ve dengeyi fiziksel ve nörolojik uyarıcıların birleştirirken analiz eden bir duyudur. Bu çalışmanın amacı, yaşlı popülasyondaki vücut farkındalığı, denge kontrolü ve propriyosepsiyon gibi ana faktörlerin ilişkisini aynı anda bulmaktadır. 48 katılımcı bu çalışmaya dahil edildi (40 kadın, 8 erkek, ortalama yaş ±69.08). Vücut farkındalık, Vücut Farkındalık Anketi ile değerlendirildi ve denge kontrolü değerlendirmesi için Mini-BESTest kullanıldı. Propriyosepsiyon için eklem pozisyon duyusu, hareket duyusu ve Romberg testi ölçüldü. Vücut Farkındalık Anketi yaş, denge kontrolü ve propriyosepsiyon ile herhangi bir anlamlı ilişkisi göstermedi ($p>0.05$). Denge ve katılımcıların yaş korelasyonunda güçlü bir ilişki bulundu, yaş arttıkça denge puanının azaldığını gösterdi ($p<0.05$). Denge ve propriyosepsiyon korelasyon arasında anlamlı ilişki sadece eklem pozisyonu duyu değerlendirmesinde, ölçülen eklemlerin bir yönünde bulundu. Katılımcıların yaşı ile propriyosepsiyon arasında anlamlı bir ilişki bulunmadı, ancak eklem pozisyonu anlamında tek bir yön dışında ($p<0.05$). Eklem pozisyon duyusu ölçümlerinde, değerlendirilen her iki bacakta da eklem skorları arasındaki anlamlı ilişkiler mevcuttu. ($p<0.05$). Belirtilen sonuçlara rağmen, Yaşlanmanın yaşlılarda denge kontrolünü etkilediği ve propriyosepsiyonun yaş ve denge kontrolünden etkilenebileceği sonucuna vardık.

Anahtar kelimeler: Vücut farkındalık, denge, propriyosepsiyon, yaşlı insanlar

1. INTRODUCTION

The starting point in this current study will be explaining the main difficulties that elderly people go through every day. When naming them as difficulties, we think about the life situations that might be risky for them like, risk of falls, lack of body movements, lack of trust in the body, lack of self-confidence when doing one work and so on.

Number of injuries that happen because of falls in elderly are considered a huge public-health concern, referring to one of the main causes of pain, functional impairment, restriction, and death in this population. (1) Furthermore, the elderly which used to have any fall experience fear because of a possible consequent fall that could restrict their mobility and daily activities due to weak muscle strength. (2)

Aging is related with decline in ability to keep the posture while standing in either bipedal or unipedal stance, when reacting to sudden perturbations, while performing a normal walk or when aiming to overpass obstacles. Factors like adaptive, sensory, and motor factors of balance come to be more and more sensitive as they gather the exposure to many injurious, degenerative, and infective actions. (3)

Body awareness is the process of understanding the various states of the body, processes and reactions that are supposed to derive from sensory, interoceptive and proprioceptive paths and that a person has the ability to be attentive of.

Body awareness is explained as the result of a dynamic and interactive process that appears to a) reflect multiple efferent, afferent, forward and backward neural actions, b) adds cognitive appraisal and unconscious gating, and c) built by the one’s perspectives, expectations, experience and involvement in a social and cultural context. (4)

Balance can be explained like a rapid synergistic cooperation between different physiologic and cognitive factors that allow fast and precise feedback to a perturbation. (5)

Keeping the straight-up posture is a complex activity achieved through multisensory combination, motor control, and context-specific feedback. By time and during aging, physiological changes appear in one's visual, vestibular, somatosensory inputs, as well as muscular effectors and central processing. Furthermore, the inter-joint coordination is also affected. When the congruency between sensory cues decreases and combined with physical decline means that vertical balance control becomes more challenging for older adults (6)

Maintaining good balance is considered as an essential skill for daily life needs and requires a mixture of information from the sensory output regarding the body's position corresponding to the surroundings and the capability to generate a proper motor response to control body motion. (7) That is why we say that disorders of balance and gait are essentially important for the elderly people because they compromise self-reliance and contribute to the risk of falls and many types of injuries. (8)

One other major factor that affects the falling probability for the elderly is the proprioception. We can explain that proprioception is a sense that analyses position, motion and equilibrium from the combination of physical and neurological stimuli. It carries the capacity to sense joint position and joint motion, which are important factors consequent to mechanoreceptors found in the capsules of joints and ligaments. (9)

We can divide the proprioception into static and dynamic or active and passive proprioception. (10) Static proprioception refers to the feeling the extremity's position while motionless, though dynamic proprioception implicates the estimation of the joint current location and speed during an active movement or when performing a passive displacement. (11)

Proprioception with age is being decreased (12), and therefore it leads to many other problems like gait disorders, low of self-independence, and a great risk of falls. (13)

As it was mentioned in one research, trainers recommend the rehabilitation of proprioception in case to have higher improvement joint stability after an injury. An injured joint that does not carry by itself a highly sensitive proprioceptive

feedback system may not respond properly to variations in forces placed at the time of unexpected movements.

By age progress, degradations in the proprioception level or sensitivity result in declining of feeling the changes in the movement of the body mass. (14, 15, 16)

The relation between the variables in this study (body awareness, balance control and proprioception) were not investigated before in just one study and give the relation of it with the elderly population. While various of variables have been done by many previous studies, there have been no attempt on investigation of these all three factors in one extensive study, designed to screen different variables in one single model.

The purpose of this current study is to figure out the importance when it comes to talk for the key factors for the elderly that affects their quality of life, like balance and proprioception. Evaluating these two variables and including the assessment of the body awareness too, is very important feature to know if they interact with each other or not. Using an evidence-based scale would be a very good correlation that in the future will help us in deciding with the proper treatment and rehabilitation plan and possible unindicated deficits among elderly.

2. GENERAL INFORMATIONS

2.1 Awareness

When it comes to talk about awareness we can explain briefly that awareness means being conscious; cognizant, informed alert.

In other word awareness is the capability of one person to perceive, to sense, or to be careful of different circumstances, objects, or sensory arrangements. In this level of alertness, the sense information can be taken by an on holder without essentially implying understanding. Furthermore, awareness may also lead to the knowledge or sense about a social, scientific, or political issue and in the other hand is described as a kind of self-awareness. Other meaning of awareness is the ability to deal with different situations and tasks. (17)

Because the awareness is likely in the concerned population in normal situations, some of the awareness tests are directed with a diagnostic intend to look which forms of the domain of knowledge is missing in the population, so that a proper and remedial program can be established if it is needed. (17)

Evaluation of awareness in many cases comes with various types of nomenclatures like scales, tests or questionnaires. Assessment of awareness can be for different purposes of the following:

- The diagnostic purpose that helps determine which domain of knowledge is lacking in the community
- Maximum accomplishment of the individuals
- Typical performance of the group (17)

2.1.1 Body Awareness

Body awareness is a theory that can be expressed as a consciousness symbol, physiological, sensory and physical, furthermore, it can be defined as the ability of one's person to know his own body. (18) Attention might be different when we look to some individual factors such as memory and experience, even though changes in social status and self-recognition. (19) Body awareness can involve the sensitivity to

internal signals and senses as well. (20) In other word we can say that body awareness directs attention to the body, while static and dynamic. (21) In order to perform a daily cooperation with the environment and to create the direction for the preparation of motion and the capability to identify the body parts like head, neck, limbs and trunk is essential in the formation of body awareness. (22)

Body perception is based on different but very important elements. These elements include the structure of body perception related to sensory feedback, ideas and concepts about the dynamic composition of the body itself and its connections with the surrounding environment. These two connected elements can be described as: the body schema (BS) that contains sensorimotor representations of the body that help in guiding the movements, and the body image (BI) that involves all the other representations related to the body which are not used for motion, either they are considered conceptual or emotional. (22)

The definitions for the body schema (BS) and body image (BI) have been discussed in many articles with different explanations and concepts that drives more to methodological and conceptual confusion in many fields. In addition, body schema contributes in giving the immediate sign for the perception of your own body without stopping the relationship of its parts with the objects around it and the space. (23) Because the organization of all proprioceptive information is crucial for one person to move, body schema plays a major role in directing and guiding the movements. (24)

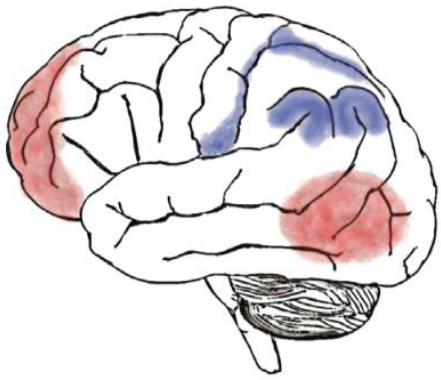

Figure 1. Scheme representing the cortical areas (super-lateral surface) related to body schema (blue) and body image (red). (25)

The cortical regions associated to body schema are placed in the supramarginal and angular gyri of the inferior parietal lobe (Figure 1). Therefore, there are communications with other cortical regions too that collect information from vestibular, auditory and visual systems, like superior parietal lobe and temporal lobe, which in turn plan the motor fields of the frontal lobe and the message that was combined, serves as a guide for motion. (26)

The body image (BI), in contrast, is interpreted like the mental description of the body, including all the processes that one person encounters and conceptualizes. It is a particular phenomenon structured in the existential and individual experience of each human being: with oneself, with others and with the universe; it is a combination of neural processes with its plastic characteristic and the environmental, social and psychological subtleties. The emotions, values, personal history expressed in gestures, looks and body movements are present in the BI. (27)

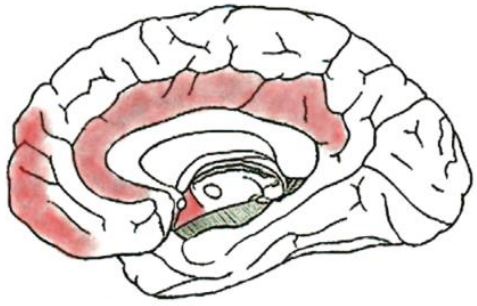

Figure 2.Scheme representing the cortical areas (medial surface) related to body image (red) (25)

In the other hand, the cortical regions that are relevant to body image construction are distinct from the parts connected to body schema. However, body awareness is established not only by body schema but by body image too and cortical areas are interconnected together so as they help in integration of body location, size of the segments and the perception of the body itself. (25)

2.1.2 Assessment of Body Awareness

There are many ways how to assess the body awareness, including different types of questionnaires and scales. One of them is the questionnaire that was used in this current study is Body Awareness Questionnaire (BAQ). Another example includes Body Awareness Scale (BAS), the Body Awareness Scale-Health (BAS-H) and the Body Awareness Rating Scale (BARS) (28)

The Body Awareness Questionnaire (BAQ), developed in 1989 by Shields et al., is a form of assessment that is used to evaluate self-reported attentiveness to non-emotive bodily processes, in other words, the understanding of internal body rhythms and sensations. This scale provides a 7-point Likert scale, that is used to notice any small alterations in normal physiological functioning and the mind's ability to predict any of bodily responses such as illness, sleep, fatigue and hunger. When the score of BAQ is higher we can say that the patient's body is sensitive to distinct bodily reactions; in other word, body awareness of that person is better. (29)

2.2 Balance Control

The ability to keep an upright stance or position is known to be very important for controlling motor abilities and acquisition where it represents a fundamental demand for both physical and daily activities. (30)

Balance control is the ability or capacity of the nervous system to identify when the body is an unstable position and it generates correct responses that helps in bringing the center of mass back to the support base. (31) Balance is controlled with the help of other systems too like visual, somatosensory, and vestibular systems, and by time it might be influenced by many diseases, musculoskeletal disorders or with the increase in age. (32)

Balance is categorized as static balance and dynamic balance. Static balance refers to keeping stability on a firm, fixed, non-moveable base of support whereas dynamic balance is the potential for bringing the vertical projection of the center of gravity near the supporting base. (33) To maintain postural stability, static and dynamic balance are considered very important factors. Therefore, in many previous

discussed articles it was shown that exercising enhances balance control in different age categories and diseases. (34)

Balance shows a complex interaction between the motor and sensory systems. As it was described previously, balance depends on the responses from sensory information such as somatosensory, vestibular, and visual sources. The central nervous system processes information by matching the person's body posture earlier experience with reflex motor actions. (32)

The main functional goals of the balance control include:

1. Keeping of a specific postural position, such as standing or sitting,

2. Facilitation of voluntary activity, such as the movement changings between postures,

3. Activities that recover equilibrium to external disturbances, such as a trip, slip or push. (35)

2.2.1 Vestibular System

The vestibular system is explained as a complex sensory organization where it includes the connection among the peripheral vestibular apparatus, the visual system, muscles of the body, brainstem, cerebellum and the cortex. Small structures that are found in the inner part of the ear builds up the projection of vestibular apparatus and helps to notice each head movement and forces of the gravity that occurs in the body. All this information is carried by vestibular areas found in the brain with the purpose of letting the body know how to maintain balance and keep proper spatial orientation while moving, as well as to adjust processing of visual images during movement. (36)

Previous articles mentioned that there are two possibilities that can cause dysfunction of the vestibular system and cerebral trauma: (1) when the peripheral receptors are impaired can bring incorrect information of movement or (2) the brain areas which are in control of central integration of somatosensory, visual and vestibular information might be damaged. (37)

2.2.2 Visual System

The visual pathways represent the action of receiving, relaying and therefore processing visual information. The structures that made up the entire visual system include the eye, optic nerves, chiasm tracts, lateral geniculate nucleus (LGN) of the thalamus, radiations, striate cortex and extrastriate association cortices. Form follows activity and structural relations often precisely establish the underlying components of visual processing. (38)

2.2.3 Somatosensory System

Somatosensory feedback is explained as an essential component of normal motor control, planning and adaptation. (39) Afferent pathways that made up the somatosensory system include muscular, musculo-articular and cutaneous receptors. (40) All the receptors found in muscles, joints and skin, help in providing awareness of our extremities position and movement. In the whole concept, somatosensors show the transfer actions that can be characterized as high-pass filters of the input(s) they react back to. (41)

2.2.4 Assessing Balance Control in Older Adults

It is known that in the older ages the ability to maintain static and dynamic balance is usually affected. (42) However, in order to evaluate the balance in a comprehensive way, Balance Evaluation Systems Test (BESTest) and the other short versions of this test, such as Mini-BESTest and Brief-BESTest, the Timed Up and Go (TUG) test, Usual Gait Speed (UGS) have been proposed by many recent studies. (43)

2.2.4.1 BESTest

The BESTest is considered as a clinical dynamic balance evaluation tool that includes 36 items categorized into six different systems: biomechanical constraints, stability limits/verticality, anticipatory postural adjustments, postural responses, sensory orientation and stability in gait. (44)

BESTest has been used in various population groups such as healthy adults, people with sub-acute stroke, balance deficits, cerebral stroke, Parkinson’s disease, peripheral neuropathy and vestibular dysfunction. (43) The advantage that this test

take is that it helps in identifying the balance systems that are affected or preserved, contributing for the development of a specific treatment or intervention. (42)

2.2.4.2 Mini-BESTest

The Mini-BESTest is a shorter form of the original BES-Test. It is classified as a clinical balance assessment tool which consists of 14 parts, including four of the six systems: anticipatory postural adjustments, reactive postural control, sensory orientation and dynamic gait. The total score is 28 points and each task are scored on a three-point scale (zero to two). The higher the final score, the higher balance control is expressed to be. The Mini-BESTest presents a total score for dynamic balance. (45) It has been used to assess balance control in people with different condition such as multiple stroke, sclerosis, traumatic brain injury and vestibular disorders. (46)

2.2.4.3 Brief-BESTest

The Brief-BESTest is another balance assessment measure that consists of eight items of the original BESTest, one item for each procedure and two items (functional forward reach and single-leg stance) are scored bilaterally. The total score for this test is 24 points in total and each item is recorded on a four-point scale (zero to three). Like in the previous mentioned tests, higher score refers to better balance achievement. (47) The Brief-BESTest has been used for various conditions that include people struggling with multiple sclerosis, stroke Parkinson's disease, and peripheral neuropathy. (48)

2.2.4.4 TUG

The Timed Up and Go (TUG) test is a simpler way to assess one's mobility because it involves tasks such as standing, sitting, walking, and turning, which are usually used for daily life activities. (49) Earlier studies widely used the TUG test in different population groups such as community dwelling of elderly, in people with hip osteoarthritis or in people with vestibular disorders. (50)

2.2.4.5 UGS

A 'vital sign' and a good indicator of well-being in the older people was considered to be the gait speed since it has been proved that reflects health status and global functioning among this population. (51) Thus, individuals' Usual Gait Speed

(UGS) is related to their functioning in the society and is considered as a strong predictor of a wide range of results among elderly, especially when it is related with the risk of falling. (52)

2.2.5 Balance Deficits

Many of the following pathologic conditions like hemiplegia and craniocerebral injury, moderate-severe traumatic brain injury, cerebellar atrophy, ataxia and whiplash syndrome have been identified and described after the disruption or impairment of static and dynamic balance (37) Although the other factors that contribute in decreasing of the ability to maintain balance are dizziness, cognition, postural hypotension, a decline in functional performance, depression, visual disturbance, slow reaction time, weak of musculature are major indicators to maintain balance. (53)

2.3 Proprioception

Sense or sensation literally is defined as a specific particular form of stimulus as, for instance, warmth or touch. Whereas, perception can be explained as a cerebral activity made up to define the main structure of a stimulus and its origin. (54)

For many years the questions related to how to define the proprioception and how to make one fully definition for it was quite challenging. In many studies, researchers were describing the proprioception with different conceptualization, thus making it difficult to be understood by readers. The definition of proprioception that was generally agreed upon many researches is “Proprioception is the perception of joint and body movement as well as position of the body or body segments in space” (55)

In one other study that was related to proprioception, they have discussed that proprioception’s main goal is to accomplish roles in feedback and feedforward sensorimotor processes and in managing the muscle rigidity, particularly making it very important for joint stability, movement acuity, co-ordination, and balance. (56)

2.3.1 Neuroanatomical Components of Proprioceptive System

Proprioceptive information is processed in sequence starting at the level of spinal cord, brain stem and higher cortical fields, along with subcortical cerebral nuclei and cerebellum. (57), (58)

The ascending pathways promote the transmission of the information to the medulla and thalamus, after that it forwards it to somatosensory cortex (conscious proprioception); or by the spinal nucleus to the cerebellum (unconscious proprioception). (59)

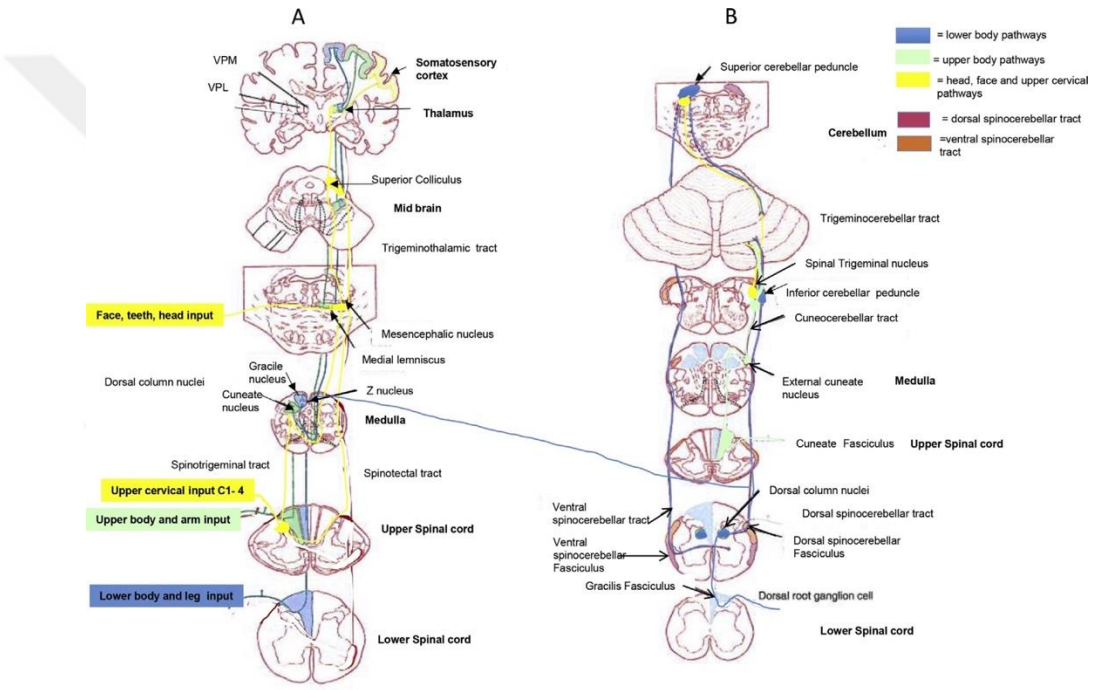

Figure 3.Dorsal column Medial lemniscus pathway to Cerebral Cortex for conscious proprioception, B) Spinocerebellar pathway to the Cerebellum for unconscious proprioception (59)

In order to understand the neuroanatomical components of the proprioception, one previous study has given the explanations of it by dividing into the three main directions of the proprioceptive afferents' pathways and the related motor neuronal connections being involved too. (59)

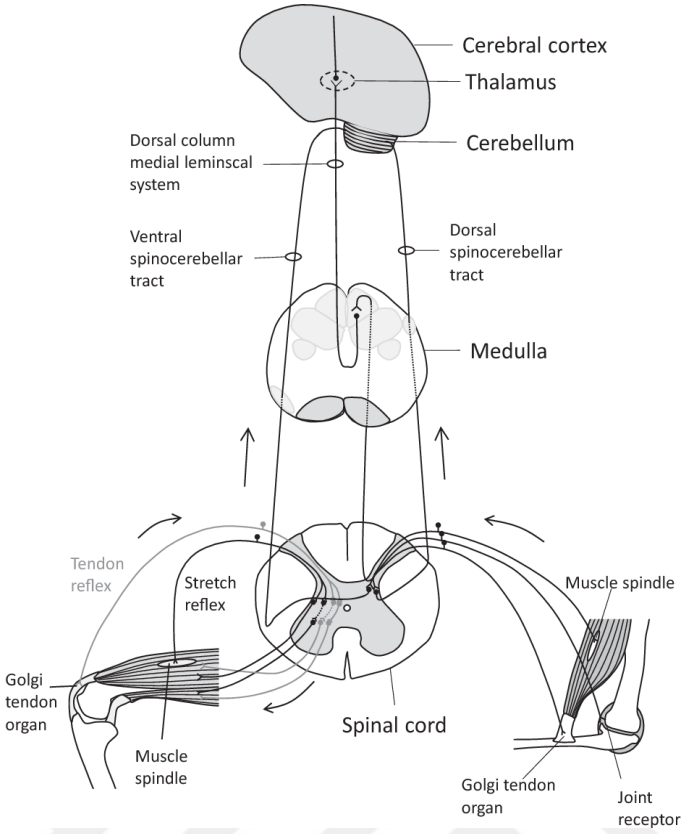

Figure 4. Components and directions of the proprioceptive pathways (60)

Afferent direction 1, starting at the level of spinal cord, shows the proprioceptive afferent attachments on to Aα and specifically Aγ motor neurons for generating reflexes constructed in purpose of saving the joints against any possible harmful stresses. Destination 2 illustrates the pathways directed to cerebellar linkage, which are essential for maintaining the posture, balance, and motion in general. Destination 3, the cerebral cortex, is the final proprioceptive afferent direction where perception takes place and can result in proprioception. (55)

Mechanoreceptors are specialized nerve endings which carry the sensory information as a product of proprioception, i.e., transducers which are responsible for transforming mechanical stimulus to action potentials and carry it to the central nervous system. Mechanoreceptors that particularly contribute to proprioceptive system are named as proprioceptors, they can be found in muscle, tendon, joint and fascia, whereas, the skin receptors can be counted as contributors to proprioception too.

In the table 1, the type and the activities of the different mechanoreceptors are described, that are as a part of the human body and help in proprioception. (59)

Mechanoreceptors	Type	Stimulation
Muscle-tendon unit	Muscle spindle	Muscle length Velocity of change of muscle length
Joint	Golgi tendon organ Ruffini ending Pacinian ending Mazzoni ending Golgi ending	Active muscle tension Low and high load tension and compression loads throughout entire ROM
Fascia	Ruffini ending Pacinian ending	Low and high tension loads during joint movement
Skin	Hair follicle receptor Ruffini ending Pacinian ending Merkel ending Meissner ending	Superficial tissue deformation/ stretch or compression during joint movement

Table 1. Types of the mechanoreceptors found in the human body (59)

Some previous studies that investigated the proprioception, they have mentioned that joint proprioceptors have been stimulated only at the extreme range of motion during movement, but now is proven that proprioceptors found in the joints provide input during the whole range of motion of a joint, under both high and low load circumstances where it makes possible for stimulation of strong discharges from the muscle spindle themselves and which have been classified as vital for joint stability. (61)

2.3.1.1 Muscle spindle

The most important source that contribute in the proprioception system are muscle spindles (62), that are found in all skeletal muscles in parallel with the extrafusal muscle fibers. (58) They are classified as highly sensitive structures and their density depends on which part of the body they are found in, fulfilling different functional demands. Muscle spindles contain modified intrafusal fibers where they are innervated by gamma motor neurons that are different from the extrafusal muscle fibers that are supplied by alpha motor neuron. (63)

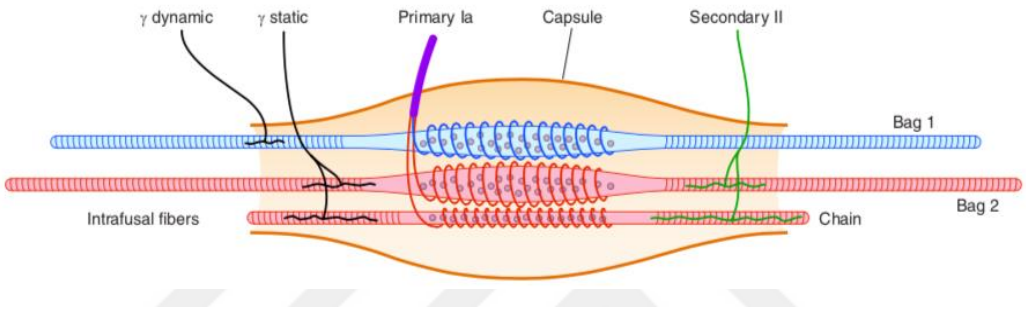

Figure 5. Diagrammatic representation of the mammalian muscle spindle. (64)

2.3.1.2 Golgi tendon organs

For the procession of the proprioceptive information, Golgi tendon organs (GTO) are considered as another important contributors, which are located in muscle tendons. They help in the protection of the muscle from being overloaded, when the muscle tension increases. Ib sensory axions carry all the tension information that has to be with this overload on the muscles and which GTOs are innervated from. (64)

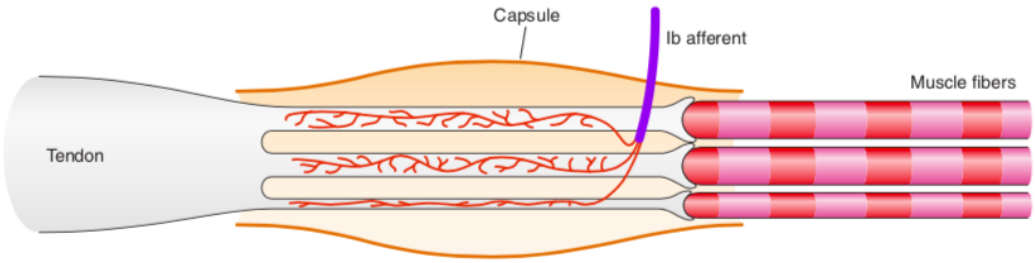

Figure 6. Diagrammatic representation of the Golgi tendon organs (64)

As it was discussed previously in this study, proprioception plays a key role in the planning of movements which can include: feedback mechanism, feedforward mechanism, and the adjustments of muscle tightness, in order to attain specific functions for movement precision, co-ordination and stability regarding the joints and balance. (65)

In order to get an efficient intact neural control of movements, proprioceptive signals carried by mechanoreceptors in joints, muscles, tendons and skin are very important. (66) The information that was found in a previous study, mentioned that in case of proprioceptive afferents failure, it may cause many impairments such as controlling the muscle tone, disrupting postural reflexes and critically impairs temporal spatial as well as spatial aspects of volitional movement. (67), (65)

2.3.2 Testing Proprioception

Assessment of an individual's status proprioception can be done by using the techniques which are considered as specific tests of proprioception. These techniques include joint position sense, motion or force sense. (62) Testing of proprioception can be done in two ways, rather passive or active or expressing in other words, biasing the mechanoreceptors of the joints or stimulating muscle-tendon mechanoreceptors. (68)

2.3.2.1 Joint position sense

Recently, the most common evaluation method in testing proprioceptive sensitivity done among elderly is the capability to sense the static location of a joint, or extremity. The process when assessing the position sense generally focuses on how one person can be accurate in producing or matching a given joint angle in the elimination of sight, and thus these tests can be done in two ways. First, in ipsilateral remembered matching tasks, the examiner displaces the joint of the patient to a target angle, holds it for several seconds and returns back to starting position. After this demonstration, is asked from the patient to replicate the same motion based on the proprioceptive memory. Whereas, the second method is named as contralateral concurrent matching, where the examiner does the same displacement of the patient's joint to a target angle and holds the movement at the same place without bringing it

to starting point. In this part, is asked from the patient to produce the same matching motion with the contralateral extremity. (69)

2.3.2.2 Motion sense

The motion sense tests evaluate the ability to recognize joint movement being assessed by applying three methods which include, threshold to detection of passive motion (TTDPM) (70), movement discrimination tests (71), or the acuity of a tracking task (72). However, several earlier studies in the purpose of proprioceptive function showed significant differences in motion sense compared between young and old adults by measuring the threshold for which passive joint movement could be perceived. (69)

In the motion sense assessment many of the variables are mostly determined in JPS, TTDPM and force sense tests as mentioned before. These variables include constant error (CE), variable error (VE) and absolute error (AE). (73) In order to get accurate mean values from the joint that is being tested, earlier researchers suggested to perform the assessment using three to five test trials. (74)

2.3.2.3 Romberg's test

Romberg's test is considered as another way to assess the proprioception. It helps discovering any impairment related to proprioception that may have been hidden by vision. The Romberg's test analyzes functional integrity of the all involving proprioceptive pathways. (75) We mark the Romberg test as positive in case we see the patient is struggling to maintain the balance control when the vision is eliminated or when the imbalance dramatically declines even more after the participant is asked to close the eyes (if imbalance was seen in the presence of vision). In some cases, even healthy individuals without any proprioceptive issues tend to swing more when they close their eyes. The ability to maintain the heel-to-toe position for six seconds is labeled as low normal performance. In young participants this number is quite higher, making it possible to perform for thirty seconds but this performance is noted to decline in older population. (76)

2.3.3 Deficits of Proprioception

There are many conditions that contribute in the decline of proprioception. Problems like neurological and orthopaedical are specially correlated with damages in proprioception and motion destruction such as stroke (77) (78), Parkinson's disease (79), focal dystonia (80), peripheral sensory neuropathies or injuries happening in ligaments, joint capsules, and muscles. (81)

When the proprioception in some phases is considered lost or degraded this lead in the appeal of failure in controlling the movement, so the person feels more confident relying on visual load for better feedback and feedforward activities. This might cause difficulties in training novel movement, furthermore, difficulties in developing the quality of movement or keeping this quality in a specific number of repetitions as a reason of absence in feedback for adaptation and skill refinement. (82)

Disturbed or impaired proprioception is found to be correlated with different musculoskeletal disorders or complaints referring to pain, trauma, and effusion, as well as fatigue. (59) Planful research have showed that the most where impaired proprioception had correlation was in the acute and chronic phases of musculoskeletal pain disorders in the regions like cervical (83), lumbar (84), spine, as well as upper (85), and lower extremities. (86)

In the short amount of time, disturbed proprioception prone to have adverse impact on feedforward and feedback motor control and in the arrangement of muscle stiffness. This might be considered as a reason for various clinical complaints such as balance control impairment and clumsiness in musculoskeletal disorders. (87) In long durations, impaired proprioception, sequent impaired motor output from the central nervous system, and the insufficient muscular protection of joint tissues may be patho-physiologically correlated with high risk of injury and recurrence and persistence of pain disorders, including the onset and progression of secondary (post-injury) osteoarthrosis. (59)

2.4 Aging

Aging is considered a process of passage in time of which starts in the uterus. There are many of the accepted theories that tried on defining aging process

biologically. The first concept submitted that by time, all the things related to our body gradually decreases. It is identified that there might be some specific changes during the time progress. The second concept is recognized as biological clock theory which mentions that aging process is being coordinated by biological time. It was been proved by some researches that in some cells there is a limited number of replications after which the cell degradation occurs. The third mentioned concept, stated that during the normal biological responses free radicals are produced. Because of this, damages keep increasing with age and causing changes in different tissues and cell functions. With aging, changes on the pathophysiological occur by the contribution of oxygen radicals. Nonetheless, aging is a considered life journey that refers us to many changes, uniqueness and often numerous diagnoses. Healthcare providers must notice these changes and the whole patient should be considered. (88)

2.4.1 Age Related Changes

As it was mentioned above, with age our body starts to be different and many functional and physiological changes can be seen. In the table below, we have showed changes that occur in different systems and consequences they might bring. (29)

Systems	Some of the changes	Effects on functional ability
Cardiovascular system	Heart loses its capacity of resiliency Blood vessels shrink and harden - volume of heart decreases - heart can get less blood itself The cardiac reserve reduces and heart loses its resiliency Pulse rate, force of mechanical heart beat and diastolic functioning declines in strain	Aging individual is less able to respond to increased stress of greater workload and tires easier Risks of arrhythmia, vulvular defect, coronary heart disease, carditis and high blood pressure Breathing capacity declines and breathing gets harder, more work to get oxygen

	Suppleness of pulmonary tissue and weakness of breathing muscles	
Musculoskeletal system	Muscle strength decreases Mass of the bones and muscles decrease Stiffness and pain of joints	Slowing of movements and early muscle fatigue Constricted ROM (range of movement) Problems and limitations on walking
Senses (hearing and vision)	Declining of hearing Declining of visual accuracy between the ages 60 and 80 Adaptation becomes slower	difficult, can cause balance problems
Proprioseptic system and balance	Problems to recognize and reintegrate information from proprioseptic system Proprioseptic inputs can be distorted in some situations	Dizziness Swaying while standing Challenging to get information of movements, position of the joints and force of muscle contractions
Nervous system	Volume of brain becomes smaller	Reduction of attention and memory partly caused by brain changes Slowness of functions

3. METHODS & MATERIALS

3.1 Study Design

Current research is a correlational non-experimental study. Our study was conducted at the “Kadikoy Municipality Alzheimer Center”. The “Yeditepe University” and “Kadikoy Municipality Alzheimer Center” have the cooperation agreement.

3.1.1 Sample Size

Sample size of this study was estimated by using G*Power 3.1. The number of participants that was estimated to be 48, included only one group.

3.2 Participants

Number of the participants were 48 from elderly population. The participants were recruited from the “Kadikoy Municipality Alzheimer Center”. All participants voluntarily accepted to participate in this study, being asked directly to volunteer after the nature of the procedure was explained to them in details.

- Number of females 40
- Number of males 8

3.2.1 Inclusion Criteria

All participants were at the age between 65-75.

- Volunteers scoring above 24 on the Mini Mental State Examination (MMSE) (89)
- Being physically independent
- Not being affected by blindness and deafness,
- Not having any cardiovascular disorder that can influence gait or balance control,
- Not having other problems including the physical, psychological, neurological diseases

3.3 Statistical Methods

The data was analyzed on the computer using SPSS 25.0 (Statistical Packages of Social Sciences). The conformity of the data to the normal distribution will be evaluated by Kolmogorov-Smirnov test. Descriptive statistics will be shown as mean ± standard deviation, minimum and maximum value for continuous variables and categorical variables will be shown as frequency and percentage. The chi-square analysis was used to compare categorical variables. Because the data were not suitable for normal distribution, Mann-Whitney u test was used. Spearman correlation coefficient was used because of the absence of normal distribution within data. $p < 0.05$ would be considered statistically significant.

3.4 ASSESSMENT METHODS

All participants in the study went through the same procedure in the same order. Each participant was given his own time, first a consent form was handed to them for approving to participate. The examiner was sitting next to them while they were reading the consent form. Second, the Mini Mental State Examination test was done to them, asking each question one by one, and checking if they fulfill the inclusion criteria or not. Participants who met the goal score of Mini Mental State Examination test continued to have their social and medical history noted by examiner.

Participants who met the inclusion criteria, went through the assessment as followed below.

3.4.1 Body Awareness Questionnaire

Body awareness of individuals was evaluated with the validity and reliability of Turkish Body Awareness Questionnaire (BAQ) developed in 1989 by Shields, Mallory & Simon. (20) Subjects filled the questionnaire while sitting in a comfortable settings and environment. They took their time to answer all the questions. Examiner was present in case of any enquires and to provide the information about the scoring of the test.

3.4.2 Mini-BESTest

It is a reliable and valid balance assessment protocol in the purpose of evaluation the balance control. (90) Procedure was followed by the examiner instructions according to the Mini-BESTest protocol. Duration varied 15-20 minutes. Each participant wore a belt for safety purposes and it was carried under the close attention of the examiner.

Figure 7. Anticipatory and sensory orientation tasks of the Mini-BESTest

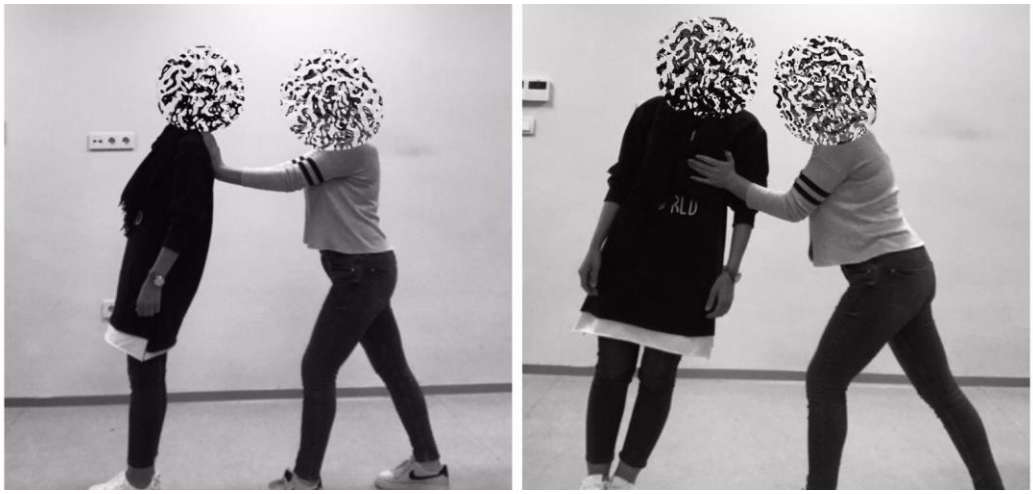

Figure 8. Reactive postural control task of the Mini-BESTest

Figure 9. Step over obstacles task in the dynamic gait of the Mini-BESTest

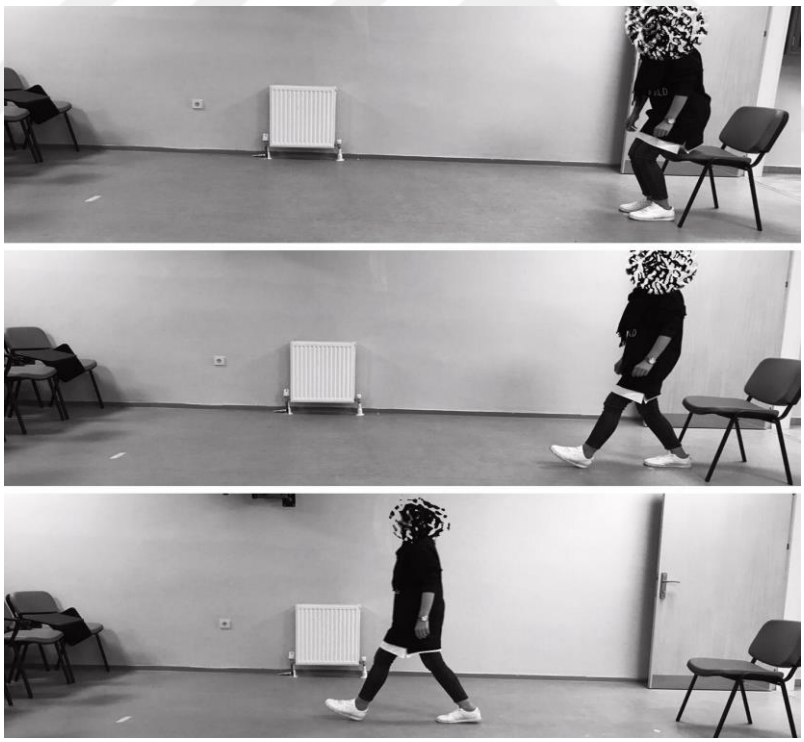

Figure 10. Timed Up & Go with dual task in the dynamic gait of the Mini-BESTest

3.4.3 Proprioception

Assessment was carried in three stages.

3.4.3.1 Joint Position Sense

Participants performed the assessment in an upright sitting position, in a chair, joints alignment was in the 90-degree position for hip, knee and ankle. Joints that were involved in the assessment are:

- Hip joint – target angle was 30 degree of hip flexion. Examiner was demonstrating the target angle using a goniometer. Participants were asked to look at the angle achieved, and then from them it was asked to demonstrate the same angle with the eyes closed. Assessment was carried for both legs for three trials and mean value was taken and noted in the data collection form. (74)

- Knee joint – target angle was 60 degrees of knee extension. Examiner was demonstrating the target angle using a goniometer. Participants were asked to look at the angle achieved, and then from them it was asked to demonstrate the same angle with the eyes closed. Assessment was carried for both legs for three trials and mean value was taken and noted in the data collection form.

- Ankle joint - target angle was 30 degrees of plantar flexion. A foam roller was placed under the ankle joint to facilitate plantar flexion movement. Examiner was demonstrating the target angle using a goniometer. Participants were asked to look at the angle achieved, and then from them it was asked to demonstrate the same angle with the eyes closed. Assessment was carried for both legs for three trials and mean value was taken and noted in the data collection form.

Figure 11. Demonstration of joint position sense evaluation of the hip flexion and knee extension

Figure 12. Demonstration of joint position sense evaluation of the ankle plantarflexion

3.4.3.2 Motion Sense

Participants performed the assessment in an upright sitting position, in a chair, a foam roller was placed under the ankle joint to facilitate movement. Joints that were assessed are 1. Distal Interphalangeal joint (DIPJ), 2. Proximal Interphalangeal joint (PIPJ), 3. Metatarsophalangeal joint (MTPJ), 4. Talocrural joint (TCJ)].

Examiner asked participants to close their eyes while the examiner performed movement of up and down directions in the previously mentioned joints, from distal to proximal, and taking feedback from the participants. Only those who did not feel the correct movement which was performed in DIP was then proceeded to PIP and so on. Assessment was carried for three trials for both limbs. Participants who

answered two trials out of three correctly, did not proceed to assess the next joint. All the information was noted by the examiner in the data collection form.

Figure 13. Demonstration of motion sense evaluation in the DIP and PIP joints

Figure 14. Demonstration of motion sense evaluation in the MTP and TC joints

3.4.3.3 Romberg Test

Romberg testing was the last step of the procedure. It was used to assess the proprioception in a upright standing position. Participants were asked to stand and close their eyes, hands placing on the hips, and feet close to each other for 30 seconds. Number of sways were noted by the examiner on the data collection form. Examiner made clear to the participants to ask for the elimination of the test if they felt any discomfort or loss of balance.

Figure 15. Demonstration of Romberg test

3.4.4 Equipment

Tools that were used in the procedure are: stop watch, measuring tape, Tempur foam, incline ramp, a box 23cm, firm chair without arms, goniometer, securing belt, foam roller.

4. RESULTS

Table 2. Participant's socio-demographic information

	N	%
Age		
Mean ±Sd	69.08±3.55	
Min-Max	65-75	
Gender		
Female	40	83.3
Male	8	16.7
BMI		
Normal	21	43.8
Over-weight	27	56.3
Dominant Part		
Right	48	100
MMSE		
Mean ±Sd	28.18±.22	
Min-Max	24-30	
Physically Active		
Yes	48	100
Morbid Obesity		
No	48	100
Acute Pain		
Yes	7	14.6
No	41	85.4
Hypertension		
Yes	19	39.6
No	29	60.4
Cardiovascular Disease		
Yes	14	29.2
No	34	70.8
Eyes, Ears Problems		
Yes	19	39.6
No	29	60.4
Diabetic		
Yes	11	22.9
No	37	77.1
Physical, Psychological, Neurological prob.		
Yes	10	20.8
No	38	79.2
Smoking		
No	17	35.4
Quitted	21	43.8
Still	10	20.8
Medicines		
Yes	39	81.3
No	9	18.8
Surgeries		
Yes	37	77.1
No	11	22.9

	N	%
Performance of Physical Activity		
0	10	20.8
2-3	19	39.6
3+	19	39.6
Type of Exercise		
Pilates	6	15.8
Swimming	2	5.3
Resistance training	2	5.3
Jogging	18	47.4
Home exercises	10	26.3
Time of Exercise(minutes)		
Mean ±Sd	54.60±19.60	
Min-Max	25-120	
Exercise Evaluation		
Fair	1	2.6
Good	11	28.9
Very Good	19	50
Excellent	7	18.4

Table 3. BAQ and Mini-BESTest scores

	N	Minimum	Maximum	Mean SD
BAQ	48	67.00	126.00	105.9 (11.9)
Mini-BESTest	48	6.00	28.00	21.7 (4.2)

BAQ: Body Awareness Questionnaire

In the Body Awareness Questionnaire participant's mean was shown to be 105.9. From 48 people answered, minimum score was 67 and the maximum was 126. In the Mini-BESTest participant's mean was shown to be 21.7. From 48 people answered, minimum score was 6 and the maximum was 28. (table 3)

Table 4. Participant's Joint Position sense scores

	N	Minimum	Maximum	Mean	SD
AnklePlantAAE.R	48	.00	25.00	9.02	4.76
AnklePlantAAE.L	48	.00	28.00	8.12	5.70
KneeExtAAE.R	48	.00	27.00	7.06	6.47
KneeExtAAE.R	48	.00	27.00	5.75	6.03
HipFlexAAE.R	48	.00	25.00	5.37	5.22
HipFlexAAE.R	48	.00	18.00	5.00	4.33

AnklePlantAAE.R: Ankle Plantarflexion Absolute Angle Error Right, AnklePlantAAE.L: Ankle Plantarflexion Absolute Angle Error Left, KneeExtAAE.R: Knee Extension Absolute Angle Error Right, KneeExtAAE.L: Knee Extension Absolute Angle Error Left, HipFlexAAE.R: Hip Flexion Absolute Angle Error Right, HipFlexAAE.L: Hip Flexion Absolute Angle Error Left

In the right ankle plantarflexion AAE participant's mean was shown to be 9.02. From 48 people answered, minimum score was 0 and the maximum was 25. In the left ankle plantarflexion AAE participant's mean was shown to be 8.12. From 48 people answered, minimum score was 0 and the maximum was 28. In the right knee extension AAE participant's mean was shown to be 7.06. From 48 people answered, minimum score was 0 and the maximum was 27. In the left knee extension AAE participant's mean was shown to be 5.75. From 48 people answered, minimum score was 0 and the maximum was 27. In the right hip flexion AAE participant's mean was shown to be 5.37. From 48 people answered, minimum score was 0 and the maximum was 25. In the left hip flexion AAE participant's mean was shown to be 5.00. From 48 people answered, minimum score was 0 and the maximum was 18. (table 4)

Table 5. Participant's Motion sense Status

	N	%
DIPR		
Yes	43	89.6
No	5	10.4
DIPL		
Yes	36	75
No	12	25
PIPR		
Yes	3	60
No	2	40
PIPL		
Yes	7	58.3
No	5	41.7
MTPR		
Yes	2	100
No	0	0
MTPL		
Yes	4	61
No	1	39
TCR		
Yes	-	-
No	-	-
TCL		
Yes	1	100
No	0	0

DIPR: Distal Interphalangeal Right joint, DIPL: Distal Interphalangeal Left joint, PIPR: Proximal Interphalangeal Right joint, PIPL: Proximal Interphalangeal Left joint, MTPR: Metatarsophalangeal Right joint, MTPL: Metatarsophalangeal Left joint, TCR: Talocrural Right joint, TCL: Talocrural Left joint

In the motion sense status, for the right leg, from 48 participants in DIPR joint, 43 answered as yes, so no further investigation was obtained for them in the same limb. 5 of them answered as no, the assessment for them went through the next joint. In PIPR joint, 3 out of the 5 participants answered as yes, 2 of them as no, and the assessment for them went through the next joint. In MTPR joint, the 2 of them answered as yes, so no further investigation was obtained for them in the same limb. (table 4) For the left leg, from the 48 participants in DIPL joint, 36 answered as yes, so no further investigation was obtained for them in the same limb. 12 of them answered as no, the assessment for them went through the next joint. In PIPL joint, 7 out of 12 participants answered as yes, 5 of them as no, and the assessment for them went through the next joint. In MTPL joint, 4 out of 5 participants answered as yes, so no further investigation was obtained for them in the same limb. In TL joint, the only participant left answered as yes, so no further investigation was obtained. (table 5)

Table 6. Correlation between age of participants, BAQ, Mini-BESTest and Joint Position Sense of Proprioception

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	*	-,072	**-,315***	-,181	-,259	,012	-,082	**,310***	,210
2		*	,077	-,169	-,092	,002	,080	-,001	,078
3			*	-,033	-,016	**,288***	,164	-,064	-,129
4				*	**,468****	,212	,056	,118	,191
5					*	-,037	-,205	-,203	**-,302***
6						*	**,295***	**,395****	,159
7							*	**,309***	,261
8								*	**,425****
9									****

Spearman Correlation; p<0.005*, p<0.001**;

(1) Age (2) Body Awareness Questionnaire, (3) Mini-BESTest, (4) Ankle Plantarflexion Absolute Angle Error Right, (5) Ankle Plantarflexion Absolute Angle Error Left, (6) Knee Extension Absolute Angle Error Right, (7) Knee Extension Absolute Angle Error Left, (8) Hip Flexion Absolute Angle Error Right, (9) Hip Flexion Absolute Angle Error Left

Age showed a negative meaningful relation with Mini-BESTest and a positive meaningful relation with proprioception position sense for right hip flexion. Body Awareness Questionnaire is shown to have no significant relationship with age, Mini-BESTest and the position sense. Mini-BESTest has a significant relation with the right knee extension. A strong relationship is found between right ankle plantar flexion and left ankle plantar flexion. Left ankle plantar flexion is shown to have a negative meaningful relationship with left hip flexion. A significant relation is found between right knee extension with left knee extension and right hip flexion. In the left knee extension is found a relation with right hip flexion and a strong meaningful relationship between hip flexion right and left. (table 6)

Table 7. Comparison between DIPR joint of the Motion Sense, BAQ and Mini-BESTest results

	DIPR	N	Mean	Z	P
BAQ	Yes	43	23,57	-1,352	,176
	No	5	32,50		
Mini-BESTest	Yes	43	24,62	-,170	,865
	No	5	23,50		

Mann Whitney U Test; p<0.005*, p<0.001**;

BAQ: Body Awareness Questionnaire, DIPR: Distal Interphalangeal Right joint

In the motion sense, DIPR joint is shown not to have any significance relation with the Body Awareness Questionnaire and the Mini-BESTest. (table 7)

Table 8. Comparison between DIPL joint of the Motion Sense, BAQ and Mini-BESTest results

	DIPL	N	Mean	Z	P
BAQ	Yes	36	25,38	-,751	,453
	No	12	21,88		
Mini-BESTest	Yes	36	25,60	-,948	,343
	No	12	21,21		

Mann Whitney U Test; p<0.005*, p<0.001**;

BAQ: Body Awareness Questionnaire, DIPL: Distal Interphalangeal Left joint

In the motion sense, DIPL joint is shown not to have any significance relation with the Body Awareness Questionnaire and the Mini-BESTest. (table 8)

Table 9. Comparison between PIPR joint of the Motion Sense, BAQ and Mini-BESTest results

	PIPR	N	Mean	Z	P
BAQ	Yes	3	3,17	-,296	,767
	No	2	2,75		
Mini-BESTest	Yes	3	3,50	-,889	,374
	No	2	2,25		

Mann Whitney U Test; p<0.005*, p<0.001**;

BAQ: Body Awareness Questionnaire, PIPR: Proximal Interphalangeal Right joint

In the motion sense, PIPR joint is shown not to have any significance relation with the Body Awareness Questionnaire and the Mini-BESTest. (table 9)

Table 10. Comparison between PIPL joint of the Motion Sense, BAQ and Mini-BESTest results

	PIPL	N	Mean	Z	P
BAQ	Yes	7	6,36	-,163	,871
	No	5	6,70		
Mini-BESTest	Yes	7	6,21	-,331	,740
	No	5	6,90		

Mann Whitney U Test; p<0.005*, p<0.001**;

BAQ: Body Awareness Questionnaire, PIPL: Proximal Interphalangeal Left joint

In the motion sense, PIPL joint is shown not to have any significance relation with the Body Awareness Questionnaire and the Mini-BESTest. (table 10)

Table 11. Comparison between BMI, BAQ, Mini-BESTest and Joint Position Sense scores

	BMI	N	Mean	Z	P
BAQ	Normal	21	23.86	-,281	,779
	Overweight	27	25.00		
Mini-BESTest	Normal	21	28.57	-1,791	,073
	Overweight	27	28.80		
AnklePlantAAE.R	Normal	21	20.26	-1,878	,060
	Overweight	27	27.80		
AnklePlantAAE.L	Normal	21	23.62	-,386	,700
	Overweight	27	25.19		
KneeExtAAE.R	Normal	21	24.36	-,063	,950
	Overweight	27	24.61		
KneeExtAAE.L	Normal	21	26.21	-,756	,450
	Overweight	27	23.17		
HipFlexAAE.R	Normal	21	20.36	-1,820	,069
	Overweight	27	27.72		
HipFlexAAE.L	Normal	21	19.52	-2,186	**,029***
	Overweight	27	28.37		

Mann Whitney U Test; p<0.005*, p<0.001**;

BMI: Body Mass Index, BAQ: Body Awareness Questionnaire, AnklePlantAAE.R: Ankle Plantarflexion Absolute Angle Error Right, AnklePlantAAE.L: Ankle Plantarflexion Absolute Angle Error Left, KneeExtAAE.R: Knee Extension Absolute Angle Error Right, KneeExtAAE.L: Knee Extension Absolute Angle Error Left, HipFlexAAE.R: Hip Flexion Absolute Angle Error Right, HipFlexAAE.L: Hip Flexion Absolute Angle Error Left

When BMI increases, hip flexion angle error increases too. BAQ and Mini-BESTest including the other joints angle error have no significant relationship with the BMI.

Table 12. Comparison between DIPL joint of the Motion Sense and BMI results

Groups		**BMI**		Total	X2	sd	p
		Normal	Overweight				
DIPL	Yes	17	19	36	5,25	1	,401
	No	4	8	12			
Total		21	27	48			

Chi Square Test; p<0.005*, p<0.001**;

BMI: Body Mass Index, DIPL: Distal Interphalangeal Left joint

No significance relationship is found between the body mass index and motion sense in the DIPL joint. (table 12)

Table 13. Comparison between PIPL joint of the Motion Sense and BMI results

Groups		**BMI**		Total	X2	sd	p
		Normal	Overweight				
PIPL	Yes	3	4	7	1,67	1	,408
	No	1	4	5			
Total		4	8	12			

Chi Square Test; p<0.005*, p<0.001**;

BMI: Body Mass Index, PIPL: Proximal Interphalangeal Left joint

No significance relationship is found between the body mass index and motion sense in the PIPL joint. (table 13)

No comparison was made for the rest of the joints in the motion sense as the expected counts for the other joints showed to be more than 20% less than 5 and all the individual expected counts 1 or greater.

Table 14. Comparison between Performance of Physical Activity, BAQ, Mini-BESTest and Joint Position Sense scores

	Performance of physical activity	N	Mean	Chi-Square	P
BAQ	0	10	24.30	,537	,765
	2-3	19	22.89		
	3+	19	26.21		
MiniBESTEST	0	10	26.95	,511	,774
	2-3	19	24.63		
	3+	19	23.08		
AnklePlantAAE.R	0	10	29.00	1,377	,502
	2-3	19	22.92		
	3+	19	23.71		
AnklePlantAAE.L	0	10	26.55	,277	,871
	2-3	19	23.82		
	3+	19	24.11		
KneeExtAAE.R	0	10	23.20	,232	,891
	2-3	19	25.63		
	3+	19	24.05		
KneeExtAAE.L	0	10	30.05	4,258	,119
	2-3	19	26.39		
	3+	19	19.68		
HipFlexAAE.R	0	10	31.20	5,304	,071
	2-3	19	26.21		
	3+	19	19.26		
HipFlexAAE.L	0	10	25.80	,703	,704
	2-3	19	25.89		
	3+	19	22.42		

Kruskal Wallis Test; p<0.005*, p<0.001**;

BAQ: Body Awareness Questionnaire, AnklePlantAAE.R: Ankle Plantarflexion Absolute Angle Error Right, AnklePlantAAE.L: Ankle Plantarflexion Absolute Angle Error Left, KneeExtAAE.R: Knee Extension Absolute Angle Error Right, KneeExtAAE.L: Knee Extension Absolute Angle Error Left, HipFlexAAE.R: Hip Flexion Absolute Angle Error Right, HipFlexAAE.L: Hip Flexion Absolute Angle Error Left

No significance relationship is found between the performance of physical activity, Body Awareness Questionnaire scores, Mini-BESTest and motion sense. (table 14)

Table 15. Comparison between DIPR joint of the Motion Sense and Performance of Physical Activity

Groups		**Performance of physical activity**			Total	X2	sd	p
		Do not	2-3 times	More than 3 times				
DIPR	Yes	9	16	18	43	1,04	1	,568
	No	1	3	1	5			
Total		10	19	19	48			

Chi Square Test; p<0.005*, p<0.001**;

DIPR: Distal Interphalangeal Right joint

No significance relationship is found between the performance of physical activity and motion sense in the DIPR joint. (table 15)

Table 16. Comparison between DIPL joint of the Motion Sense and Performance of Physical Activity

Groups		**Performance of physical activity**			Total	X2	sd	p
		Do not	2-3 times	More than 3 times				
DIPL	Yes	8	16	12	36	2,5	1	,299
	No	2	3	7	12			
Total		10	19	19	48			

Chi Square Test; p<0.005*, p<0.001**;

DIPL: Distal Interphalangeal Left joint

No significance relationship is found between the performance of physical activity and motion sense in the DIPL joint. (table 16)

Table 17. Comparison between PIPR joint of the Motion Sense and Performance of Physical Activity

Groups		**Performance of physical activity**			Total	X2	sd	p
		Do not	2-3 times	More than 3 times				
PIPR	Yes	0	2	1	3	,40	1	,329
	No	1	1	0	2			
Total		1	3	1	5			

Chi Square Test; p<0.005*, p<0.001**;

PIPR: Proximal Interphalangeal Right joint

No significance relationship is found between the performance of physical activity and motion sense in the PIPR joint. (table 17)

Table 18. Comparison between PIPL joint of the Motion Sense and Performance of Physical Activity

Groups		**Performance of physical activity**			Total	X2	sd	p
		Do not	2-3 times	More than 3 times				
PIPL	Yes	1	2	4	7	,83	1	,929
	No	1	1	3	5			
Total		2	3	7	12			

Chi Square Test; p<0.005*, p<0.001**;

PIPL: Proximal Interphalangeal Left joint

No significance relationship is found between the performance of physical activity and motion sense in the PIPL joint. (table 18)

Table 19. Comparison between MTPL joint of the Motion Sense and Performance of Physical Activity

Groups		**Performance of physical activity**			Total	X2	sd	p
		Do not	2-3 times	More than 3 times				
MTPL	Yes	1	0	3	4	,20	1	,082
	No	0	1	0	1			
Total		1	1	3	5			

Chi Square Test; p<0.005*, p<0.001**;

MTPL: Metatarsophalangeal joint

No significance relationship is found between the performance of physical activity and motion sense in the MTPL joint. (table 19)

Table 20. Comparison between Romberg test results, BAQ and Mini-BESTest

	Romberg	**N**	**Mean**	**Chi-Square**	**P**
BAQ	1 Sway	18	16.50	3,421	,181
	2 Sways	11	13.36		
	Could not	2	26.00		
Mini-BESTest	1 Sway	18	17.25	2,628	,269
	2 Sways	11	15.68		
	Could not	2	6.50		

Kruskal Wallis Test; p<0.005*, p<0.001**;

BAQ: Body Awareness Questionnaire

No significance relationship is found between the Romberg test and Body Awareness Questionnaire and Mini-BESTest. (table 20)

5. DISCUSSION

The objective of this current study was to investigate the relationship between the three variables which include body awareness, balance control and proprioception among elderly. The best to our knowledge, this is the first study to examine the association between these main variables.

In the present study, as a first assessment method we included body awareness, where the Body Awareness Questionnaire (BAQ) scores were used. The results of BAQ did not show any significant relationship compared with age of participants, balance control and proprioception in both position and motion sense and Romberg test.

In a previous study, they investigated the body awareness level on the elderly prior and after eight weeks of intervention, using the two types of assessment tools, BAS (Body Awareness Scale) and BAQ (Body Awareness Questionnaire. At the final assessment they have discovered that the results that they got from BAQ was significantly smaller when they compared to the results of the BAS, which showed to be a significant improvement. (29)

On the other hand, in another study, which evaluated the body awareness and the single-leg jump among old population who were practitioners of Tai Chi, using the BAS tool for the assessment, showed that Tai Chi practitioners showed a significantly higher level of body awareness compared with the other control group of participants which presented to be physically active within the same energy level. (91)

Furthermore, a similar related study, which investigated the relationship of yoga, body awareness and body responsiveness, mentioned that greater levels of body awareness were seen within yoga intervention group, including more beneficial self-objectification and body satisfaction results compared with the other control group which received only aerobic exercises. (92)

In comparison of body awareness and balance control, a consistent study done among healthy adults, with age differences between 18-65, had similar results

with this study, noting that there was no significant relationship found between the dynamic balance control and body awareness results assessed by BAQ. (93)

However, a correlation was done between body awareness score results with the other factors to see if we can get any meaningful relation. No significant relationship was found between the performance of the physical activity and BMI compared with the scores of BAQ, among elderly. However, there was a lack of evidence related to the findings of body awareness done in the old population.

In addition to this, previous studies that investigated body awareness, they mentioned that body awareness is presented to be as the ability to notice complex body cues (94), and most of the preliminary evidence suggests that in most cases in the future it might be effective in the management of chronic diseases which include chronic low back pain (95,96), congestive heart failure (94), chronic renal failure (97), and irritable bowel syndrome (98).

Related to previously mentioned findings, one recent study that investigated patients with chronic low back pain, confirmed that a focus on the sensory components of pain was more beneficial than attempts to suppress awareness of that pain (99). A similar research, patients experiencing the phantom pain have shown that sensory discrimination training can reduce pain (100) and reorganize phantom pain-related representation areas of the sensory cortex. (101). These findings seem to contradict the traditional understanding of body awareness and suggest that body awareness is a complex, multi-dimensional construct in need of more nuanced conceptualization. (102)

When understanding or explaining the body awareness, the target is set to be more on a ‘mindful’ focus of body awareness such as sensory aspects of emotions, uncomfortable physical sensitivity, or on pain in general, which are not covered by the BAQ. (102)

The second assessment done in this study was the evaluation of balance control. For dynamic balance evaluation in old population, the best match was found to be the Mini-BESTest, comparing with the other measurement tools. This information was supported by many other research articles, concluding that Mini-BESTest might be more accurate in assessing the dynamic balance in elderly.

Examples include two previous studies, which compared the results of the Mini-BESTest with Berg Balance Scale, as both of them are considered suitable for evaluation of the dynamic balance in older adults. One of them stated that, Mini-BESTest test showed to have higher sensitivity/specificity then the Berg to diagnose people with unusual postural responses, (103) and the other one mentioning that Mini-BESTest presented to have a reduced ceiling effect, slightly greater level of reliability, and more accuracy in analyzing patients which show significant improvement in balance function. (104)

Our findings related to balance measurement on elderly, showed to have meaningful relationship between each other in some categories. Positive results include scores of Mini-BESTest correlated with age of the participants, showing to have significant relation, resulting that with the increase in age, the decline in dynamic balance control might be seen.

This finding is consistent with a previous study assessing the ageing effect on balance control in the older adults, noting that weakness in some muscle groups could potentially affect the impairment of an individual's capability to correct the body's center of gravity fluctuations and effectively prevent a fall. As the muscle strength decreases, referring in increase on postural sway, which can be connected to a higher amount in the correction of muscle activation and muscle co-activation. Similarly, when there is greater amount of one muscle activation might lead to larger load of a random activity, as it was explained above, emerging in the increase of postural sway. Like this change can happen in elderly under the same circumstances of muscle strength drop or the when a decrease in nerve conduction speed is seen, both of conditions have seen to occur because of age. (105)

A similar article that agreed with our findings was found, using different assessment tool but proving that age plays a major role in balance degradation. They have concluded that, even when using low-cost computerized measurement tools, makes it possible for exposure of any specific task from age-related impairment in balance control performance in a category of older adults. (106)

As it was stated previously, we did not find any relationship between Mini-BESTest and body awareness scores. In addition to this, no meaningful relation was

found in comparison with proprioception either. In both motion and position sense involved and Romberg test too, the only relation found was between Mini-BESTest and the motion including right knee extension in position sense, showing that when scores of balance increase, the absolute angle error of right knee extension increases too. No correlated study was found comparing these two variables together.

In contrast with our results, previous reports show that balance control has an impact on proprioception and vice versa. One article stated that, lower integrity of the right hemisphere's cortical proprioceptive pathway was correlated with a decrease of Mini-BESTest records in healthy older adults, explaining that decline in balance refers in decline of proprioception. (107)

Moreover, the relationship within hip proprioception and dynamic balance was supported by one earlier study too. When older adults were stratified by joint position sense performance, those with higher hip proprioceptive perception recorded significantly greater score on the Mini-BESTest, referring that higher balance control performance is strongly associated with high proprioceptive precision. (108)

Additional comparison was made between balance control, BMI and performance of physical activity, taken as a self-report by the participants. In our study, balance scores did not show any meaningful relationship with the BMI of participants, neither with the level of physical performance by participants. As a reason it may be that the assessment for BMI and the performance of physical activity were taken directly from the subjects, not evaluated by any method.

In contrast with our findings, two studies stated that BMI is a significant factor that can influence balance instability. One of them showing that higher BMI was correlated with low TUGT (Timed Up and Go Test) performance in a study of eight UK cohort studies (109), and the other one presented that the correlation appeared only in women when compared with males, resulting that BMI only in women might have a relation to dynamic balance. Thus, stating that, if BMI increases, the TUGT may became longer, and the obese women might experience a higher risk of falling. (110)

In contrast with these previous reports, one article reported that BMI was not associated with the balance test in a study of 355 Brazilian older adults aged over 60 years old. (111)

For the balance control and the level of physical performance few articles stated that they found a relationship among balance control and the performance of daily activities, presenting that those showed to have better balance kept a good level of independence either. (112), (113) Also another research found, concluded that there is significant relation between balance control and physical activity in the elderly, their results suggesting that it is possible to improve the balance control in the elderly by planning to increase the physical activity among them. (114) On the other hand, other previous studies that used to test similar findings, no statistically meaningful relationship was found within balance control and the level physical activity performance. (115), (116)

One of the limitations presented in previous research, which compared the relationship between BMI and balance in older adults, is the absence of inclusion of the amount of physical activity performed as a confounding factor. (117), (118) Whereas, physical activity might help in improving balance in older adults by decreasing the amount of fat mass. In any case, another study stated that a significant relation among BMI and balance control was supported in obese participants aside from their physical activity level. (119) Such differences may be due to the characteristics of the samples analyzed in these studies and the measurement methods used.

The final stage of assessment in this study was the evaluation of proprioception. Because proprioception is one of the most important components of the sensorimotor system that contributes to postural control, we made the assessment including the three testing techniques which involved joint position sense, motion sense and the Romberg test.

Age-related changes in central or peripheral somatosensory function, or both, likely underlie proprioception decline in older adults. (120) In our study, in the position sense of proprioception, a single meaningful relation was seen between age and right hip flexion, meaning that when age increases, AAE of the hip flexion

increases too. In comparison with the other joints of the lower extremity, in the both sides, we got significant relationships between each other. Results show that when AAE increases in the right ankle plantar flexion, it increases on the left side too. Besides that, when the left ankle plantar flexion AAE increases, the left hip flexion AAE decreases, resulting in a negative relationship. In the knee joint, when AAE increased in the right side, showed to increase in the other side too. Strong relation was found when the AAE increased in the right knee extension, showing an increase of AAE in the hip flexion same side, but at the same time resulting that, in the increase of AAE in left knee extension, affected an increase of AAE in the right hip flexion too. For the hip joint, a strong relationship is showed to be between each other, presenting that an increase of AAE in right hip flexion results in the increase of the left hip flexion. When making a comparison by joints, we might say that when proprioception may be impaired, it can affect the other side of the joints too.

In contrast with this finding, one study demonstrated that proprioceptive information differs from leg to leg and also is loaded independently, thus, this load decreases with disturbance amplitude. Weighting of proprioceptive information of one leg has no influence on the weight of the proprioceptive information of the other leg. (121)

This may be explained when mentioning that information of each sensory system is weighted by a weighting factor relative to the contribution of sensory information of the other sensory systems. Deterioration of a sensory system will affect its own weight and the weights of other systems. For example, deficient vestibular information will result in a lower vestibular weight (i.e., down weighting) and will be subsequently compensated by increased reliance on sensory information of other sensory systems to maintain standing balance. (122)

A related article showed that when comparing healthy young and elderly participants, elderly people showed to rely more on their proprioceptive system while performing balance, representing a higher proprioceptive load. (123)

Similar to our results, one study done for assessing the proprioception among elderly women suffering from osteoarthritis, suggested that no meaningful relation was found within the measures of proprioceptive sensitivity, including joint position

sense, kinesthesia, and muscular strength in elderly women suffering from knee OA, and especially, the age did not influence the values obtained by these measures. (124)

In contradiction to our findings that did not show any relationship with balance control and proprioception status among elderly, it was mentioned by many articles that an impaired proprioception can be rebuilt by including balance training routine. Including one of those findings, stating that, balance training reduced elderly subjects' overactive proprioceptive feedback and enhanced vestibular orientation. The modified use of sensory information can be interpreted as a change in postural control strategies representing a higher-level adaptive mechanism. (125)

However, a comparison of each joint was made for the motion sense of proprioception too, including the correlation between BMI and performance of physical activity but we did not get any meaningful relationship. Neither in the Romberg test, when compared with the Mini-BESTest and body awareness scores. In the correlation of the BMI with joint position sense, a relationship was found when BMI increased, the left hip flexion AAE showed to be increased too. No relationship was found between joint position sense and the performance of physical activity among elderly.

6. CONCLUSION

In conclusion, we might say that body awareness did not show any relationship with balance control and proprioception but balance control showed to be affected when age of the participants was increasing. Proprioception showed to be affected by age of participants and balance control too, only in one direction of the joint position sense. In the joint position sense, we might conclude that the proprioceptive load within the joints were affected by each other.

Future studies might consider to include a larger sample size of participants and having an equal number between the genders so the comparison within the gender could be done. Using another tool for assessing body awareness might be useful. For balance control measurement, future studies might consider in using computer-based tools for better scoring results and for better outcome. For BMI and performance of physical activity correlation, future studies might include the direct assessment for each participant, not only by self-report of participants.

Limitations of this study are that participants who reported to have acute pain, physical problems, neurological problems but not severe and having in the past, were included in the study for participation with their approval.

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APPENDIXES

Appendix 1. Ethical Committee Approval

T.C. YEDİTEPE ÜNİVERSİTESİ

Sayı : 37068608-6100-15- 1697 **13/06/2019**
Konu: Klinik Araştırmalar
Etik kurul Başvurusu hk.

İlgili Makama (Bardha Agushi)

Yeditepe Üniversitesi Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü Doç. Dr. Rasmi Muammer'in sorumlu araştırmacı olduğu **"Yaşlılar Arasında Vücut Farkındalık, Denge Kontrolü Ve Propriosepsiyon İlişkisi"** isimli araştırma projesine ait Klinik Araştırmalar Etik Kurulu (KAEK) Başvuru Dosyası **(1670)** kayıt Numaralı KAEK Başvuru Dosyası), Yeditepe Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından **12.06.2019** tarihli toplantıda incelenmiştir.

Kurul tarafından yapılan inceleme sonucu, yukarıdaki isimi belirtilen çalışmanın yapılmasının etik ve bilimsel açıdan uygun olduğuna karar verilmiştir (**KAEK Karar No:1045**).

Prof. Dr. Turgay ÇELİK
Yeditepe Üniversitesi
Klinik Araştırmalar Etik Kurulu Başkanı

Appendix 2. Participant's Consent Form (English)

Consent to Participate in a Research

Title of the study: Relationship between body awareness, balance control and proprioception among elderly

Investigator's name: Bardha Agushi
Department: Physiotherapy and Rehabilitation
Contact number: +90 (544) 9403230

Introduction

• You are being asked to be in a research study of assessment of a group of physical variables and the effects of them on elderly people

• We ask you to read this form and ask any questions that you may have before agreeing to be in the study

Purpose of Study

- Purpose of the study is to investigate the relationship between body awareness, balance control and proprioception among elderly adults

- Ultimately, this research will be used for Master degree thesis and may be used in external publications

Description of the Study Procedures

⇒ You will take a part as one group in this study according to your inclusion criteria

⇒ You will go through some assessments to examine your body awareness, by filling a questionnaire and your balance control by using a balance protocol first, and then by using a balance device, after it you will go through proprioception evaluation to see if you own any sensory deficits

⇒ Data will be collected in the data collection form for statistical reasons

⇒ The procedure will be conducted by a physical therapist in the Kadikoy Municipality Alzheimer Center

⇒ The procedure time will be approximately 35 / 45 minutes

Risks/Discomforts of Being in this Study

• There are no reasonably foreseeable (or expected) risks. There may be unknown risks.

• Due to the nature of the approach that works on balance, a slight discomfort might occur.

Confidentiality

• This study is anonymous. We will not be collecting or retaining any information about your identity.

• The records of this study will be kept strictly confidential. Research records will be kept in a locked file, and all electronic information will be coded and secured using a password protected file. We will not include any information in any report we may publish that would make it possible to identify you.

Right to Refuse or Withdraw

• The decision to participate in this study is entirely up to you. You may refuse to take part in the study at any time without affecting your relationship with the investigators of this study or the institution. You have the right not to answer any single question, as well as to withdraw completely from the interview at any point during the process; additionally, you have the right to request that the interviewer not use any of your interview material.

Right to Ask Questions and Report Concerns

• You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have any further questions about the study, at any time feel free to contact me (Bardha Agushi) at bardhaagushi@gmail.com, or by telephone number at +90(544)9403230. If you like, a summary of the results of the study will be sent to you. If you have any problems or concerns that occur as a result of your participation, you can report them to the investigator at the number above.

Consent

• Your signature below indicates that you have decided to volunteer as a research participant for this study, and that you have read and understood the information provided above. You will be given a signed and dated copy of this form to keep, along with any other printed materials deemed necessary by the study investigators

Subject's name: _____

Signature: _____

Investigator's name: _____

Signature: _____

Appendix 3. Participant's Consent Form (Turkish)

Araştırmaya Katılma İzni

Çalışmanın başlığı: Yaşlılar arasında vücut farkındalık, denge kontrolü ve propriyosepsiyon ilişkisi

Araştırmacının adı: Bardha Agushi
Bölüm: Fizyoterapi ve Rehabilitasyon
İletişim: +90 (544) 9403230

Giriş

• Sizden bir grup fiziksel değişken değerlendirmesinin ve bunların yaşlı insanlar üzerindeki etkilerinin araştırıldığı bir araştırmada bulunmanız isteniyor

• Sizden bu formu okumanızı ve araştırmaya katılmayı kabul etmeden önce aklınıza gelebilecek tüm soruları sormanızı istiyoruz

Çalışmanın amacı

- Çalışmanın amacı yaşlı yetişkinlerde vücut farkındalığı, denge kontrolü ve propriyosepsiyon arasındaki ilişkiyi araştırmaktır
- En sonunda, bu araştırma yüksek lisans tezi için kullanılacak ve dış yayınlarda kullanılabilir

Çalışma Prosedürlerinin Açıklaması

⇒ Bu çalışmaya dahil edilme kriterlerinize göre bir grup olarak yer alacaksınız

⇒ Bir anket doldurarak vücut farkındalık incelemek için bazı değerlendirmelerden geçeceksiniz sonra denge için önce bir denge protokolü kullanarak ve sonra bir denge cihazı kullanarak, ondan sonra herhangi bir duyusal eksiklik olup olmadığını görmek için propriyosepsiyon değerlendirmesinden geçeceksiniz

⇒ İstatistiksel nedenlerle bilgi toplama formunda bilgi toplanacaktır

⇒ İşlem bir fizyoterapist tarafından gerçekleştirilecektir Kadikoy Belediyesi Alzheimer Merkezinde

⇒ İşlem süresi yaklaşık 35/45 dakika olacaktır

Bu Çalışmadaki Olmanın Riskleri/Rahatsızlıkları

• Makul olarak öngörülebilir (veya beklenen) riskler yok. Bilinmeyen riskler olabilir.

• Dengede çalışan yaklaşımın doğası gereği, hafif bir rahatsızlık meydana gelebilir.

Gizlilik

• Bu çalışma anonimdir. Kimliğiniz hakkında herhangi bir bilgi toplamayacağız veya saklamayacağız.

• Bu çalışmanın kayıtları kesinlikle gizli tutulacak. Araştırma kayıtları kilitli bir dosyada tutulacak ve tüm elektronik bilgiler şifre korumalı bir dosya kullanılarak kodlanacak ve güvence altına alınacaktır.
Yayınlayabileceğimiz hiçbir rapora, sizi tanımlamayı mümkün kılacak hiçbir bilgi dahil etmeyeceğiz.

Reddetme veya Çekme Hakkı

• Bu çalışmaya katılma kararı tamamen size bağlıdır. Bu araştırmanın ya da kurumun araştırmacılarıyla ilişkinizi etkilemeden, herhangi bir zamanda çalışmaya katılmayı reddedebilirsiniz. Tek bir soruya cevap vermeme ve işlem sırasında herhangi bir noktada görüşmeden tamamen geri çekilme hakkınız vardır; ayrıca, görüşme yapan kişiden herhangi bir görüşme materyalini kullanmamasını isteme hakkınız vardır.

Soru Sorma ve Endişelerini Bildirme Hakkı

• Bu araştırma çalışması hakkında soru sorma hakkınız var ve bu soruları çalışma öncesi, sırası ve sonrasında tarafımdan cevaplandırmaktadır. Çalışma hakkında başka sorunuz varsa, herhangi bir zamanda benimle temas kurmaktan çekinmeyin (Bardha Agushi) bardhaagushi@gmail.com tarafından veya telefon numarama +90(544)9403230. İsterseniz, çalışmanın sonuçlarının bir özeti size gönderilecektir. Katılımınızın sonucu olarak ortaya çıkan herhangi bir sorun veya endişeniz varsa, bunları yukarıdaki numaradan araştırmacıya bildirebilirsiniz.

İzin

• Aşağıdaki imzanız bu çalışmaya araştırma katılımcısı olarak gönüllü olmaya karar verdiğinizi ve yukarıda verilen bilgileri okuduğunuzu ve anladığınızı gösterir. Sizinle bu formun imzalı ve tarihli bir kopyası verilecektir, araştırma görevlileri tarafından gerekli görülen diğer basılı materyallerle birlikte.

Katılımcının adı: _____

İmza: _____

Araştırmacının adı: _____

İmza: _____

Appendix 4. Mini Mental State Examination Form (Turkish)

Mini Mental Durum Testi

Mini-Mental State Examination (MMSE)

Hastanın Adı Soyadı: ..... Tarih: ...../...../.....

	Puanı
Oryantasyon (Her soru 1 puan, toplam 10 puan)	
Hangi yıl içindeyiz?	.....
Hangi mevsimdeyiz?	.....
Hangi aydayız?	.....
Bu gün ayın kaçı?	.....
Hangi gündeyiz?	.....
Hangi ülkede yaşıyoruz?	.....
Şu an hangi şehirde bulunmaktasınız?	.....
Şu an bulunduğunuz semt neresidir?	.....
Şu an bulunduğunuz bina neresidir?	.....
Şu an bu binada kaçıncı kattasınız?	.....
Kayıt Hafızası (Toplam puan 3)	
• Size birazdan söyleyeceğim üç ismi dikkatlice dinleyip ben bitirdikten sonra tekrarlayın (Masa, Bayrak, Elbise) (20 sn. süre tanınır). Her doğru isim 1 puan.	.....
Dikkat ve Hesap Yapma (Toplam puan 5)	
• 100'den geriye doğru 7 çıkartarak gidin. Dur deyinceye kadar devam edin. (Her doğru işlem 1 puan: 100, 93, 86, 79, 72, 65)	.....
Hatırlama (Toplam puan 3)	
• Yukarıda tekrar ettiğiniz kelimeleri tekrar söyleyin (Masa, Bayrak, Elbise) (Her kelime 1 puan)	.....
Lisan (Toplam puan 9)	
a. Bu gördüğünüz nesnelerin isimleri nedir? (saat, kalem) 1'er puan toplam 2 puan (20 saniye süre ver)	.....
b. Şimdi size söyleyeceğim cümleyi dikkatle dinleyin ve ben bitirdikten sonra tekrar edin. "Eğer ve fakat istemiyorum" (10 saniye süre ver) 1 puan	.....
c. Şimdi sizden bir şey yapmanızı isteyeceğim, beni dikkatle dinleyin ve söylediğimi yapın. "Masada duran kâğıdı elinizle alın, iki elinizle ikiye katlayın ve yere bırakın lütfen" Toplam puan: 3, süre: 30 sn. her bir doğru işlem: 1 puan	.....
d. Şimdi size bir cümle vereceğim. Okuyun ve yazıda söylenen şeyi yapın. (1 puan) -Bir kâğıda "GÖZLERİNİZİ KAPATIN" yazıp hastaya gösterin-	.....
e. Şimdi vereceğim kâğıda aklınıza gelen anlamlı bir cümleyi yazın (1 puan)	.....
f. Size göstereceğim şeklin aynısını çizin; aşağıdaki şekli arka sayfaya (1 puan)	.....

Folstein MF, Folstein SE, McHugh PR (1975) J Psychiatr Res. 1975 Nov;12(3):189-98.

Toplam Puan (0-30): .....

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Tasarım ve düzenleme: Dr. Ender Saltaş 2016

Appendix 5. Body Awareness Questionnaire Form (Turkish)

VÜCUT FARKINDALIĞI ANKETİ

Aşağıdaki ifadelerde insanların kendileriyle ilgili hissettikleri bazı durumlar listelenmiştir. Her ifadeyi okuduktan sonra ifadenin solundaki boşluğa ifadenin sizin için hangi derecede doğru olduğunu 1'den 7'ye kadar değerlendirerek numarayı yazınız. Doğru veya yanlış cevaplar yoktur. En doğru cevap ifadenin sizin tecrübenize uygunluğunu dürüstçe yansıtandır.

Benim için hiç doğru değil — Benim için tamamen doğru

1 2 3 4 5 6 7

1. Vücudumun çeşitli yiyeceklere verdiği tepkilerdeki farklılığı anlarım.
2. Bir yerimi çarptığımda berelenme olup olmayacağını her zaman söyleyebilirim.
3. Kendimi ertesi gün ızdırap duyacak kadar fiziksel olarak zorlayıp zorlamadığımı her zaman bilirim.
4. Bazı yiyecekleri yediğim zaman enerji düzeyimdeki değişimleri her zaman fark ederim.
5. Grip olacağımı önceden anlarım.
6. Dereceyle ölçmeden ateşimin olduğunu bilirim.
7. Açlıktan kaynaklanan yorgunluk ile uykusuzluktan kaynaklanan yorgunluk arasındaki farkı ayırt edebilirim.
8. Uykusuzluğun beni günün hangi saatinde etkileyeceğini doğru tahmin edebilirim.
9. Gün boyunca aktivite düzeyimdeki değişikliklerin farkındayım.
*10.Vücut fonksiyonlarımdaki mevsimsel ritim ve döngüleri fark etmiyorum.
11. Sabah uyanır uyanmaz gün boyunca ne kadar enerjim olacağını bilirim.
12. Yatağa gittiğimde o gece ne kadar iyi uyuyacağımı söyleyebilirim.
13. Yorgun olduğumda vücudumdaki belirgin tepkileri fark ederim.
14. Hava değişikliklerine karşı vücudumun verdiği tepkileri fark ederim.
15. Dinlenmiş bir şekilde uyanmak için gece ne kadar uyumam gerektiğini tahmin edebilirim.
16. Egzersiz alışkanlıklarım değiştiğinde enerji düzeyimin nasıl etkileneceğini tahmin edebilirim.
17. Benim için gece uyumaya gitmenin belli bir uygun zamanı vardır.
18. Aşırı açlık durumundaki özel vücut tepkilerimi fark ederim

*=ters skorlanan madde

Appendix 6. Mini-BESTest Protocol

Mini-BESTest: Balance Evaluation Systems Test

ANTICIPATORY **SUB SCORE: /6**

1. SIT TO STAND

Instruction: "Cross your arms across your chest. Try not to use your hands unless you must. Do not let your legs lean against the back of the chair when you stand. Please stand up now."

(2) Normal: Comes to stand without use of hands and stabilizes independently.
(1) Moderate: Comes to stand WITH use of hands on first attempt.
(0) Severe: Unable to stand up from chair without assistance, OR needs several attempts with use of hands.

2. RISE TO TOES

Instruction: "Place your feet shoulder width apart. Place your hands on your hips. Try to rise as high as you can onto your toes. I will count out loud to 3 seconds. Try to hold this pose for at least 3 seconds. Look straight ahead. Rise now."

(2) Normal: Stable for 3 s with maximum height.
(1) Moderate: Heels up, but not full range (smaller than when holding hands), OR noticeable instability for 3 s.
(0) Severe: ≤ 3 s.

3. STAND ON ONE LEG

Instruction: "Look straight ahead. Keep your hands on your hips. Lift your leg off of the ground behind you without touching or resting your raised leg upon your other standing leg. Stay standing on one leg as long as you can. Look straight ahead. Lift now."

Left: *Time in Seconds Trial 1:_____Trial 2:_____*
(2) Normal: 20 s.
(1) Moderate: < 20 s.
(0) Severe: Unable.

Right: *Time in Seconds Trial 1:_____Trial 2:_____*
(2) Normal: 20 s.
(1) Moderate: < 20 s.
(0) Severe: Unable

To score each side separately use the trial with the longest time.
To calculate the sub-score and total score use the side [left or right] with the lowest numerical score [i.e. the worse side].

REACTIVE POSTURAL CONTROL **SUB SCORE: /6**

4. COMPENSATORY STEPPING CORRECTION- FORWARD

Instruction: "Stand with your feet shoulder width apart, arms at your sides. Lean forward against my hands beyond your forward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall."

(2) Normal: Recovers independently with a single, large step (second realignment step is allowed).
(1) Moderate: More than one step used to recover equilibrium.
(0) Severe: No step, OR would fall if not caught, OR falls spontaneously.

5. COMPENSATORY STEPPING CORRECTION- BACKWARD

Instruction: "Stand with your feet shoulder width apart, arms at your sides. Lean backward against my hands beyond your backward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall."

(2) Normal: Recovers independently with a single, large step.
(1) Moderate: More than one step used to recover equilibrium.
(0) Severe: No step, OR would fall if not caught, OR falls spontaneously.

6. COMPENSATORY STEPPING CORRECTION- LATERAL

Instruction: "Stand with your feet together, arms down at your sides. Lean into my hand beyond your sideways limit. When I let go, do whatever is necessary, including taking a step, to avoid a fall."

Left
(2) Normal: Recovers independently with 1 step (crossover or lateral OK).
(1) Moderate: Several steps to recover equilibrium.
(0) Severe: Falls, or cannot step.

Right
(2) Normal: Recovers independently with 1 step (crossover or lateral OK).
(1) Moderate: Several steps to recover equilibrium.
(0) Severe: Falls, or cannot step.

Use the side with the lowest score to calculate sub-score and total score.

SENSORY ORIENTATION **SUB SCORE: /6**

7. STANCE (FEET TOGETHER); EYES OPEN, FIRM SURFACE

Instruction: "Place your hands on your hips. Place your feet together until almost touching. Look straight ahead. Be as stable and still as possible, until I say stop."

Time in seconds:_____
(2) Normal: 30 s.
(1) Moderate: < 30 s.
(0) Severe: Unable.

8. STANCE (FEET TOGETHER); EYES CLOSED, FOAM SURFACE

Instruction: "Step onto the foam. Place your hands on your hips. Place your feet together until almost touching. Be as stable and still as possible, until I say stop. I will start timing when you close your eyes."

Time in seconds:_____

(2) Normal: 30 s.
(1) Moderate: < 30 s.
(0) Severe: Unable.

9. INCLINE- EYES CLOSED

Instruction: "Step onto the incline ramp. Please stand on the incline ramp with your toes toward the top. Place your feet shoulder width apart and have your arms down at your sides. I will start timing when you close your eyes."

Time in seconds:_____

(2) Normal: Stands independently 30 s and aligns with gravity.
(1) Moderate: Stands independently <30 s OR aligns with surface.
(0) Severe: Unable.

DYNAMIC GAIT **SUB SCORE: /10**

10. CHANGE IN GAIT SPEED

Instruction: "Begin walking at your normal speed, when I tell you 'fast', walk as fast as you can. When I say 'slow', walk very slowly."

(2) Normal: Significantly changes walking speed without imbalance.
(1) Moderate: Unable to change walking speed or signs of imbalance.
(0) Severe: Unable to achieve significant change in walking speed AND signs of imbalance.

11. WALK WITH HEAD TURNS – HORIZONTAL

Instruction: "Begin walking at your normal speed, when I say "right", turn your head and look to the right. When I say "left" turn your head and look to the left. Try to keep yourself walking in a straight line."

(2) Normal: performs head turns with no change in gait speed and good balance.
(1) Moderate: performs head turns with reduction in gait speed.
(0) Severe: performs head turns with imbalance.

12. WALK WITH PIVOT TURNS

Instruction: "Begin walking at your normal speed. When I tell you to 'turn and stop', turn as quickly as you can, face the opposite direction, and stop. After the turn, your feet should be close together."

(2) Normal: Turns with feet close FAST (≤ 3 steps) with good balance.
(1) Moderate: Turns with feet close SLOW (≥4 steps) with good balance.
(0) Severe: Cannot turn with feet close at any speed without imbalance.

13. STEP OVER OBSTACLES

Instruction: "Begin walking at your normal speed. When you get to the box, step over it, not around it and keep walking."

(2) Normal: Able to step over box with minimal change of gait speed and with good balance.
(1) Moderate: Steps over box but touches box OR displays cautious behavior by slowing gait.
(0) Severe: Unable to step over box OR steps around box.

14. TIMED UP & GO WITH DUAL TASK ***[3 METER WALK]***

Instruction TUG: "When I say 'Go', stand up from chair, walk at your normal speed across the tape on the floor, turn around, and come back to sit in the chair."

Instruction TUG with Dual Task: "Count backwards by threes starting at ___. When I say 'Go', stand up from chair, walk at your normal speed across the tape on the floor, turn around, and come back to sit in the chair. Continue counting backwards the entire time."

TUG: _____seconds; Dual Task TUG:_____seconds

(2) Normal: No noticeable change in sitting, standing or walking while backward counting when compared to TUG without Dual Task.
(1) Moderate: Dual Task affects either counting OR walking (>10%) when compared to the TUG without Dual Task.
(0) Severe: Stops counting while walking OR stops walking while counting.

When scoring item 14, if subject's gait speed slows more than 10% between the TUG without and with a Dual Task the score should be decreased by a point.

TOTAL SCORE: _____/28

Appendix 7. Data Collection Form (English)

PARTICIPANTS INFORMATIONS

First Name: _____ Middle (if applicable): _____

Last: _____ Contact number: _____

Date of birth: ____/____/_____

Sex: F ☐ M ☐

Current Height: _____ cm Current Weight: _____ kg/ lbs

BMI: _____

Dominant part: Right ☐ Left ☐

MEDICAL HISTORY

Mini Mental State Examination score: _____ points

Physically independent
(ability to walk 20 m without resting and assistance) Yes / No

MEDICAL CONDITIONS

To the best of your knowledge, have you ever had a serious medical problem related to the following?

- Morbid obesity Yes / No
- Acute pain Yes / No
- Eyes, ears problems Yes / No
- Problems such as physical, psychological, respiratory, neurological Yes / No
- High blood pressure Yes / No
- Cardiovascular disease Yes / No
- Diabetes Yes / No

Do you smoke?

☐ I never smoked ☐ I smoked but now I quit ☐ Yes, I smoke

Do you use medicines?

☐ Yes, _____ ☐ No

Previews operations?

☐ Yes, _____ ☐ No

How you score your health status?

☐ Poor ☐ Fair ☐ Good ☐ Very Good ☐ Excellent

Do you perform physical activities?

☐ I do not ☐ 2-3 times a week ☐ more than 3 times a week

Type of the physical activity?

☐ I do not do ☐ Fitness ☐ Pilates ☐ Swimming ☐ Body strengthening

☐ Football ☐ Jogging ☐ Running ☐ Volleyball ☐ Basketball

For how much time you do physical activity? _____

How much you score your physical activity?

☐ Poor ☐ Fair ☐ Good ☐ Very Good ☐ Excellent

The Body Awareness Questionnaire (126 points max.) Score: _____

Mini-BESTest (28 points max.) Score: _____

Proprioception

- Joint position sense (eyes closed):

Ankle plantar flexion

	Right limb
Target angle	30 degree
Perceived angle	1st trial:
	2nd trial:
	3rd trial:
	Mean:
Actual Angle Error (AAE)	

	Left limb
Target angle	30 degree
Perceived angle	1st trial:
	2nd trial:
	3rd trial:
	Mean:
Actual Angle Error (AAE)	

Knee extension

	Right limb
Target angle	60 degree
Perceived angle	1st trial:
	2nd trial:
	3rd trial:
	Mean:
Actual Angle Error (AAE)	

	Left limb
Target angle	60 degree
Perceived angle	1st trial:
	2nd trial:
	3rd trial:
	Mean:
Actual Angle Error (AAE)	

Hip flexion

	Right limb
Target angle	30 degree
Perceived angle	1st trial:
	2nd trial:
	3rd trial:
	Mean:
Actual Angle Error (AAE)	

	Left limb
Target angle	30 degree
Perceived angle	1st trial:
	2nd trial:
	3rd trial:
	Mean:
Actual Angle Error (AAE)	

- Motion sense (movements of up and down, eyes closed):

Distal Interphalangeal joint (DIP):

	Right limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

	Left limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

If No, continue to the other joint

Proximal Interphalangeal joint (PIP):

	Right limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

	Left limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

If No, continue to the other joint

Metatarsophalangeal joint (MTJ):

	Right limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

	Left limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

If No, continue to the other joint

Talocrural joint (TC):

	Right limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

	Left limb
1st trial	Yes / No
2nd trial	Yes / No
3rd trial	Yes / No

- Romberg test: number of sways: ____; ____ sec / 30 sec

Appendix 8. Data Collection Form (Turkish)

KATILIMCININ BİLGİLERİ

İsim: _____ Soy isim: _____

Doğum tarihi: ____/____/_____

Yaş: _____

Cinsiyet: K ☐ E ☐

Boy: _____ cm Kilo: _____ kg/ lbs BMI: _____

Dominant taraf? Sağ Sol

TIBBİ GEÇMİŞ

Mini Mental Durum Testi skor: _____ puan

Fiziksel olarak bağımsız
(dinlenmeden ve yardım almadan 20 m yürüyebilme yeteneği) Evet / Hayır

TIBBİ DURUMLAR

Bildiğiniz kadarıyla, aşağıdakilerle ilgili ciddi bir tıbbi sorun yaşadınız mı?

- Morbid obezite Evet / Hayır
- Akut ağrı Evet / Hayır
- Gözler, kulaklar problemleri Evet / Hayır
- Fiziksel, psikolojik, solunum, nörolojik gibi problemler Evet / Hayır
- Hipertansiyon Evet / Hayır
- Kardiyovasküler hastalığı Evet / Hayır
- Şeker hastalığı Evet / Hayır

Sigara İçiyor Musunuz?

[ ] Hiç İçmedim. [ ] Sigara İçtim Ama Bıraktım [ ] Hala İçiyorum

Sürekli kullandığınız bir ilaç var mı?

[ ] Evet (.....) [ ] Hayır

Herhangi bir ameliyat geçirdiniz mi (sünnet hariç)?

[ ] Evet ..... [ ] Hayır

Sağlınızı nasıl değerlendiriyorsunuz?

[ ] Çok zayıf [ ] Zayıf [ ] Orta [ ] İyi [ ] Çok iyi

Fiziksel aktivite yapıyor musunuz?

[ ] Yapmıyorum [ ] Haftada 3 günden az [ ] Haftada 3 gün veya daha fazla

Egzersizin tipi:

[ ] Yapmıyorum [ ] Fitness [ ] Pilates [ ] Yüzme [ ] Vücut

[ ] Geliştirme [ ] Futbol [ ] Koşu [ ] Yürüyüş [ ] Voleybol

[ ] Basketbol [ ] Ev egzersizleri

Egzersizin süresi: .....

Fiziksel performans düzeyinizi nasıl algılarsınız/nasıl tanımlarsınız?

[ ] Çok zayıf [ ] Zayıf [ ] Orta [ ] İyi [ ] Çok iyi

Vücut Farkındalık (126 puan max.) Skor: _____

Mini-BESTest (28 puan max.) Skor: _____

Propriyosepsiyon

- Eklem pozisyon duygusu (gözler kapalı):

Ayak bileği planlar fleksiyon

	Sağ taraf
Hedef açı	30 derece
Algılanan açı	1:
	2:
	3:
	Ortalama:
Actual Angle Error (AAE)	

	Sol taraf
Hedef açı	30 derece
Algılanan açı	1:
	2:
	3:
	Ortalama:
Actual Angle Error (AAE)	

Diz ekstansiyon

	Sağ taraf
Hedef açı	60 derece
Algılanan açı	1:
	2:
	3:
	Ortalama:
Actual Angle Error (AAE)	

	Sol taraf
Hedef açı	60 derece
Algılanan açı	1:
	2:
	3:
	Ortalama:
Actual Angle Error (AAE)	

Kalça fleksiyon

	Sağ taraf
Hedef açı	30 derece
Algılanan açı	1:
	2:
	3:
	Ortalama:
Actual Angle Error (AAE)	

	Sol taraf
Hedef açı	30 derece
Algılanan açı	1:
	2:
	3:
	Ortalama:
Actual Angle Error (AAE)	

- Hareket duygusu (yukarı ve aşağı hareketler, gözler kapalı)

Distal Interphalangeal eklem (DIP):

	Sağ taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

	Sol taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

Hayırsa, diğer ekleme geçin

Proximal Interphalangeal eklem (PIP):

	Sağ taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

	Sol taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

Hayırsa, diğer ekleme geçin

Metatarsophalangeal eklem (MTJ):

	Sağ taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

	Sol taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

Hayırsa, diğer ekleme geçin

Talocrural eklem (TC):

	Sağ taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

	Sol taraf
1	Evet / Hayır
2	Evet / Hayır
3	Evet / Hayır

- Romberg testi: sağlanma: ____; ____ san / 30 san

Curriculum Vitae

Personal Informations

Name	Bardha	**Surname**	Agushi
Place of Birth	Vranje, Serbia	**Date of Birth**	03.10.1994
Nationality	Albanian	**TR ID Number**	99674946240
E-mail	bardhaagushi@gmail.com	**Phone number**	0(544)-9403230

Education

Degree	Department	The name of the Institution Graduated From	Graduation year
Doctorate			
Master	Physiotherapy and Rehabilitation	**Yeditepe University**	
University	Physiotherapy and Rehabilitation	**"Hasan Prishtina" University**	2016
High school	-		

Languages	**Grades (#)**
Albanian	Native language
English	Excellent
Turkish	Excellent

Work Experience (Sort from present to past)

Position	**Institute**	**Duration (Year - Year)**
Physiotherapist volunteer	Mediclinic Hospital, United Arab Emirates	3 months (2015)
Physiotherapist volunteer	"Fiziatria" Clinic	1 month (2017)

Computer Skills

Program	**Level**
Microsoft Office Word	Excellent
Microsoft Office PowerPoint	Excellent
SPSS	Good

Others (Projects / Certificates / Rewards)

Kinesio-taping Certificate
Integrated Kinetic Neurology Certificate
Mulligan Concept Upper Quadrant Certificate