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ASSESSMENT OF DYNAMIC AND STATIC BALANCE AMONG OFFICE WORKERS

MASTER OF SCIENCE THESIS

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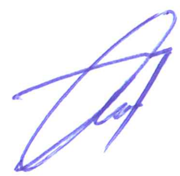
I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.



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DEDICATION

I would like to extend a special thank to several people that have been specifically significant for me. A special gratitude I give to my supervisor, Şule Demirbaş who contributed perfectly by significant suggestions and encouragement assisted me to finish this thesis. First I would like to dedicate this thesis to my family members and especially thank them for their endless support. Second, I would like to express my deepest greetings to my dear brother Murat Turhan who has been supporting my health perspective by his visions since my childhood who has always been there for me. My professional journey would be less joyous without him.

Doruk Turhan

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LIST OF SYMBOLS/ABBREVATIONS

BESS	: Balance Error Scoring System
BMI	: Body Mass Index
BOS	: Base of Support
DVT	: Deep Vein Thrombosis
COM	: Center of Mass
GL	: Gravith Line
SEBT	: Star Excursion Balance Test
SD	: Standard Deviation
SB	: Static Balance
DB	: Dynamic Balance
AL	: Anterolateral
A	: Anterior
AM	: Anteromedial
M	: Medial
PM	: Posteromedial
P	: Posterior
PL	: Posterolateral
L	: Lateral
SLS	: Single Leg Stand
DLS	: Double Leg Stand
TS	: Tandem Stand
TRAP	: Trapezius
SCM	: Sternocleidomastoideus
ABD	: Rectus abdominis kası
HAM	: Hamstring
QUAD	: Rectus femoris
GAS	: Gastrocnemius
PCS	: Physical Component Summary

MCS : Mental Component Summary

PF : Physical Function

PRL : Physical Role Limitations

SF : Social Function

MH : Mental Health

ERL : Emotional Role Limitations

V : Vitality

GH : General Health

ABSTRACT

Turhan, D. (2018) Assessment of Dynamic and Static Balance Among Office Workers. Yeditepe University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation. Master Thesis. İstanbul.

Balance is a general term that defines the dynamics of body posture to prevent falls. Simple changes in posture can have a positive effect on individuals who have spent most of their days sitting down. The aim of this study is to provide some scientific data in order to develop work efficiency and ergonomic environment for the office population. Our study involved 60 participants, divided into two groups as office workers (n=30 ; mean age: 31,33±3,07 yrs ; 17 female ; sitting duration: 6,40±1,22 h), and active workers (n=30 ; mean age 33,37±6,26 yrs; 10 female ; sitting duration: 3,83±0,99 h). To assess the quality of life, Short Form 36 (SF-36) questionnaire was used, while Balance Error Scoring system (BESS) was used to assess static balance and Star Excursion Balance Test (SEBT) for dynamic balance. Physcal Function scores were 77,59±13,08 for the experiment group and 85,55±13,50 for the control group and a significant difference was found between groups (t=-2,319, p<0,05). Pain scores were 60,17±22,21 for the experiment group and 74,50±20,80 for the control group and a significant difference was found between groups (t=-2,580, p<0,05). Mental Health scores were 66,00±18,55 for the experiment group and 75,07±13,88 for the control group and there was a significant difference between groups (t=-2,143, p<0,05). General Health scores were 50,50±28,05 for the experiment group and 61,17±20,91 for the control group and significant difference was found between groups (t=-2,674, p<0,05). Physical Component Summary values in the experiment group was 66,75±16,67 while in the control group was 76,40±14,64; and the difference was found to be significant (t=-2,383, p<0,05). No significant differences found in terms of dynamic and static balance between groups.

Key Words: dynamic balance, static balance, office workers, prolonged sitting, quality of life

ÖZET

Turhan, D. (2018) Ofis Çalışanlarında dinamik ve Statik Dengenin Değerlendirilmesi. Yeditepe Üniversitesi Saglik Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon ABD. Yüksek Lisans Tezi. İstanbul.

Denge, düşmeyi önlemek için postür dinamiklerini tanımlayan genel bir terimdir. Bu çalışmanın amacı, ofis çalışanlarının iş verimliliğini arttırmak ve ergonomik ortam geliştirmek amacıyla bazı bilimsel veriler sağlamaktır. Çalışmamıza 60 katılımcı dahil edilmiş ve ofis çalışanı (n=30; yaş ort: 31,33 ± 3,07 yıl; 17 kadın; oturma süresi: 6,40±1,22 saat) ve aktif çalışanlar (n=30; yaş ort: 33,37 ± 6,26 yıl; 10 kadın; oturma süresi: 3,83±0,99 saat) olarak iki gruba ayrılmıştır. Yaşam kalitesini değerlendirmek için Kısa Form 36 (SF-36), statik dengeyi değerlendirmek için Denge Hata Puanlama Sistemi (BESS), dinamik denge için ise Yıldız Denge Testi (SEBT) kullanılmıştır. Fiziksel Fonksiyon skorları deney grubu için 77,59±13,08, kontrol grubu için 85,55±13,50 idi ve gruplar arasında anlamlı fark bulundu (t=-2,319, p<0,05). Ağrı skorları deney grubu için 60,17±22,21, kontrol grubu için 74,50±20,80 idi ve gruplar arasında anlamlı fark bulundu (t=-2,580, p<0,05). Zihinsel Sağlık skorları deney grubu için 66,00±18,55, kontrol grubu için 75,07 ± 13,88 idi ve gruplar arasında anlamlı fark vardı (t=-2,143, p<0,05). Genel Sağlık skorları deney grubu için 50,50±28,05, kontrol grubu için 61,17±20,91 idi ve gruplar arasında anlamlı fark bulundu (t=-2,674, p<0,05). Deney grubunda Fiziksel Komponent Özet değerleri 66,75±16,67 iken kontrol grubunda 76,40±14,64; ve farkın anlamlı olduğu bulundu (t=-2,383, p<0,05). Gruplar arasında dinamik ve statik denge açısından anlamlı bir fark bulunamamıştır.

Anahtar Kelimeler: dinamik denge, statik denge, ofis çalışanları, uzun süre oturma, yaşam kalitesi

1. INTRODUCTION AND AIM

Balance is a general term that defines the external and internal variables of posture to prohibit falls and related to the forces which occur on the body and the inertial properties of body parts[1]. Proper balance is important for athletic performance in sports areas as well as for the prevention of injuries, as well as for the realization of daily life activities. The literature has basically separated the static and dynamic balance conditions. Static stability is stabilized understanding conditions such as silent standing; dynamic balance is considered to be the protection or recovery of balance in response to internal or external interventions. Thus, from a neuromechanical point of view, the postural control system is continuously required to hold stable or reposition the center of mass (COM) along support surface area (SSA)[2].

It has been reported that the poor posture in the sitting position can lead to a loss of balance in the person[3]. Although there are no studies directly evaluating the effects of long sitting on balance, previous studies have reported that the bad postures of people working with computer for a long time are related to musculoskeletal disorders and neck pain. Other studies on balance have shown that decreasing the perception of joints is an important factor in reducing balance ability[4].

Sitting for a long time decreases the speed of the blood circulation, causing the collection of fluids in the legs. Problems that may occur range from edema and varicose veins to ankles and to vital blood clots called deep vein thrombosis (DVT). If most of the work time is at the desk, stretching the neck toward a keyboard or bending the head towards a phone can force the cervical vertebrae and cause permanent imbalances[5].

The causes of musculo-skeletal problems are thought to be multifactorial and contribute to the development of various risk factors. Work factors, such as prolonged sitting, and repetitive work and muscle load, are thought to be sources of pain. Gender and physical activity are also factors that thought to be the potential reason for musculo-skeletal pain[6].

Postural control is defined as the qualification to carry on the base of support (BOS) in a statically minimum manner, and the adequacy to perform a task dynamically while maintaining a position[7]. Postural stability defined as maintaining a particular posture and is usually a subset of the postural balance defined by changes in the body's center of pressure[8]. Balance is one of the most important preconditions for safe and independent mobility[9].

Our study was designed considering the literature on the effect of imbalances that may occur in the musculoskeletal system on postural control among people working with a sitting posture. It was aimed to measure the change in the dynamic and static balance abilities of the participants due to long-term sitting.

The hypothesis' of this study are H0, H1 and H2;

H0: Prolonged sitting affects balance and quality of life negatively in long term.

H1: Prolonged sitting has no effect on balance and quality of life in long term.

H2: Prolonged sitting has no effect on balance while affecting quality of life negatively.

2. GENERAL INFORMATION

Human beings provide their movements and contact with earth with two feet. Within the movements; When a foot is in contact with the floor when walking, there are situations when the feet are not in contact when running or both feet are in contact (standing). These situations are a major challenge for the balance control system. This is mainly due to 2/3 of the body mass is about 2/3 the height of the body. When the control system does not operate continuously, the natural postural control becomes unstable [10].

Simple changes in posture can have a positive effect on individuals who have spent most of their days sitting down [11]. The aim of this study is to provide some basic information in order to contribute to public health and literature as well as to develop good posture and work efficiency and ergonomic environment in the office population.
The visual system and the musculoskeletal system work with other sensorimotor systems to control and maintain the standing posture or body position during movement. Even if the position of the body changes, it helps to create a fixed focus on the objects. The vestibular system performs this by detecting the mechanical forces acting on the vestibular organs during movement [12].

World Health Organization defines work-related musculoskeletal disorders as muscle, tendon, peripheral nerves and vascular injuries; this results from repeated or continuous use of a particular body part [13].

2.1. POSTURAL CONTROL

2.1.1 Definition of Postural Control

Balance or postural control is defined as the ability to maintain the BOS with minimal effort and to perform a duty in a stable position. In addition; postural balance is the balance between all forces acting on the body to maintain the desired position and orientation(14). There are two conceptual theories in the literature under the titles of "Reflex Theory" and "Systems Theory" which explain postural control. According to Reflex Theory; postural control is triggered by continuous reflex responses generated by the sensory system. On the other hand, according to Systems Theory; postural control occurs with the adaptation through the communication of the variables connected to the person's activity and environment(15). There are 4 basic mechanisms that provide postural control.

Static Postural Control is the ability to control COM at the level of support surface area (SSA) during standing silent posture.

Adaptive Postural Control is to maintain balance while voluntary movement.

Reactive Postural Control is maintaining the balance by responding to external forces when external forces (collision, arrival of an object, tripping, etc.) occur.

Proactive Postural Control can be defined as getting prepared against a situation that a person expects and can be physically effective. In this system, postural control is performed subconsciously within the instinct of maintaining the body's stability(16).

2.1.2 Postural Orientation and Sequence

Postural orientation is the positioning and alignment of body parts according to the environment(14).

2.1.3. Biomechanical Components of Postural Control

2.1.3.1. Base of Support (BOS)

The support base for standing on a flat, stable surface is defined as the area within the circumference of the touch between the surface and two feet. When the feet are comfortably positioned while the person is standing quietly, the floor of the support area is almost square(15).

2.1.3.2. Center of Mass and Gravity

When a body is activated by gravity, all of the mass particles in which the body is formed are exposed to a gravitational force directed towards the center of the earth. The total force generated by all of these small gravitational forces is the weight of the body, and the resulting force is the COM of the body(16). It is located in anatomical position of the human body, 2 – 2,5 cm in front of the second sacral vertebra(17).

2.1.3.4 Postural Stability Limit

The limits of postural stability are defined as the area where a person can move the COM and maintains the postural control without displacing BOS(19).

2.1.3.5. Gravity Line (GL)

It is the vertical line of the center of gravity to the floor. The reference points of the gravitational line of the human body in the basic standing posture:

Anterior view:

. The middle of the mandible and sternum

. Symphysis pubis

. The center of the horizontal line connection centers of the knee joints

. Center of the horizontal line connection centers of ankle joints

Posterior view:

. C7 vertebrae processus spinosus.

. The middle of the interscapular region

. Processus Spinosus of Columna Vertebralis

. The midline of the sacrum

. The center of the horizontal line connection centers of the knee joints

. Center of the horizontal line connection centers of ankle joints

Lateral view:

. Behind the ear (processus mastoideus)

. Large tubercle of the humerus

. The middle of the Trochanter major

. Behind the patella

. 2- 2,5 cm lateral malleolus (17)

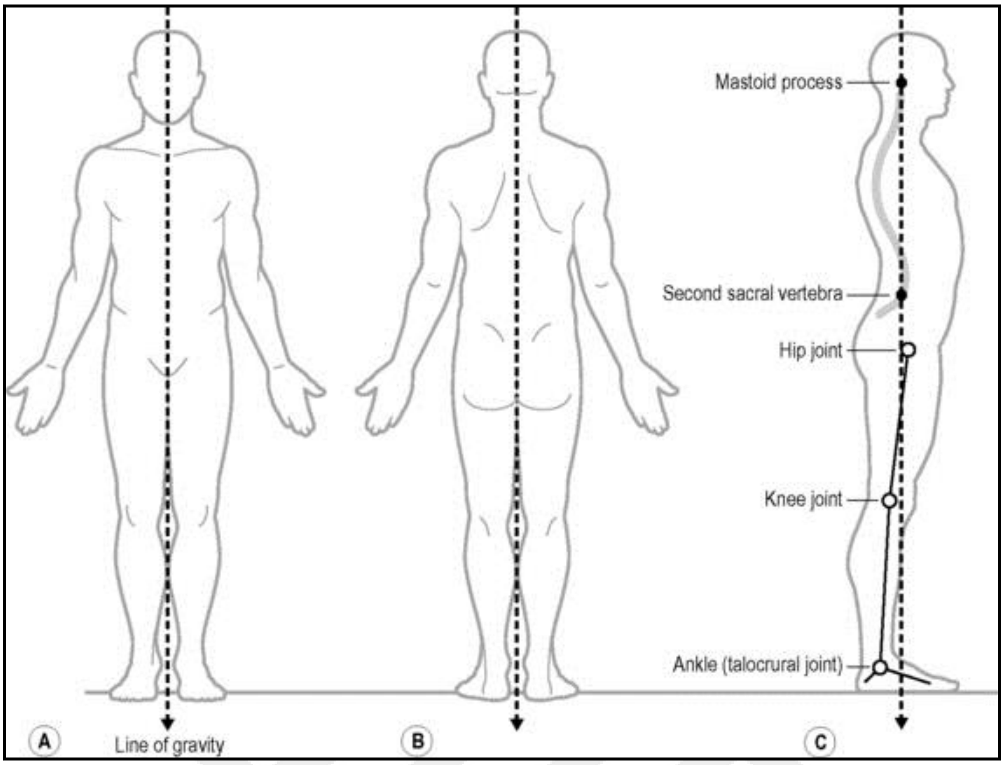

Figure 2.1: Gravity Line A. Anterior, B. Posterior, C. Lateral [53]

2.2. BALANCE

Balance is the ability of the person to hold the body center of gravity on the surface of contact with the earth. In other words, the human body is defined as the ability to control the desired posture when it is stationary and mobile. Ensuring this; it is thought that balance is one of the most important elements in order to perform complex motor activities[20].

Another source defining the balance is referred to as a term that describes the dynamic that resists the fall of the body to the earth. To be able to maintain the alignment of the human body against the effects of internal and external forces and to ensure that the composition of the forces acting on the body is zero[21].

There are two main mechanisms for controlling balance: *sensory strategies* and *motor strategies.*

Table 2.1: Balance Control Strategies

Sensory Strategies	Motor Strategies
Proprioception	Ankle Strategy
Visual Abilities	Hip Strategy
Vestibular System	Weight Shifting Strategy
	Stepping Strategy
	Suspension Strategy

2.2.1. Sensory Strategies

Sensory data from somato-sensory, vestibular systems and visual system should be gathered to interpret multifaceted sensory environments. While person change the sensory nurture, they must re-rate relative dependence on each one of the senses. Healthy persons rely on information (6%), visual (10%) and vestibular (20%) information with a strong BOS in a daylight sphere.

But, when an individual keeps still on an unstable surface, their sensory weight is increased to visual and vestibular information because he/she reduce the dependence on surface somatosensory input to keep postural orientation. The ability to re-rate sensory information based on sensory content is substantial to maintain stability in a process from a well-lit path to a dimly lit path(19).

The strategies that arise in each case are limited by both external constraints and internal constraints. Internal restrictions include biomechanical constraints such as the number of limbs available, range of motion, and strength of the muscles involved. The size of the foot support, the dimension on which the attention focuses on the task, the accuracy of sensory information, and the neural restrictions such as the force and position control mechanism in the nervous system will shape the final strategy(27,19).

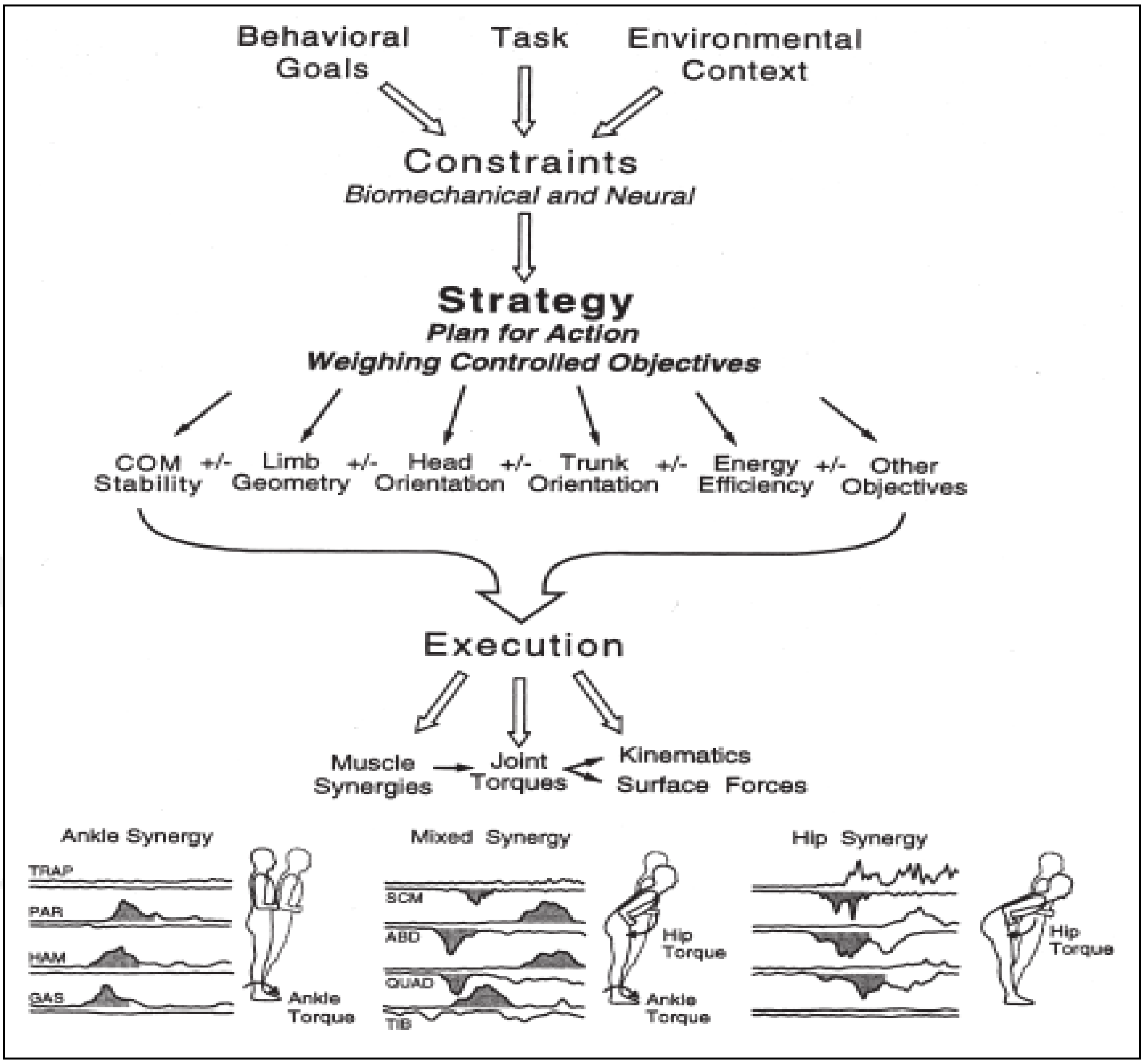

Figure 2.2: The conceptual framework of the emergence of the strategic action plan.

2.2.1.1. Proprioception

Proprioception was defined by Sir Charles Sherrington at the beginning of the 20th century as the perception of the position and movement of the body in space. In addition, proprioception is defined as the articulation of the tactile sensation, which becomes a sensory sensation that can perceive the position of the joint. In other words, it is a special sense that the sense of the movement and position of the joints can be perceived together(48).

Balance is essential to carry out the tasks of movement and posture and to allow the continuation of daily life [20]. Balance is not an isolated property, but it is below the capacity to realize many activities that make everyday life. Activities (sitting in armchair, carrying a heavy child, cleaning a window or running into a busy road) require different and multivariate differentiations in muscle tonus and activity within the postural control system. One of the most important factors in controlling balance is proprioception[21].

2.2.1.2. Visual System

The tasks of the visual system are as follows.

i. Provide information on the location of the head relative to the environment.

ii. Provide information to control the head and maintain gaze alignment

iii. Provide information to control the direction and speed of head movements

When the proprioceptive or vestibular inputs are insufficient/unreliable to fixate the gaze to an object, visual stimuli can be used to increase stability. Visual inputs can sometimes provide false information, such as the balance control system, which causes the illusion of a large object, such as a nearby bus, while a person is still standing.

2.2.1.3. Vestibular System

The vestibular system ensures information about the position and movement of the head in terms of inertia and gravity forces. While the semicircular channel receptors detect the angular acceleration of the head, otoliths receptors perceive the linear acceleration and head position relative to gravity. The semicircular canals are especially responsible for rapid head movements and sudden distortion (shifts, inclinations, stumbles) during walking; otoliths respond to gentle head movements (postural oscillations). As a result, additional information should be provided from the mechanical receptors of the central nervous system (CNS) in order to see real imagery of the head's position relative to the body. The vestibulospinal reflex stimulates antigravity muscles at all levels of the spinal cord, creating compensation against postural changes in the body. The vestibuloocular reflex induces the extraocular muscles by stimulating the vestibular nuclei and stabilizes the vision during head and body movements[18, 74].

2.2.2. Motor Strategies

Three basic movement strategies may be used to carry on balance in body posture. Two of these strategies hold the feet in place while the other strategy changes the support base by individual stepping or reaching.

2.2.2.1. Ankle Strategy

Ankle strategy is the strategy used to provide small amounts of oscillation while standing on a hard surface where the body acts as a flexible reverse pendulum in the ankle[(75)].

2.2.2.2. Hip Strategy

The hip strategy is used when the body applies torque on the body to move the center of mass (COM) quickly, when people are standing on narrow or compatible surfaces that do not allow adequate ankle torque, or when the center of mass is moved quickly. Taking a step to restore balance is not particularly important when walking and holding the feet in place. However, even if the step is taken by the person in response to an external perturbation, the first attempt is to return the COM to its initial position by applying angular torque. An elderly individual at risk of falling tends to take more steps in getting, reaching, and using hip strategies than an individual with a low risk of falling and using an ankle strategy. However, the fear of falling can also lead to additional use of the hip strategy[(75)].

Although postural movement strategies are triggered in 100 ms in response to an external perturbation, individuals can influence which strategy is chosen and how the responses are based on intent, experience, and expectations.

2.2.2.3. Weight Shifting Strategy

Weight-Shift Strategy (Lateral Plane) The movement strategy utilized to control mediolateral perturbations involves shifting the body weight laterally from one leg to the other. The hips are the key control points of the weight-shift strategy. They move the COM in a lateral plane primarily through activation of hip abductor and adductor muscles, with some contribution from ankle invertors and evertors[(75)].

2.2.2.4. Stepping Strategy

A step forward or backward is used to enlarge the BOS and recuperate balance control if a large force displaces the COM beyond the limits of stability. The uncoordinated step that follows a stumble on uneven ground is an example of a stepping strategy[(75)].

2.2.2.5. Suspension Strategy

The suspension strategy is observed during balance tasks when a person quickly lowers his or her body COM by flexing the knees, causing associated flexion of the ankles and hips. The suspension strategy can be combined with the ankle or the weight-shift strategy to enhance the effectiveness of a balance movement[(75)].

2.2.3. Sensory-Motor Integration

A potential damage happening in the cerebellum or additional motor area of the basal ganglia disrupts the process of incoming sensory information, resulting in sensory information in response to environmental changes and leading to disruption of predicted and reactive postural adjustments. When one or more senses gave false information in patients with a wide range of neurological disorders, problems of sensory organization arose as over-tolerance for a certain sense of balance control or a more general inability to choose a suitable sense for balance control. Individuals based on inputs based on heavy visual inputs or somatosensory become unstable or remain under conditions where the preferred emotion is absent or false, while those with generalized adaptation problems are unstable in any case where the sensory input is not correct[(76)].

2.2.4. Entropy of Balance

Although the concept of entropy in terms of balance is relatively new, there is a longstanding interest in analyzing biological phenomena in terms of regularity and chaos. But there is no consensus on the biological interpretation of entropy. In some studies, the increase in entropy was interpreted as a positive phenomenon and in some studies, it was interpreted as negative. In general, entropy can be interpreted differently in biological events. Irregularity and high entropy can be interpreted as a healthy state of “alertness”. This interpretation shows similarity with the “straight line” situation seen in death moments. On the contrary, a broken system may solidify and become trapped in repetitive situations that cannot cope with the difficulties that may occur. On the other hand, disorder and high entropy can be interpreted as a sign that the system has lost its structure and has become less sustainable. This definition is close to interpreting entropy as a measure of a disorder. While measuring changes in the pressure center (COP) during quiet standing, chaotic excursions can be interpreted as a sign of poor balance. On the other hand, chaotic excursions are also known as a feature of a successful alert strategy to maintain balance. Obviously, both interpretations may be correct, but the question then is how to decide which theory would be more appropriate in the case discussed. In general, there is no clear agreement when a high entropy indicates a pathological condition or when it can be interpreted as a sign of health[77].

A decrease in entropy can be interpreted as a sign that more forces are given to the forces that bring the COP curve to the center. Conversely, a higher entropy can be interpreted as showing that balancing requires less attention and effort and can be managed by the autopilot. The exceptional case that most authors find is a greater irregularity associated with aging, as well as greater entropy. While less complexity is generally expected for older individuals, this does not necessarily mean that smaller entropy will occur. When the hypothesis that increased entropy requires less attention to balance control, inconsistency is observed in light of the results obtained for the elderly. Increased entropy may in some cases be interpreted as an inability to balance. Therefore, an increase in entropy when the eyes are closed can be interpreted as a decrease in equilibrium control as a lack of visual input will occur[78].

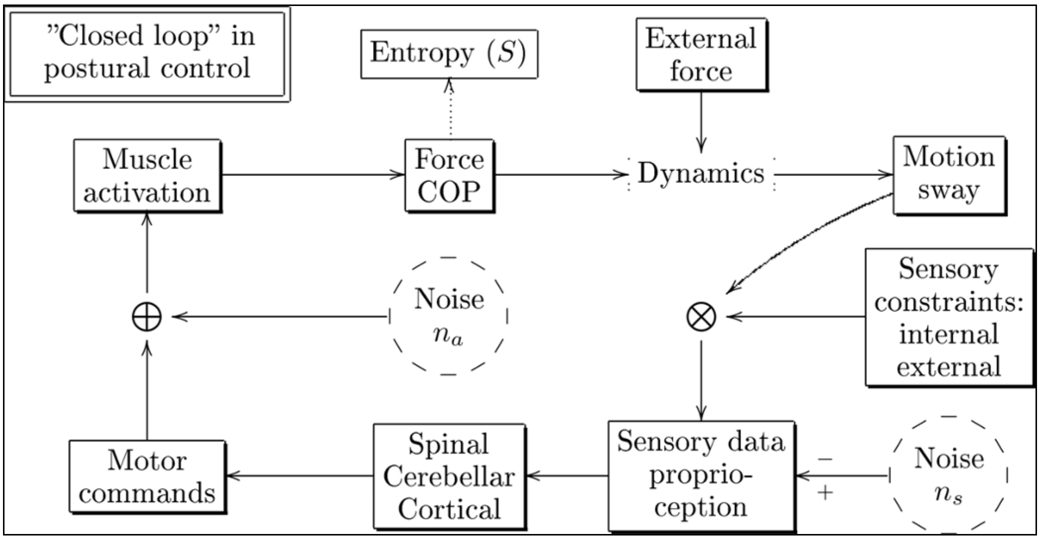

Figure 2.3: Control system of balance.

2.2.5. Static and Dynamic Balance Ability

Static balance is the ability to maintain the support base with minimum movement. It is usually achieved in a standing subject by means of devices that measure the body's movements or center of gravity or mostly the pressure center, or through some tests. An example of a static balance is the ability to provide the human body balance on a support surface area at a particular location or position in the center of gravity(22). The combination of forces acting on the body while moving from a stationary state to a movement tends to disrupt the present static balance. As a result of the application of this resultant force to the body, the body tends to move either linearly or angularly. In these cases, the dynamic balance comes into play(49).

Dynamic balance can be considered as the ability to maintain or restore a balance on an unstable surface, when performing a task, restoring a stable position, or with a minimum external movement(23). In other words, dynamic balancing is the ability of the person to maintain the stability of the posture during movement(24). Responses to unexpected perturbations, such as support surface translation, are commonly used to study dynamic postural control(25).

Maintaining and controlling posture under static or dynamic conditions are the basic requirements for daily activities. From a bio-mechanical point of view, static and dynamic balance is strikingly different. In static conditions (ie, quiet standing), protection of the balance is usually modeled as an inverted pendulum; the controlled value is the protrusion towards the floor of the center of gravity. On the other hand, although the dynamic balance during the walk still requires control over the COG, it doesn’t require the COG to be into the area of the foot(26).

2.3. BALANCE ASSESSMENT METHODS

2.3.1 Static Balance Assessment

Berg Balance Test assesses the balance performance in 14 sub-tests that are common in everyday life. These elements are applied with increasing difficulty and evaluate the person's efficiency to keep the sitting and standing positions. The standing posture balance is evaluated by the participant using the basics of less support. This test has been developed specifically to assess the postural control during sitting or standing but is often used to evaluate a history of falls, neurological disorders or elderly people with stroke(50).

Functional Reach test assesses a person's efficiency to reach forward as far as possible, without taking any steps or falling. This allows the participant to move their COGs towards the edge of the support base, providing quantitative dynamic information about its ability to maintain postural control. It is stated that the Functional Reach Test has very good validity in the risk of a falling subject(51).

Romberg Balance Test on firm and soft support surfaces examines participants' balance ability under the four conditions ordered based on increasing difficulty. Phase 1 allows the participant to benefit from all sensory inputs that contribute to balance. Phase 2 tests the balance only when vestibular and proprioceptive information is available; test goes on eyes-closed to eliminete vision. In phase 3, the participant should maintain stability on a foam surface that reduces proprioceptive input and leaves only visual and vestibular cues. Finally, in Phase 4, the visual input is removed again and the participant’s efficiancy to keep the stability using only the vestibular system is tested(54).

Tiltboard balance test is performed under eyes open as well as eyes closed conditions. The participant is placed with his feet, against the medial malleolus, sits in the center of an 18x18 curved plate. The inclination board has angle markers with a 0 to 60 degree graph extending from the board to the wall. The subject is told to stand while hands on hips and keep postural control as long as possible while the primary examiner tipped the tilt board to the sides. A second examiner guards against falls and watched for any postural compensations, especially upper extremity movement, that would cause the ending the trial. In the eyes-closed condition, the trial is terminated if the participant opened the eyes as well. 2 trials are administered to each side, for both the eyes-open and eyes-closed conditions. The best performance to each side is recorded. The degree line to which the angle marker is most near at the point where the subject makes a postural adjustment is recorded, up to the maximum of 60 degrees [55].

BESS includes 3 different posture conditions on a solid surface and an unstable foam surface. In 3 postures there is a double leg posture (feet together), a single leg posture (unusual leg) and a tandem posture (vague leg behind the raids, from heel to foot). Each posture is performed for 20 seconds with the eyes-closed and hands hold on the hips, while the clinician counts the participants' mistakes. Each of the errors is counted as 1 point and summed to characterize the balance gaps. For each posture, item scores are calculated by summarizing the number of errors, and compound scores are calculated by summing item scores, and lower scores indicated a better postural control. Intrarater (ICC: 0.50-0.98) reliability values for BESS have been reported to be from poor to excellent[56,57,58].

BESS is performed in 3 different configurations on a hard surface and a softer foam surface. These 3 feet have double leg posture (feet together), one leg posture (unusual leg) and tandem posture (indefinite leg in front of raids, heel to foot). With each of the tests placed on the waist of the open and closed hands for 20 seconds, the distance in the center is counted as compensation. Each error is counted as 1 point and all errors are summed to achieve a total score. The intrarater (ICC: 0.50-0.98) reliability values for BESS have been reported to range from poor to excellent[59,60,61,62].

2.3.2. Dynamic Balance Assessment Methods

Timed up and Go (TUG) is an objective clinical measure for assessing functional mobility and balance, and thus the risk of falling. The TUG measures the duration taken for an individual to rise from a chair, walk 3 meters, turn, walk back and sit. It does not address degraded performance while performing a simultaneous duty. A version of the TUG with a manual task (TUGm) has been found to investigate the effect of multiple tasks on functional mobility in community-dwelling older adults. In the TUGm, the subject is requested to stand up from a chair, walk 3 meters, turn, walk back and sit during holding a glass of water with one hand. The TUGm more closely resembles the demands of daily activities than the simple TUG. It has been stated that the TUGm could identify pre-frailty individuals among the community-dwelling elderly better than simple TUG. The TUGm has demonstrated excellent inter-rater reliability

(ICC value, 0.99) and intra-rater reliability (ICC value, 0.99) with healthy older adults [(57)].

The Functional Movement Screen comprises 7 sub-tests such as deep squat, hurdle step, inline lunge, shoulder mobility reaching, active straight-leg raise, trunk stability pushup, and rotary stability, each relating to movement capacity.[5,6] Each task yields a score ranging from 0 to 3 (0: indicating pain, 1: a score indicating that the task could not be fulfilled, 2: compensating that the task was completed and 3: indicating that the person completed without compensation). Individual task points are added to achieve a total score ranging from 0 to 21, and the high score is directly proportional to the movement capacity. It has been stated that the FMS to have moderate-to-excellent interrater reliability (ICC: 0.74 to 0.92) and poor-to-excellent interrater reliability for both composites (0.18-0.98) and item scores (0.33-1.0) [(58)].

Star Excursion Balance Test (SEBT) This test includes a single-leg balance with an outreach task and also assists in the assessment of sensorimotor competence while providing a general idea of stability during the task of reaching the lower limb. 3 main directions or 8 total reach directions, anterior, anteromedial, posterior, posteromedial, medial, anterolateral, lateral and posterolateral may be used. Each reach task generates a normalized score calculated by dividing the raw reach distance by each participant's limb length and multiplying by 100. For the purposes of this study, we used the normalized item score across all trials for each reaching task. In addition, we calculated a composite score by taking the sum of the maximum item score for each reaching task, dividing by the participant’s limb length and then multiplying by 100 as described. It has been stated that the SEBT has shown good-to-excellent intrarater (ICC:0.67-0.96) and strong-to-excellent interrater reliability for both normalized (ICC: 0.84-0.93) and raw scores (0.89-0.94)[(63,64,65)].

3. MATERIAL AND METHODS

3.1. SUBJECTS

Our study was conducted between May 2018 and October 2018 in Kemerburgaz University Vocational School of Health Services, Physiotherapy Laboratory with 60 participants in the 25-50 age group. All participants were given a form including the purpose of the study and the questionnaires to be used during the assessment. After this protocol, they were voluntarily asked to sign a form stating their participation.

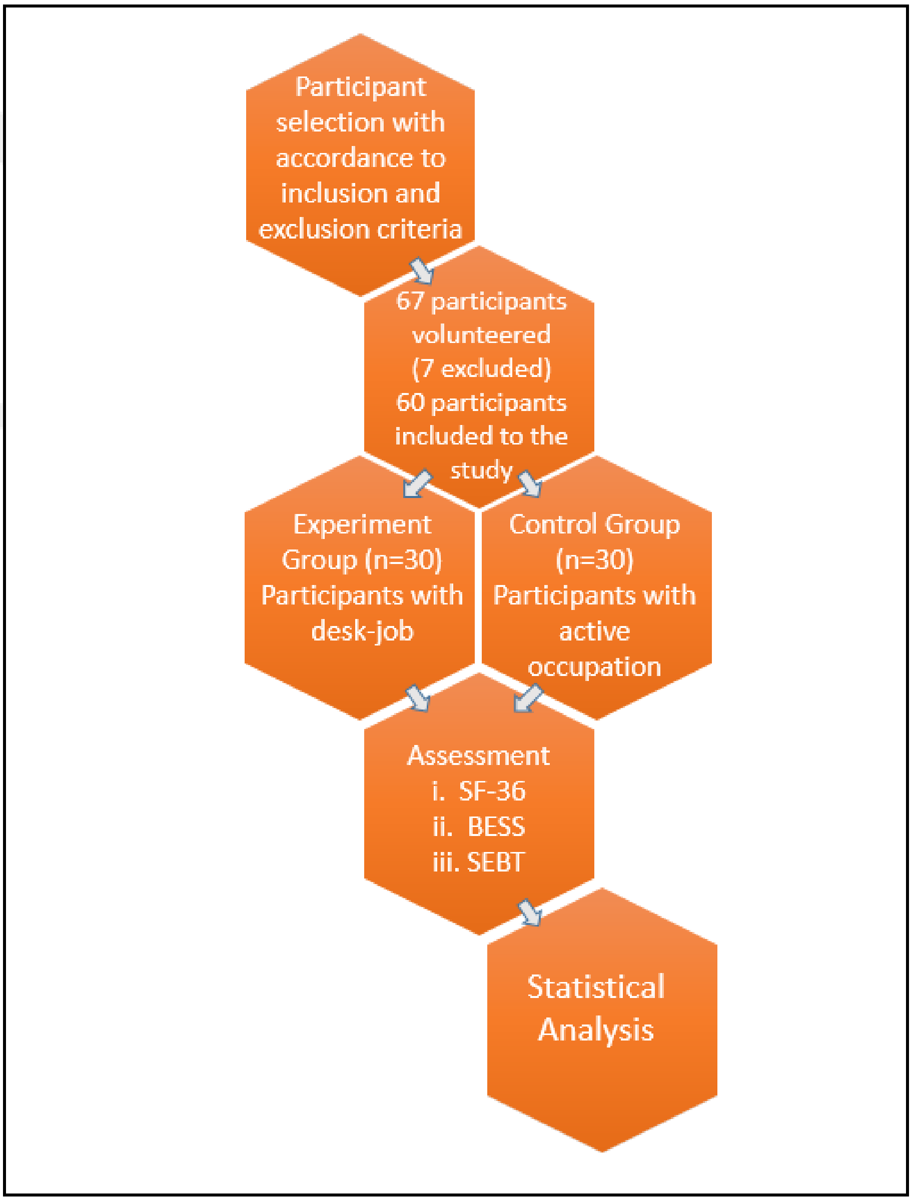

Figure 3.1. Study Diagram

Inclusion Criteria

For the experiment group;

i. Being an office worker for at least 4 years,
ii. Working at least 16 days per month,
iii. Working at a desk job at least 5 hours per day on the days worked,
iv. to be in the range of 25-50 years

For the control group;

i. To work in a non-desk job for at least 4 years,
ii. Working at least 16 days per month,
iii. Working at a non-desk job at least 5 hours per day on the days worked,
iv. to be in the range of 25-50 years

Exclusion Criteria:

i. Being under 25, over 50,
ii. Major trauma,
iii. Having suffered lower extremity injuries in the last 6 months,
iv. To have a serious visual/auditory disorder.
v. Pregnancy

3.2. ASSESSMENT

The following procedures were applied to the participants.

3.2.1. Sociodemographic Data Collection Survey:

Sociodemographic data questionnaire was used to determine the characteristics of the participants and to include them in the analysis data. The questionnaire includes physical and sociodemographic characteristics, general health information, age, gender, height, body weight, chronic diseases, surgical experience, drug use, smoking and alcohol habits, exercise participation history, duration and frequency of exercise.

3.2.2. Short Form 36 Quality of Life Survey

The evaluation of the quality of life of the participants was made using the Short Form 36 (SF-36) questionnaire. It was applied to both groups in order to evaluate and analyze the quality of life of office workers. The SF-36 survey has 36 items and measures 8 basic concepts as follows:

i. Physical function

ii. Role limitations due to physical problems;

iii. Physical pain;

iv. General health status;

v. Vitality;

vi. Social function;

vii. Role limitations due to emotional problems

viii. Mental health.

Each field is scored in a range from 0 to 100 and 100 is the best score possible[35,36]. In this study, the SF-36 questionnaire was analyzed in terms of two different summary scores: Physical Component Summary (PCS) and Mental Component Summary (MCS) [37,38]. The SF-36 provides a general overview of the participant's subjective views on different aspects of life[39]. The Turkish version of the SF-36 has been translated and approved by the MOS-Trust, the origin of the survey[40]. A study by Kocyigit H, Aydemir O, and Fisek G has tested and found valid and reliable[41].

3.2.3. Static Balance Assessment

Balance Error Scoring System (BESS); is applied to all participants to evaluate static balance and provides a cost-effective and objective method for evaluating static postural stability.

The Balance Error Scoring System consists of the following phases:

i. Double leg stance (feet together and hands on hips)
ii. One leg stance (hands hip, standing on the non-dominant foot)
iii. Tandem stance (non-dominant foot behind the dominant foot)

BESS include 3 different static posture on a hard and a foam surface. 3 postures include a pair of leg postures (feet together), one leg posture, and two-person posture. While each of the postures is performed for 20 seconds and the hands are positioned at the waist, the clinician counts the errors that the participant makes. Each error is counted as 1 point. Scores are calculated by collecting error numbers for each stance, so low scores show a better balance. It has been reported that the reliability values of BESS for both intrarater (ICC: 0.50-0.98) and interrater (ICC: 0.44-0.96) range from weak to excellent.

Subjects were tested in bare feet. The participants were held on a hard floor and in a closed position on the foam surface. Balance errors were counted and recorded during the 20-second trial. An error was defined in cases such as opening the eyes, removing the buttocks, taking the step, disrupting the position or removing the position, lifting the front leg or heel, lifting the hip more than 30 degrees or not returning to the test position for more than 5 seconds(28). The maximum total number of errors for a single condition is 10. If a subject issues multiple errors at the same time, only one error has been recorded. For example, if the participant takes the step or stumbles, opens his eyes and removes his hands from his hips at the same time, then only one error is recorded(29).

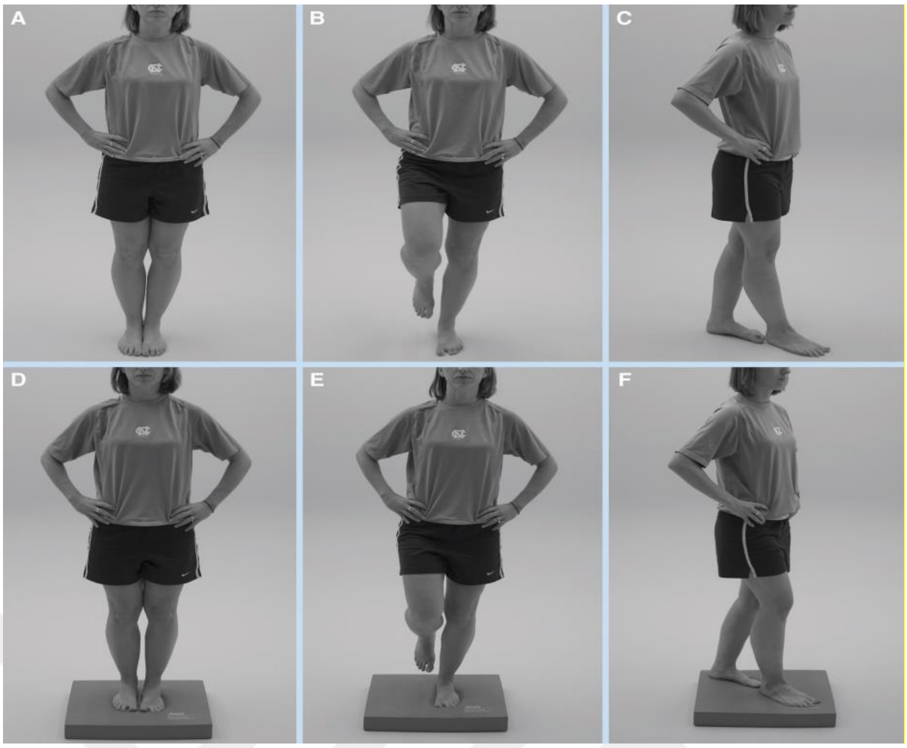

Figure 3.2: BESS Sub-test Standing Positions: A: Double Leg Stance, B: Single Leg Stance, C: Tandem Stance, D: Double Leg Stance, E: Single Leg Stance (foam surface), F: Tandem Stance (foam surface) [52].

3.2.4. Dynamic Balance Evaluation

Star Excursion Balance Test offers a simpler, more reliable and cost-effective alternative than the more sophisticated instrument methods currently available. SEBT is a dynamic stability test that can perform a more accurate limb function assessment than only tests with silent postures[30]. The purpose of these tests is to reach as far as possible with a leg in each of the 8 directions located at 45-degree intervals from the center of the star while maintaining the balance on the contralateral leg (Figure 3). To perform these tasks, the standing foot needs to use ankle dorsiflexion, knee flexion and hip flexion range of motion and requires adequate force, proprioception and neuromuscular control.

SEBT is a single-leg balance arrangement comprising an 8-way, one-way access. This test assists in the assessment of sensorimotor deficits, while at the same time giving a general idea of the stability of the lower extremity in one task. It is used in 8 reach zones in the city: lateral, anterolateral, anterior, anteromedial, medial, posterior, posteromedial and posterolateral. Where each direction is a normalized, calculated by dividing the raw binding distance by the medial malleol (measured as anterior superior iliac spine (ASIS)) to the length of the adapter limb and then multiplied by 100. Previous studies have stated that SEBT has shown good-to-excellent intrarater (ICC: 0.67-0.96) and strong-to-excellent interrater reliability for both normalized (ICC: 0.84-0.93) and raw scores (0.89-0.94)[19].

The test was verbally explained to each participant and was allowed to ask any questions about the test. The participant was asked to reach the directions determined by the contralateral leg, ie the access leg while maintaining the one leg posture. The target was determined to reach as far as possible in 8 directions to touch the farthest possible point as far as possible to avoid using the support leg support and was notified to the participant. The participant was then asked to return both of his feet to the center of the star while maintaining the balance. Each participant made 3 circuits of SEBT. In each circuit, 3 trials were performed in each of the 8 directions.

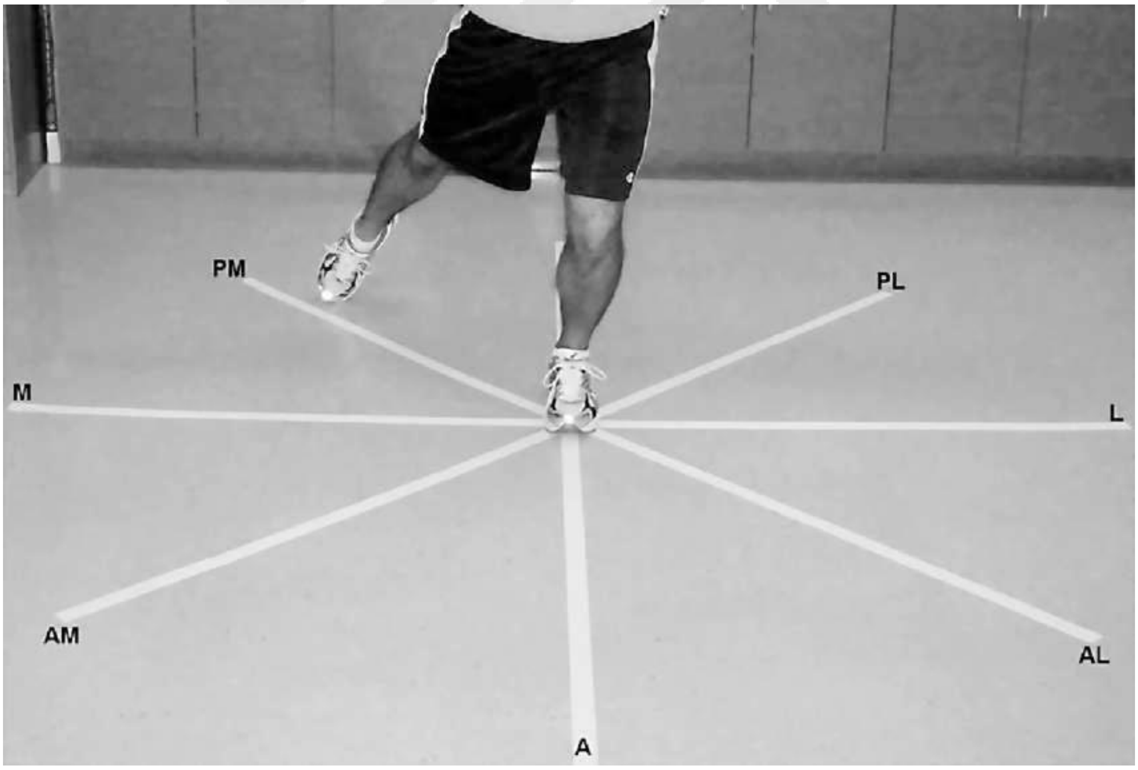

Figure 3.3: Reaching Directions for SEBT [31].

3.3. STATISTICAL ANALYSIS

Data analysis was performed using SPSS version 24 program. Descriptive statistical data are expressed as mean ± Standard Deviation, (min.-max.) Or (%). The significance of this study in statistical analysis was determined by the letter “p” in terms of variables. The p-value of $p < 0,05$ was considered to be significant for the p-value, which is the only criterion that can confirm the validity of the hypotheses proposed. The level of significance was set at $p < 0,05$. Kolmogorov-Smirnov normality test was used for distribution analysis and independent sample t-test was used for group comparisons. Correlation analysis was performed using the pearson correlation coefficient and $p<0,01$ and $p<0,05$ values were used to determine significance level.

4. RESULTS

4.1. DESCRIPTIVE STATISTICS

60 volunteer healthy individuals were included in the study. Gender distributions of the participants are shown in Table 4.1 and their sociodemographic characteristics are shown in Table 4.2.

Table 4.1: Gender Distribution across Groups

		Experiment Group (n=30)	Control Group (n=30)	P
Gender	Female:	n=17 (%57)	n=10 (%33)	,071
	Male:	n=13 (%43)	n=20 (%67)	

Of the 60 individuals included in our study, 27 were female (45%) and 33 were male (55%). Of the 30 participants in the experiment group, 17 were female and 13 were male. Of the 30 participants in the control group, 10 were female and 20 were male.

Table 4.2: Sociodemographic Characteristics of the Subjects

	Experiment Group (n=30)	Control Group (n=30)	P
	Mean±SD (min.-max.)	Mean±SD (min.-max.)	
Height (cm)	170,57±8,57 (157-190)	172,10±8,73 (150-189)	,5
Weight (kg)	65,73±13,81 (49-109)	73,47±10,41 (52-105)	**,02**
BMI (kg/m^2)	22,59±4,61 (15,70-39,56)	24,71±3,08 (19,15-32,41)	**,04**
Age (year)	31,33±3,07 (25-40)	32,37±6,26 (25-49)	,42
Sitting duration (hour/day)	6,40±1,22 (5-8)	3,83±0,99 (2-5)	**,0**

The mean age and standard deviations of the participants included in the experiment group were 31,33±3,07 years and the participants included in the control group were 33,37±6,26 years. The Body Mass Index (BMI) of the participants was 22,59±4,61 in the experiment group and 24,71±3,08 in the control group. The daily sitting duration of the participants in the experiment group was 6,40±1,22 and 3,83±0,99 in the control group.

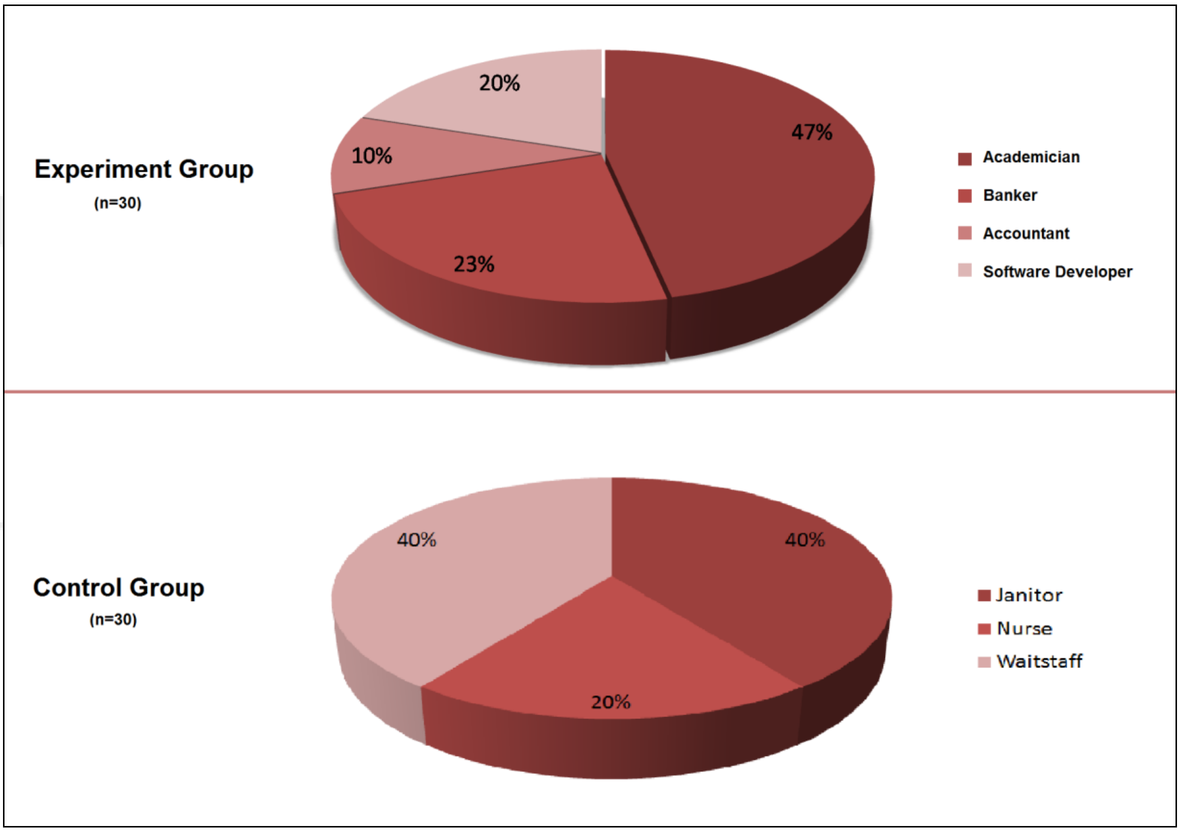

Figure 4.1: Distribution of Occupations of the Participants across Groups

In our study, 47% of the participants in the experiment group were academicians (n=14), 23% were bankers (n=7), 20% were software developers (n=6) and 10% were accountants (n=3); 40% of the patients included in the control group were janitor (n=12), 20% were nurse (n=6), and 40% were waitstaff (n=12) (Figure4.1).

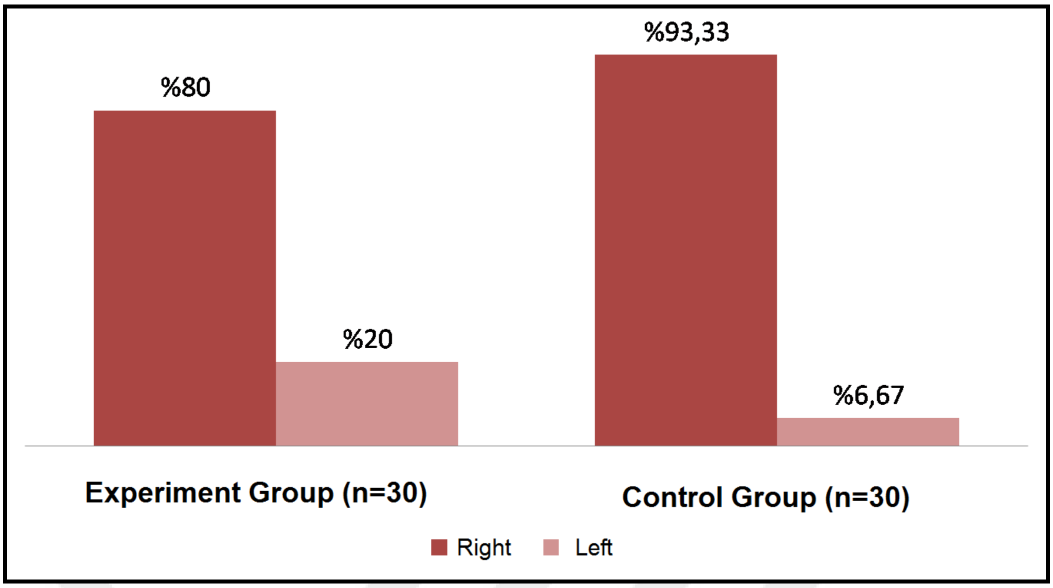

Figure 4.2: Distribution of Dominant Sides of the Participants across Groups

When the dominant side of the participants in the experiment group was examined, 80% was right (n=24) and 20% as left (n=6); In the control group, 93.33% were recorded as right (n=28) and 6.67% as left (n=2) (Figure 4-2).

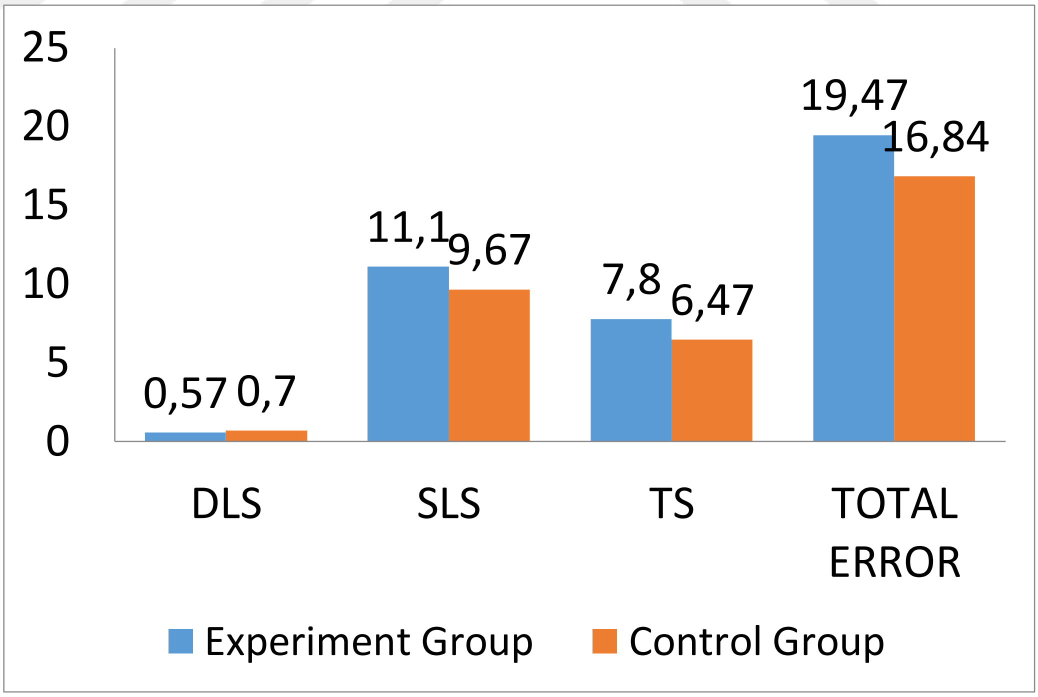

Figure 4.3: BESS Subtest Errors and Total Errors across Groups

When BESS Double Leg Stance test scores were examined, the number of errors for the balance group was 0,57, and in the control group was 0,70. When single-leg stance sub-test scores were examined, the number of errors in the experiment group was 11,1 and the number of control group errors was 9,67. In the tandem stance test, the experiment group scores were 7,80 and 6,47 for the control group. In addition, the total number of errors was 19,47 for the experiment group and 16,84 for the control group.

Table 4.3: Comparison of BESS Total Scores across Groups

Balance Error Scoring		**Mean ± SD**	**Min**	**Max**	**t**	**p**
Experiment	**(N=30)**	19,47 ± 7,07	6,	37,	1,39	,17
Control	**(N=30)**	16,83 ± 7,57	5,	36,		

When we look into the statistical analysis, comparison of BESS Total Scores among the groups is shown in Table 4.3. The BESS scores of the participants were 19,47±7,07 for the experiment group and 16,83±7,57 for the control group and no significant difference was found (t=1,392, p>0,05).

Table 4.4: Comparison of SEBT Dominant Leg Scores across groups

	Group	Mean±SD	Std. Mean Error	Min	Max	t	P
AL	Experime	73,64±9,80	1,79	56,25	91,67	-,57	,57
	Control	75,03±9,22	1,68	57,45	102,53		
A	Experime	72,70±8,83	1,61	54,95	86,59	-1,19	,24
	Control	75,35±8,41	1,54	57,45	101,27		
AM	Experime	64,70±9,39	1,71	48,19	89,02	-1,84	,07
	Control	68,96±8,51	1,55	53,19	89,87		
M	Experime	56,79±11,5	2,11	30,12	90,24	-1,53	,13
	Control	61,50±12,2	2,23	40,43	93,67		
PM	Experime	62,78±9,60	1,75	46,46	86,59	-1,17	,25
	Control	65,95±11,2	2,06	42,22	89,87		
P	Experime	68,38±10,2	1,86	51,	85,54	-,77	,44
	Control	70,48±10,8	1,98	46,81	88,61		
PL	Experime	70,15±9,81	1,79	42,	86,75	-1,25	,22
	Control	73,43±10,5	1,93	57,14	94,94		
L	Experime	71,61±8,31	1,52	50,55	85,26	-1,6	,12
	Control	75,17±8,97	1,64	53,19	93,67		

The comparison of the 8 sub-parameters of the dominant leg SEBT scores between the groups is shown in Table 4.4. AL parameter scores for the experiment group were 73,64±9,80 and 75,03±9,22 for the control group and no significant difference was found (t=-0,565, p>0,05).

A parameter scores were 72,70±8,83 for the experiment group and 75,35±8,41 for the control group, and there was no significant difference (t=-1,193, p>0,05).

AM parameter scores were 64,70±9,39 for the experiment group and 68,96±8,51 for the control group and no significant difference was found (t=-1,837, p>0,05).

M parameter scores were 56,79±11,56 for the experiment group and 61,50±12,23 for the control group, and there was no significant difference (t=-1,529, p>0,05).

PM parameter scores were 62,78±9,60 for the experiment group and 65,95±11,27 for the control group, and no significant difference was found ($t=-1,172$, $p>0,05$).

P parameter scores were 68,38±10,20 for the experiment group and 70,48±10,81 for the control group and no significant difference was found ($t=-0,772$, $p>0,05$).

PL parameter scores were 70,15±9,81 for the experiment group and 72,82±9,97 for the control group and no significant difference was found ($t=-1,248$, $p>0,05$).

L parameter scores were 71,61±8,31 for the experiment group and 75,17±8,97 for the control group and no significant difference was found ($t=-1,595$, $p>0,05$).

Table 4.5: Comparison of SEBT non-Dominant Leg Scores across Groups

	Group	Mean±SD	Std. Mean Error	Min	Max	t	P
AL	Experiment	74,62±8,53	1,56	55,68	93,42	,23	,82
	Control	75,13±8,89	1,62	55,77	92,59		
A	Experiment	72,12±8,59	1,57	54,55	87,95	-,8	,42
	Control	73,95±8,99	1,64	58,51	93,67		
AM	Experiment	65,13±10,52	1,92	40,91	85,37	-1,67	,1
	Control	69,52±9,87	1,8	47,87	89,87		
M	Experiment	58,26±11,16	2,04	38,64	82,93	-1,41	,16
	Control	61,99±9,14	1,67	44,68	77,17		
PM	Experiment	64,03±10,48	1,91	44,32	85,54	-1,37	,18
	Control	67,88±11,27	2,06	46,81	91,4		
P	Experiment	69,07±10,40	1,9	51,52	90,24	-,99	,32
	Control	71,85±11,26	2,06	52,19	93,67		
PL	Experiment	69,25±7,88	1,44	55,77	86,75	-1,72	,09
	Control	73,39±10,54	1,93	56,31	94,94		
L	Experiment	72,22±8,46	1,54	55,68	87,5	-,47	,64
	Control	73,28±8,83	1,61	56,38	94,94		

Comparison of the 8 sub-parameters of non-dominant leg SEBT scores between the groups is shown in Table 4.5. AL parameter scores were 74,62±8,53 for the experiment group and 75,13±8,89 for the control group and no significant difference was found (t=0,229, p>0,05).

A parameter scores were 72,12±8,59 for the experiment group and 73,95±8,99 for the control group, and there was no significant difference (t=-0,804, p>0,05).

AM parameter scores were 65,13±10,52 for the experiment group and 69,52±9,87 for the control group; there was no significant difference (t=-1,668, p>0,05).

M parameter scores were 58,26±11,16 for the experiment group and 61,99±9,14 for the control group, and no significant difference was found (t=-1,414, p>0,05).

PM parameter scores were 64,03±10,48 for the experiment group and 67,88±11,27 for the control group and no significant difference was found (t=-1,372, p>0,05).

P parameter scores were 69,07±10,40 in the experiment group and 71,85±11,26 in the control group ($t=-0,993$, $p>0,05$).

PL parameter scores were 69,25±7,88 for the experiment group and 73,39±10,54 for the control group and no significant difference was found ($t=-1,722$, $p>0,05$).

L parameter scores were 72,22±8,46 for the experiment group and 73,28±8,83 for the control group and there was no significant difference ($t=-0,473$, $p>0,05$).

Table 4.6: Comparison of SF-36 Subtest Scores across Groups

SF- 36	Group	Mean±SD	Std. Mean Err.	Min	Max	t	p
PF	Experiment	77,59±13,08	2,39	61,11	100,	-2,32	**,02***
	Control	85,55±13,50	2,46	55,56	100,		
PRL	Experiment	62,50±30,62	5,59	25	100,	-,86	,39
	Control	69,17±29,13	5,32	25,	100,		
Pain	Experiment	60,17±22,21	4,05	22,5	100,	-2,58	**,01***
	Control	74,50±20,80	3,8	25,	100,		
SF	Experiment	71,25±25,88	4,72	25,	100,	,39	,7
	Control	73,75±23,29	4,25	25,	100,		
MH	Experiment	66,00±18,55	3,39	36,	96,	-2,14	**,04***
	Control	75,07±13,88	2,53	36,	96,		
ERL	Experiment	55,56±37,48	6,84	0	100,	-,96	,34
	Control	64,44±33,83	6,18	0	100,		
V	Experiment	56,83±22,69	4,14	20,	95,	-2,32	,02
	Control	68,50±15,54	2,84	20,	95,		
GH	Experiment	50,50±28,05	5,12	10,	95,	-2,67	**,01***
	Control	67,50±20,63	3,77	15,	100,		

Comparison of the SF-36 quality of life questionnaire sub-tests and total scores among the groups are shown in Table 4.6. PF parameter scores were 77,59±13,08 for the experiment group and 85,55±13,50 for the control group and significant difference was found between groups (t=-2,319, p<0,05).

PRL parameter scores were 62,50±30,62 for the experiment group and 69,17±29,13 for the control group and no significant difference was found (t=-0,864, p>0,05).

Pain parameter scores were 60,17±22,21 for the experiment group and 74,50±20,80 for the control group and a significant difference was found between groups (t=-2,580, p<0,05).

SF parameter scores were 71,25±25,88 for the experiment group and 73,75±23,29 for the control group and no significant difference was found (t=0,393, p>0,05).

MH parameter scores were 66,00±18,55 for the experiment group and 75,07±13,88 for the control group and there was a significant difference between groups (t=-2,143, p<0,05).

ERL parameter scores were 55,56±37,48 for the experiment group and 64,44 ± 33,83 for the control group and no significant difference was found (t=-0,964, p>0,05).

V parameter scores were 56,83±22,69 for the experiment group and 68,50±15,54 for the control group and there was no significant difference (t=-2,323, p>0,05).

GH parameter scores were 50,50±28,05 for the experiment group and 61,17±20,91 for the control group and significant difference was found between groups (t=-2,674, p<0,05).

Table 4.7: Comparing SF-36 Physical and Mental Component Summary (PCS) Scores Among Groups

		Mean ± SD	**Min**	**Max**	**t**	**p**
PCS	**Experiment (N=30)**	66,75 ± 16,67	45,56	93,98	-2,38	**,02***
	Control (N=30)	76,40 ± 14,64	50,19	100,		
MCS	**Experiment (N=30)**	64,27 ± 23,40	25,67	94,5	-1,24	,22
	Control (N=30)	71,09 ± 18,92	28,33	98,67		

According to the statistical analysis, Physical Component Summary of SF-36 values in the experiment group was 66,75±16,67 while the control group was 76,40±14,64; and the difference was found to be significant (t=-2,383, p<0,05)

When looking into Mental Component Summary, statistical values of the experiment group were recorded as 64,27±23,40 while the control group were recorded as 71,09±18,92; thus there was no significant difference found (t=-1,241, p>0,05)

Table 4.8: Correlation among variables in experiment group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. PF														
2. PRL	,33													
3. P	,52**	,25												
4. SF	,3	,39*	,59**											
5. MH	,38*	,47**	,43*	,45*										
6. ERL	,11	,50**	,42*	,62**	,63**									
7. V	,02	,26	,35	,56**	,73**	,62**								
8. GH	,42*	,47**	,35	,66**	,78**	,64**	,79**							
9. Total	,44*	,65**	,63**	,79**	,82**	,83**	,76**	,87**						
10. PCS	,69**	,81**	,73**	,58**	,58**	,52**	,32	,55**	,80**					
11. MCS	,27	,53**	,56**	,82**	,76**	,93**	,73**	,79**	,95**	,65**				
12. APBalance	0	,34	-,24	-,17	-,16	-,27	-,12	-,03	-,11	,1	-,25			
13. MLBalance	-,08	,11	-,09	-,17	-,16	-,31	-,13	-,17	-,18	,01	-,27	,78**		
14. BESSsum	,03	,37*	,32	,33	,27	,47**	,36*	,24	,44*	,38*	,44*	-,08	-,27	

*Note. N=30. *p<.05 ; **p<.01*

According to the correlation analysis of the experiment group, static balance summary score was seen to be correlated positively with PRL, V, Total Sf-36, PCS, and MCS while strongly correlated with ERL. When we look into dynamic balance summaries, no correlation was found to be significant, thus no data shown.

Table 4.9: Correlation among variables in control group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. PF														
2. PRL	,19													
3. P	,42*	,07												
4. SF	,41*	,04	,29											
5. MH	,42*	,16	,25	,66**										
6. ERL	,25	,34	,15	,45*	,21									
7. V	,29	,06	,2	,21	,59**	,3								
8. GH	,47**	,08	,28	,2	,48**	,27	,73**							
9. Total	,63**	,48**	,50**	,65**	,68**	,71**	,61**	,64**						
10. PhySum	,63**	,75**	,65**	,29	,35	,37*	,22	,33	,75**					
11. MenSum	,42*	,25	,27	,84**	,64**	,83**	,41*	,36	,86**	,42*				
12. APBalance	-,05	,28	-,3	,09	-,11	-,02	-,1	-,14	-,03	,03	-,01			
13. MLBalance	-,06	,25	-,31	,08	-,09	,	-,01	-,11	-,01	,	,01	,93**		
14. BESSsum	,09	,05	-,28	-,07	-,26	-,14	-,41*	-,22	-,23	-,07	-,18	,31	,26	

*Note. N=30. *p<.05 ; **p<.01*

After the statistical analysis of control group correlations, static balance summary score was seen to have a negative correlation with Vitality score of SF-36. When we look into other variables, no correlation was found to be significant, thus no data shown.

5. DISCUSSION

Balance is a general term that defines the dynamics of body posture to prevent falls. Simple changes in posture can have a positive effect on individuals who have spent most of their days sitting down. The aim of this study is to provide some scientific data in order to develop work efficiency and ergonomic environment for the office population. Our study involved 60 participants, divided into two groups as office workers (n=30 ; mean age: 31,33±3,07 ; 17 female ; sitting duration: 6,40±1,22 h), and active workers (n=30 ; mean age 33,37±6,26 ; 10 female ; sitting duration: 3,83±0,99 h).

In a study conducted with 20 adults in 2018, Baker et al.[68] reported that prolonged sitting caused a decrease in cognitive skills and that the decrease in mental performance started after 90 minutes of continuous sitting. In addition, Baker et al. Found that long-term sitting increased the level of discomfort throughout the body, mostly in the lumbar region. As a result of our study, we found a significant difference in physical function, body pain, mental health and general health parameters in the comparison of Sf 36 subtests between groups. These results support the significant difference in the mental health pain and physical function parameters of SF-36 that we found in our study.

Fatigue is a sophisticated phenomenon. Acute fatigue may be seen as a normal and protective mechanism for physical and cognitive performance. On the other hand, consistent fatigue is related to disrupted cognitive performance. In addition, Dolan et al.[69] have stated that central fatigue mechanisms may inhibit lower motor neurons at the spinal level by adversely affecting cortical motor pathways and may result in decreased nerve conduction velocity in muscles as a result of intracellular acidosis. In this respect, it has been reported that muscle spindles may cause a decrease in afferent sensorimotor inputs and thus a decrease in neuromuscular control. In our study, we assessed the effects of prolonged sitting for at least 4 years of a routine, on dynamic and static balance, thus no significant difference was found. We think that the difference in our samples by means of age and occupation have caused these results. While our experiment group was comprised of office workers, Dolan et al. were built the sample of sports players.

In a study of 19 individuals, Wennberg et al.[70] Investigated the acute effect of long-term sitting on mental state and fatigue and found that cognitive performance and fatigue levels were negatively affected. This study measured the acute effect, but in our study, we selected experimental group participants according to the criteria of working at a regular desk for at least 4 years. Therefore, we think that acute negativity that affects fatigue and mental status as in the results obtained by Wennberg et al. may become chronic in a long-term cycle by adversely affecting neuroplasticity.

In a study with nine male participants, Søndergaard et al.[71] examined the effect of long-term sitting on the development of discomfort and the effect of discomfort and sitting posture on changes in COP and lumbar curvature. Changes in the sitting posture during long-term sitting were evaluated in the context of perceived discomfort by linear and non-linear analysis techniques. In line with the results obtained in this study, COP displacements were observed to be varied, while lumbar curvature increased as well as perceived discomfort.

Dempsey et al.[72] reported that one-day uninterrupted sitting increases fatigue levels and reduces sleep quality in T2D subjects compared to the control group with active breaks. Fatigue level was measured by Lee Fatigue Scale and sleep quality was measured by Consensus Sleep Diary. Exercise, alcohol and caffeine limitation was set 48 hours before the study. In the control group, who had regular active breaks during sitting, there was no difference in fatigue level and sleep quality. Dempsey et al. Suggested that measures could be taken to improve the quality of life and work productivity of sitting people. In our study, we found that long-term sitting may cause a decrease in quality of life in the long term. These results support the decrease in the quality of life we found in our study and support the ideas about taking precautions.

Investigating the relationship between sitting at a desk for a long time and taking active breaks is important in terms of increasing fat mass and decreasing muscle mass, thus being associated with many chronic diseases. As this may lead to a decrease in functional capacity and quality of life and loss of independence, especially in adults, there is an increase in studies investigating the relationship between muscle strength and functional performance in sedentary time. In addition, there is no study in the literature that directly investigates the relationship between sitting time and dynamic and static balance. In a study conducted by Reid et al.[73] 123 people, the effect of long sitting on functional performance and muscle strength was evaluated, functional performance was measured by four square step test and timed up and go test, and it was noted that sitting time significantly decreased functional performance in both tests. In addition, as a result of regression analysis, a positive relationship between total fat mass and fat mass ratio was recorded. In addition, Giannoudis et al. In a study of 162 participants (60-86 years), neither total sitting time nor watching television had a significant effect on lower extremity muscle strength and muscle mass.

6. CONCLUSION AND RECOMMENDATIONS

The aim of this study is to provide some scientific data in order to develop work efficiency and ergonomic environment for the office population. When looking into SF-36 sub-test scores; Physical function, Pain, Mental health, General health scores have been found to be affected by prolonged sitting among the office workers group. PCS values in the experiment group was 66,75±16,67 while in the control group was 76,40±14,64; and the difference was found to be significant (t=-2,383, p<0,05). No significant differences found in terms of dynamic and static balance between groups.

To our knowledge, this was one of the first studies to examine the relationship between prolonged sitting and dynamic and static balance in a population. No statistically significant associations were observed between sitting time and dynamic and static balance while the significant difference was found in sub-tests of quality of life between active-work group and desk-job group. In addition according to the correlation analysis of experiment group, static balance summary score was seen to be correlated positively with PRL, Total SF-36, PCS, and MCS while strongly correlated with ERL, however dynamic balance summaries have shown no significant correlation. Furthermore, we found a negative correlation between static balance summary score and Vitality score of SF-36 while no correlation was found to be significant between other variables.

The strength of our study is that it is one of the first studies that directly measure whether the balance is affected by long-term sitting. In addition, we think that one of the limitations of our study is that more than 2 different occupational groups were compared in both groups. In addition, with the development of technology, a number of robotic equipments have been added to the balance evaluation methods, and one of the limitations of our study is that it has manual evaluation methods. In this respect, we think that it may encourage future studies in order to use a wider sample with a narrower occupational scale and to benefit from technology among evaluation methods.

Finally, with respect to the literature and our study, to maintain mental performance and occupational productivity as well as to avoid fatigue-related musculoskeletal problems, we strongly recommend active breaks for office workers and office environments should be professionally analyzed in terms of ergonomy.

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8. APPENDICES

Annex 1. Informed Volunteer Form

Araştırmanın Adı: Ofis çalışanlarında Dinamik ve Statik Dengenin Değerlendirilmesi

LÜTFEN DİKKATLİCE OKUYUNUZ !
Bu çalışmaya katılmak üzere davet edilmiş bulunmaktasınız. Bu çalışmada yer almayı kabul etmeden önce çalışmanın ne amaçla yapılmak istendiğini anlamanız ve kararınızı bu bilgilendirme sonrası özgürce vermeniz gerekmektedir. Size özel hazırlanmış bu bilgilendirmeyi lütfen dikkatlice okuyunuz, sorularınıza açık yanıtlar isteyiniz.

Çalışmanın amacı nedir?

Ofis çalışanlarında Dinamik ve Statik Dengenin Değerlendirilmesi isimli çalışmamızda masa başı çalışan popülasyonda uzun süre oturmanın dinamik ve statik denge üzerine etkisinin araştırılması amaçlanmıştır.

Katılma koşulları nedir?

Deney grubu için;

- En az 8 yıldır ofis çalışanı olmak,
- Ayda en az 16 gün masa başı çalışmak,
- Çalışılan günlerde günde en az 6 saat masa başı çalışmak,
- 30-50 yaş aralığında olmak

Kontrol Grubu için;

- En az 8 yıldır masa başı olmayan bir işte çalışmak,
- Ayda en az 16 gün masa başı çalışmak,
- Çalışılan günlerde günde en fazla 3 saat masa başı çalışmak,
- 30-50 yaş aralığında olmak

Çalışmadan dışlanma kriterleri:

Size sözel olarak da sorulan aşağıda yazılı olan durumlardan herhangi birine sahipseniz çalışmaya katılamazsınız.

- 30 yaşından küçük, 50 yaşından büyük olmak,
- Majör travma geçirmiş olmak,
- Son 6 ayda alt ekstremite yaralanması geçirmiş olmak,
- Ciddi görsel/işitsel bozukluğa sahip olmak.

Nasıl bir uygulama yapılacaktır?

Çalışmada tedavi uygulanmayacaktır, sadece ölçümler ve değerlendirmeler yapılacaktır. Dinamik denge değerlendirmesi için yıldız denge testi, statik denge değerlendirmesi için Denge Hata Puanlama Sistemi kullanılacaktır. Ek olarak SF-36 yaşam kalitesi anketi uygulanacaktır.

Sorumluluklarım nelerdir?

Araştırma ile ilgili olarak anketleri doğru yanıtlamak ve ölçümlerde yanıltıcı davranmamak sizin sorumluluklarınızdır. Bu koşullara uymadığınız durumlarda araştırıcı sizi uygulama dışı bırakabilme yetkisine sahiptir.

Katılımcı sayısı nedir?

Araştırmada yer alacak gönüllülerin sayısı 60‘tır.

Katılımım ne kadar sürecektir?

Bu araştırmada yer almanız için öngörülen süre 15-30 dakikadır.

Çalışmaya katılma ile beklenen olası yarar nedir?

Bu araştırmada sizin için beklenen yararlar masa başı çalışmanın dinamik ve statik denge üzerinde etkisi olup olmadığı hakkında bilgi sahibi olacak olmanızdır.

Çalışmaya katılma ile beklenen olası riskler nedir?

Herhangi bir risk bulunmamaktadır.

Size bu araştırmada herhangi bir ilaç ya da tedavi uygulanmayacaktır. Bu yüzden değerlendirme ile ilgili gözlenebilecek istenmeyen etkiler olmayacaktır.

Gebelik

Bu araştırmada bir ilaç kullanımı veya herhangi bir tedavi yöntemi uygulanmayacaktır. Fakat araştırmaya gebe bireyler dâhil edilmeyecektir.

Araştırma sürecinde birlikte kullanılmasının sakıncalı olduğu bilinen ilaçlar/besinler nelerdir?

Çalışma süresince birlikte kullanımının sakıncalı olduğu ilaç ve besinler yoktur. Fakat bir rahatsızlık ile karşılaşırsanız, hemen doktorunuza başvurmanız ve bize haber vermeniz gerekmektedir.

Hangi koşullarda araştırma dışı bırakılabilirim?

Uygulanan değerlendirme programının gereklerini yerine getirmemeniz, çalışma programını aksatmanız veya çalışmanın etkinliğini artırmak vb. nedenlerle araştırmacı sizin izniniz olmadan sizi çalışmadan çıkarabilir.

Diğer tedaviler nelerdir?

Değerlendirmeye ek bir tedavi uygulanmayacaktır. Fakat değerlendirme sonrası, ağrılarınız olması durumunda bizi haberdar etmeniz gerekmektedir.

Yeni Bulgular

Araştırma sürecinde yapılan değerlendirmeye yönelik sizi ilgilendirebilecek herhangi bir gelişme olduğunda, bu durum size veya yasal temsilcinize derhal bildirilecektir.

Araştırma süresince çıkabilecek sorunlar için kimi aramalıyım?

Uygulama süresi boyunca, araştırma hakkında ek bilgiler almak için ya da çalışma ile ilgili herhangi bir sorun, istenmeyen etki ya da diğer rahatsızlıklarınız için 5466637535 no.lu telefondan Uzm. Fzt. Doruk Turhan'a başvurabilirsiniz.

Araştırmaya katılmayı kabul etmemem veya araştırmadan ayrılmam durumunda ne yapmam gerekir?

Bu araştırmada yer almak tamamen sizin isteğinize bağlıdır. Araştırmada yer almayı reddedebilirsiniz ya da herhangi bir aşamada araştırmadan ayrılabilirsiniz; reddetme veya vazgeçme durumunda araştırmadan istediğiniz zaman ayrılabilirsiniz. Araştırıcı, uygulanan değerlendirme şemasının gereklerini yerine getirmemeniz, çalışma programını aksatmanız veya değerlendirmenin etkinliğini artırmak vb. nedenlerle isteğiniz dışında ancak bilginiz dâhilinde sizi araştırmadan çıkarabilir.

Katilmama ilişkin bilgiler konusunda gizlilik sağlanabilecek midir?
Size ait tüm tıbbi ve kimlik bilgileriniz gizli tutulacaktır ve araştırma yayınlansa bile kimlik bilgileriniz verilmeyecektir, ancak araştırmanın izleyicileri, yoklama yapanlar, etik kurullar ve resmi makamlar gerektiğinde tıbbi bilgilerinize ulaşabilir. Siz de istediğinizde kendinize ait tıbbi bilgilere ulaşabilirsiniz

Çalışmaya Katılma Onayı:

Yukarıda yer alan ve araştırmaya başlanmadan önce gönüllüye verilmesi gereken bilgileri gösteren metni okudum ve sözlü olarak dinledim. Aklıma gelen tüm soruları araştırıcıya sordum, yazılı ve sözlü olarak bana yapılan tüm açıklamaları ayrıntılarıyla anlamış bulunmaktayım. Çalışmaya katılmayı isteyip istemediğime karar vermem için bana yeterli zaman tanındı. Bu koşullar altında, söz konusu araştırmaya ilişkin bana yapılan katılım davetini hiçbir zorlama ve baskı olmaksızın büyük bir gönüllülük içerisinde kabul ediyorum. Bu formu imzalamakla yerel yasaların bana sağladığı hakları kaybetmeyeceğimi biliyorum.

Bu formun imzalı ve tarihli bir kopyası bana verildi.

8.1.1. GÖNÜLLÜNÜN		8.1.2. İMZASI
8.1.2.1. ADI & SOYADI		
ADRESİ		
TEL. & FAKS		
TARİH		

8.1.3. AÇIKLAMALARI YAPAN ARAŞTIRMACININ		8.1.4. İMZASI
8.1.4.1. ADI & SOYADI		
8.1.4.2. TARİH		

Annex 2. Socio-demographic Data Form

GENEL BİLGİLER:

Yaş : ………….

Boy(cm) : ………….

Kilo(kg) : ……….....

Cinsiyet : Kadın ☐ Erkek ☐

Eğitim durumu : İlkokul ☐ Lise ☐ Lisans ☐ Lisansüstü ☐ Doktora ☐

Çalışıyor musunuz? : Evet ☐ Hayır ☐

Meslek: : …………………….

Gelir Düzeyi: : Düşük ☐ Orta ☐ Yüksek ☐

Medeni durum: : Evli ☐ Bekar ☐ Boşanmış ☐

Çocuğunuz var mı? : Evet ☐ Hayır ☐

Evet ise kaç tane? : …………………….

İLETİŞİM BİLGİLERİ

Adres :

Telefon :

e-mail :

GENEL SAĞLIK DURUMU

1. Sigara ya da herhangi bir tütün ürünü kullanıyor musunuz?

Evet ☐ (adet/gün):…..……………………...)

Hayır ☐

2. Alkol kullanıyor musunuz? Evet ise haftada kaç gün kullandığınızı ve miktarını belirtiniz.

Hayır ☐

Az miktarda, kısa süredir ☐

Orta düzeyde, 10 yıldan az ☐

Fazla miktarda, uzun süredir ☐

3. Daha önce herhangi bir cerrahi operasyon geçirdiniz mi?

Evet ☐ (Belirtiniz:…..……………………...)

Hayır ☐

4. Tanısı konmuş herhangi bir kronik rahatsızlığınız var mı?

Evet ☐ (Belirtiniz:…..……………………...)

Hayır ☐

5. Düzenli olarak kullandığınız bir ilaç var mı?

Evet ☐ (Belirtiniz:……..…..……………….)

Hayır ☐

6. Tanısı konmuş herhangi bir psikolojik rahatsızlığınız var mı?

Evet ☐ (Belirtiniz: …..…………..……….)

Hayır ☐

7. Günde kaç saatiniz oturarak geçiyor?

0-3 saat ☐ 3-6 saat☐ 6-9 saat☐ 9-12 saat ☐

8. Haftada kaç gün çalışıyorsunuz?

0-3 saat ☐ 3-6 saat☐ 6-9 saat☐ 9-12 saat☐

9. Düzenli olarak egzersiz/ spor yapıyor musunuz, evet ise ne tür bir aktivite yaptığınızı belirtiniz.

Evet ☐ (……………………………………….)

Hayır ☐

10. Evet ise, haftada kaç gün spor yapıyorsunuz?

Haftada 1 kez☐ Haftada 2-3 kez☐ Haftada 4-5 kez☐ Haftada 6-7 kez☐

Annex 3. SF-36 Quality of Life Survey

Adınız Soyadınız: _________________________________ Hasta # ___________

Aşağıdaki sorular sizin kendi sağlığınız hakkındaki görüşünüzü, kendinizi nasıl hissettiğinizi ve günlük aktivitelerinizi ne kadar yerine getirebildiğinizi öğrenmek amacındadır. Her hangi bir sorunun yanıtı hakkında emin değilseniz bile size en uygun yanıtı verin. Ayrıca 10 uncu sorudan sonraki boşluğa yorumlarınızı yazabilirsiniz.

1-Genel sağlık durumunuz hakkında aşağıdaki tanımlardan hangisi doğrudur? Lütfen tek bir yanıt veriniz.

Mükemmel ◷
Çok iyi ◷
İyi ◷
Orta (fena değil) ◷
Kötü ◷

2-Bir yıl öncesi ile karşılaştırdığınızda genel sağlık durumunuzu nasıl değerlendirirsiniz?

Bir yıl öncesinden çok daha iyi ◷
Bir yıl öncesinden biraz iyi ◷
Hemen hemen aynı ◷
Bir yıl öncesinden biraz daha kötü ◷
Bir yıl öncesinden çok daha kötü ◷

SAĞLIK VE GÜNLÜK AKTİVİTELER

3-Aşağıdaki sorular bir gün içinde yapabileceğiniz işlerle (aktivitelerle) ilgilidir.

Sağlığınız bu aktiviteleri kısıtlıyor mu? Eğer kısıtlıyorsa, ne kadar? a)Zorlu aktiviteler; örneğin koşma, ağır eşyaları kaldırma, zor sporlara katılma vb	Evet, çok kısıtlı	Evet, biraz kısıtlı	Hayır, hiç kısıtlı değil
b)Orta derecede aktiviteler; örneğin bir masayı kaldırma, elektrikli süpürgeyi itme, hafif sporlara katılma vb	◷	◷	◷
c)Ağır kaldırma ve yük taşıma	◷	◷	◷
d)Çok sayıda merdiven basamağını	◷	◷	◷

çıkma			
e)Tek bir merdiven basamağını çıkma	◷	◷	◷
f)Öne eğime, çömelme veya diz çökme	◷	◷	◷
g)İki kilometreden çok yürüme	◷	◷	◷
h)Bir kilometre yürüme	◷	◷	◷
i)100 metre yürüme	◷	◷	◷
j)Kendi başına banyo yapma ve giyinme	◷	◷	◷

Annex 4. BESS and SEBT Evaluation Tables

Statik Denge

		Sert Zemin	Köpük Zemin
Denge Hata Puanlama Sistemi (DHPS)	Çift Ayak Duruş		
	Tek Ayak Duruş		
	Tandem Duruş		

Dinamik Denge

			Dominant Ayak Duruş	Non-dominant Ayak Duruş
Yıldız Denge Testi (YDT)	Anterolateral	(AL)		
	Anterior	(A)		
	Anteromedial	(AM)		
	Medial	(M)		
	Posteromedial	(PM)		
	Posterior	(P)		
	Posterolateral	(PL)		
	Lateral	(L)		

Annex 5: Ethical Approval

T.C.
İSTANBUL AREL ÜNİVERSİTESİ REKTÖRLÜĞÜ

Sayı : 69396709-050.01.01
Konu : Etik Kurul Kararları

Sayın Öğr. Gör. Reşat COŞKUN

versitemiz Etik Kurulu'nun 07/05/2018 tarih ve 2018/05 sayılı toplantısında alınan karar aşağıda sunulmuştur.

Bilgilerinizi saygılarımla rica ederim.

e-imzalıdır
Prof. Dr. İhsan DERMAN
Rektör

07/05/2018 tarih ve 2018/05 Sayılı Etik Kurulu kararı:

KARAR NO-2: Üniversitemiz Sağlık Bilimleri Yüksekokulu Fizyoterapi ve Rehabilitasyon Bölümü öğretim elamanlarından **Öğr. Gör. Reşat COŞKUN**'un "Ofis Çalışanlarında Dinamik ve Statik Dengenin Değerlendirilmesi" isimli çalışması görüşüldü. Yapılan görüşmeler sonucunda; **Öğr. Gör. Reşat COŞKUN**'un çalışmasıyla ilgili Meslek Yüksekokulu Vekil Müdürü Prof. Dr. Enver DURAN'ın da görüşü doğrultusunda söz konusu projenin uygun olduğuna oybirliği ile karar verildi.

Türkoba Mahallesi Erguvan Sokak No:26 / K 34537 Tepekent - Büyükçekmece/İSTANBUL (www.arel.edu.tr)
Aynur EKEN (Yazı İşleri Memuru) aynureken@arel.edu.tr
Tel: +90 850 8502735 Fax: +90 212 860 04 81

Annex. 6: Özgeçmiş

ÖZGEÇMİŞ

Adı ve Soyadı: Doruk Turhan

Doğum Tarihi: 14.03.1990

Doğum Yeri: Mersin

Cep Telefonu: +905466637535

E-postası: dorukturhan@gmail.com

Bildiği Yabancı Diller (Puan ve Yılı): İngilizce (94, 2018)

Uzmanlık Alanı: Ortopedik Rehabilitasyon, Kayropraktik

Derece	Bölüm/Program	Üniversite	Yıl
Lisans	Fizyoterapi ve Rehabilitasyon	Yeditepe Üniversitesi	2014
Y. Lisans	Kayropraktik	Bahçeşehir Üniversitesi	2018
Y. Lisans	Fizyoterapi ve Rehabilitasyon	Yeditepe Üniversitesi	-
Doktora	Fizyoterapi ve Rehabilitasyon	Bahçeşehir Üniversitesi	-

Görevler:

Görev Unvanı	GÖREV YERİ	Yıl
Fzt.	Sevgi Denizi Rehabilitasyon Merkezi	2014-2016
Öğr. Gör.	Kemerburgaz Üniversitesi	2016-2018
Uzm. Fzt.	Spine Clinic Center	2018-2019

Özgeçmiş Sahibinin Adı Soyadı: Doruk Turhan

Tarih: 14.03.2019

İmza: