PILATES EXERCISE POSITIVELY AFFECTS BALANCE, REACTION TIME, MUSCLE STRENGTH, NUMBER OF FALLS AND PSYCHOLOGICAL PARAMETERS IN 65+ YEARS OLD WOMEN

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

GÖNÜL BABAYİGİT İREZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF PHYSICAL EDUCATION AND SPORTS

NOVEMBER 2009

Approval of the Graduate School of Social Sciences

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ABSTRACT

PILATES EXERCISE POSITIVELY AFFECTS BALANCE, REACTION TIME, MUSCLE STRENGTH, NUMBER OF FALLS AND PSYCHOLOGICAL PARAMETERS IN 65+ YEARS OLD WOMEN

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November 2009, 158 pages

Physical changes such as impairment flexibility, balance, muscle strength and reaction time occur with aging. Regular lifetime physical activity appears to delay these factors. The purpose of this study was to determine if 12 weeks Pilates exercise could improve dynamic balance, reaction time, flexibility, muscle strength, bone density and quality of life in 65+ years old women and to investigate the changes of these parameters in a year follow up. Thirty out of a hundred women living in a Residential House in Ankara were enrolled in the study. Participants attended a 12-week series of one-hour Pilates exercise meeting three times per week. Dynamic balance, flexibility, reaction time, number of falls, muscle strength, bone mineral density, quality of life and anxiety were measured before and after exercise. Results showed that flexibility, balance, simple and choice reaction time, muscle strength, number of falls, quality of life and beck anxiety scores significantly improved in the exercise group. In addition, after a year of follow up, there were prominent decreases in simple reaction time and muscle strength, choice reaction time, number of falls and bone mineral density in control group while there were no evident changes in exercise group. Furthermore, there were significant relationships of balance with muscle strength, choice reaction time and anxiety.

As the result of this study, it can be concluded that Pilates exercise can be efficient for preventing falls, increasing muscle strength and dynamic balance, flexibility, reaction time and decreasing anxiety while increasing quality of life. In the long term, Pilates exercise may have very positive effects on bone mineral density.

Key words: Pilates, Balance, Falls, Reaction Time, Muscle Strength

ÖZ

PİLATES EGZERSİZİ, 65 YAŞ ÜSTÜ YAŞLI KADINLARDA, DENGE, REAKSİYON ZAMANI, KAS KUVVETİ, DÜŞME SAYISI VE PSİKOLOJİK PARAMETRELERİ OLUMLU OLARAK ETKİLER

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Kasım 2009, 158 sayfa

Yaşlılıkla birlikte esneklik, denge, kas kuvveti ve reaksiyon zamanında olumsuz yönde bir takım değişiklikler oluşur. Yapılan düzenli fiziksel aktiviteler ile birlikte, bu fiziksel değişikliklerde yavaşlamalar görülür. Bu çalışmanın amacı 65 yaş üstü yaşlı kadınlarda, Pilates egzersizinin dinamik denge, esneklik, kas kuvveti, reaksiyon zamanı, kemik mineral yogunluğu, düşme sayısı, yaşam kalitesi ve anksiyete üzerine etkilerini belirlemek ve bu parametrelerde 1 yıl sonra oluşan değişiklikleri araştırmaktır. Çalışmada, Ankara'daki bir huzurevinde ikamet eden yüz katılımcıdan 30 kişi rastgele olarak egzersiz grubuna alındı. Katılımcılar 12 hafta boyunca haftada 3 gun 1 saatlik Pilates egzersiz programına katıldılar. Dinamik denge, esneklik (otur-eriş), reaksiyon zamanı, düşme sayısı, kas kuvveti, kemik mineral yoğunluğu, yaşam kalitesi ve anksiyete parametreleri, Pilates egzersizi öncesi ve sonrası ölçüldü. Yapılan ölçümler sonunda Egzersiz grubunda dinamik denge, esneklik (otur-eriş), reaksiyon zamanı, düşme sayısı, kas kuvveti, yasam kalitesi ve anksiyete değerlerinde istatistiksel olarak anlamlı değişiklikler bulundu. Bir yıl sonra tekrarlanan ölçüm sonuçlarına göre ise; kontrol grubunda reaksiyon zamanı, kas kuvveti, düşme sayısı ve kemik mineral yoğunluğu değerlerinde negatif yönde dikkat çeken değişiklikler görülürken egzersiz grubunda bu değişikliklerin daha az olduğu görüldü. Bununla birlikte, denge ile kas kuvveti, seçmeli reaksiyon zamanı ve anksiyete arasında bir ilişki bulundu. Bu çalışmanın sonuçlarına göre, Pilates egzersizinin yaşlı kadınlarda, düsme sayısını azalttıgını, kas kuvvetini arttırdığını, dinamik denge ve esnekliği artttırdığını ve bununla birlikte anksiyete düzeyini düşürürken, yaşam kalitesini artırdığı sonucuna varılabilir. Uzun vadede, Pilates egzersizinin kemik mineral yoğunluğu üzerine pozitif bir etkisi olabileceği söylenebilir.

Anahtar Kelimeler: Pilates, Denge, Düsme, Reaksiyon Zamanı, Kas Kuvveti

To My Beloved Husband,

My Parents and Uncles

ACKNOWLEDGEMENTS

This thesis study was accomplished with the contribution and support of very valuable people. Thus, I would like to express my greatest appreciation of these people for their enduring support and assistance.

My gratitude and admiration are for my advisor, Prof.Dr. Feza Korkusuz, for the help and care I have received from him throughout my graduate work. His patience, perseverance and knowledge have been always inspiring.

My appreciation is sincere for the wonderful help and support by Prof.Dr.Erdal Zorba, Asist.Prof.Dr. Sadettin Kirazcı, Asist.Prof.Dr. M.Levent Ince, and Asist.Prof.Dr.Yeşim Çapa Aydın. They provided me with their expertise in scholarly writing and guidance to my understanding of research and statistical analyses.

I would like to special thank to Recep Ali Özdemir and Rüya Evin for the help in collecting data and for the help they rendered to me whenever I needed.

My sincere thank goes also to my husband and to my friends - Kubilay, Deniz, Gülfem, Rana, and Özgür - and colleagues, who helped me throughout the study. They were there whenever I needed help, thank you for all. I am also grateful to the wonderful people who participated in this study.

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SRT	Simple Reaction Time
CRT	Choice Reaction Time
QoL	Quality of Life
BMI	Body Mass Index
MPLS	Muscle Proximal Leg Strength
MMT	Muscle Manual Tester
BMD	Bone Mineral Density
RVSI	Rank Value Stability Index

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

During the past century, the number and proportion of older adults among the world population apparently increased due to socio-economic developments and better medical services. Although the majority of the population is known as young in Turkey, with the general increase in life expectancy, elderly population is growing rapidly as in the other European countries. In particular, the percentage of individuals over the age of 60 increased from 5.9 % to 8.2 % from 1950 to 2000 in Turkey, respectively. It was also predicted that population of the older adults are going to become larger than the population of younger within the next 30 years (Government Statistics, 2000).

Although this may be considered as a positive development, there are a number of serious health problems in elderly. Falls that lead osteoporotic fractures is one of them. For this reason preventive measures for falls are of critical importance (Huang, Gau, Lin, Kernohan; Kobayashi et. al., 2006). Balance, poor gait, lower limb muscle weakness, slowed reaction time have been identified as independent risk factors for falls in elderly (Lord & Sturnieks, 2005; Tinetti et al.,1994). Falls can occur with loss of balance (Lord, Clark, Webster, 1991). Older adults fall more frequently than their younger counterparts and they usually occur in normal daily living such as walking or climbing stars (Tinetti et al., 1994). Falls may occur due to deficits in balance (Tinetti et al., 1994), muscle strength, reaction time and flexibility. Exercise programs targeted to improve these deficits might result in decrease of falls and related injuries (Provience et al. 1995).

With aging, physical changes such as impairment in flexibility, balance impairment and slowing reaction time may occur (Selby, 2002). Regular lifetime physical activity appears to delay these factors (Heath, 1994). Regular exercise is one way of preventing falls and fall related fractures (Carter, Kannus, Khan, 2001). Exercise has been suggested to increase bone density (BMD) (Snow, Shaw, Winters, Witzke, 2000).

Pilates, originally developed by Joseph Pilates after the World War I, is described by practitioners as a unique method of physical fitness that uses a combination of muscle strengthening, lengthening and breathing to develop trunk muscles and restore muscle balance (K. Smith & E. Smith 2005; Bernardo, 2007; Cozen, 2000; Kloube, 2005; Smith &Smith, 2004; Latey, 2001).

Although recent studies (Caldwell, Harrison, Adams, Triplett, 2009; Johnson, Larsen, Ozawa, Wilson, Kennedy et al., 2007), reported that Pilates exercises are suitable for each age, all body types and for all fitness abilities due to the modifiable nature of movements (Kaesler, Mellifont, Kelly, Taaffe, 2007; Kloube, 2005; Segal, Hein, Basford, 2005; Sekendiz, Altun, Korkusuz, Akın, 2007), experimental attempts including control conditions are still limited and do not enable researchers to draw clear conclusions regarding the effectiveness of Pilates exercises on improving physical functioning in elderly.

Smith & Smith (2005) reviewed integrating selected Pilates based core-strengthening exercises and principles into rehabilitation treatment plans and community- and home-based programs for older adults. Older adults may benefit from Pilates in many ways: core strengthening, improvements in posture, postural stability, joint mobility, balance and coordination. Moreover, Pilates exercises can easily be integrated into traditional resistance and balance training programs.In a study that was conducted by Souza and Vieira (2006) reported that Pilates has been performing by the majority of middle-aged women and these women had musculoskeletal spine pain problems.

A research by Rogers and Gibson (2009) studied responses of adult novice practitioners (n=9) to an 8-week traditional mat Pilates program that met an hour in a day three times a week. They measured sit and reach, shoulder reach, curl-up and low back extension as well as circumferences at the waist, chest and arms. They found that Pilates classes had positive effects in selected components of fitness parameters for physically active adults who had no previous experience of a Pilates class. Moreover, Smith and Smith (2005) hypothesized that Pilates can improve physical features such as flexibility, proprioception, balance and coordination. Johnson, Larsen, Ozawa, Wilson, Kennedy et al., (2007) studied the effects of Pilates based training on balance in healthy adults and found positive effects. Hall et al. (1999) determined that Pilates-based exercise improved static balance in an elderly population. It also increases flexibility (Bernardo, 2007; Cozen, 2000; Kloube, 2005; Smith &Smith, 2005).

Exercise has proven physical, psychological and social benefits. Mostly weight-bearing exercises, balance training and Tai Chi exercises are advised to reduce falls and fractures in elderly (American Geriatric Society, 2001). A study that proved Pilates exercise reduces falls, improves reaction time, increase bone density, improves quality of life and decrease anxiety in elderly women was not carried out.

In summary, there is a clear need for well-controlled Pilates research to provide benefits of exercise in an elderly population.

1.2 Significance of the Study

Exercise helps improving fitness and psychological parameters to easily perform essential activities of daily living in elderly (Tinetti, 1994). For example, decrease in flexibility of major joints may be inadequate to allow self-dressing or having a bath.

A “Pub Med” search covering the years 1990 to 2009 revealed more than 30 studies on Pilates and in “Science Direct” search 244 articles were found. Most of them were related to the therapeutic effects of Pilates and on preventing and treating pain. Just a few studies were related with Pilates in aging and its effects.

Review of the literature is remarkable for the lack of research regarding to Pilates training in elderly. There are a few studies in the literature that used both Pilates ball and exercise band. In this study we performed modified Pilates exercises which included mat, elastic exercise band and Pilates ball.

Moreover, although it has known that Pilates exercise has many benefits on older adults' physical fitness and psychological parameters (Bernardo, 2007; Fischbach, 2006), there are little studies to support these points. In this study, we also focused to identify these statements. This study can lead shed on Pilates exercise can be effective or not for the elderly to improve health related benefits.

The results of this study may be used to promote increased participation by elderly individuals in exercise training, especially Pilates by providing evidence of a variety of physiological and psychological benefits that ultimately enhance overall independence and health later in life and the economic impact of an active lifestyle is likely to be beneficial not only to senior citizens but also to the entire health care system.

1.3 Purpose of the Study

The purposes of this study were to determine if Pilates exercise can improve dynamic balance, reaction time, flexibility, muscle strength, bone density, anxiety and quality of life and decrease number of falls in elderly women and secondly to investigate the changes in dynamic balance, reaction time, flexibility, muscle strength, bone mineral density, anxiety and quality of life in one year follow up. Thirdly, to determine any relationship between dynamic balance, flexibility, muscle strength, bone density, number of falls, anxiety and quality of life in elderly women ages over 65.

1.4 Research Questions

1. Does 12 week Pilates exercise improve (a) dynamic balance, (b) trunk flexibility, (c) muscle strength (d) simple and choice reaction time (e) bone mineral density (femur, spine) (f) quality of life and (g) anxiety in elderly women?
2. Are there any differences in dynamic balance, trunk flexibility, muscle strength, reaction time, anxiety and quality of life after a year of follow up?
3. Are there any relations between dynamic balance and muscle strength, flexibility, reaction time, bone mineral density, anxiety, number of falls and quality of life in 65+ years old women?

1.5 Research Hypotheses

This study will be guided by several research hypothesis. These are;

1. There will be significant differences in muscle strength, reaction time, flexibility, dynamic balance, number of falls, anxiety and quality of life in the exercise group versus to the control group.
2. Bone mineral density will improve in the exercise group versus the contol group.
3. There will be significant differences in muscle strength, reaction time, flexibility, dynamic balance, number of falls, anxiety and quality of life after 1 year follow up.
4. There will be relationships between dynamic balance and muscle strength, flexibility, number of falls.
5. There will be no relationship between dynamic balance and bone density, reaction time, quality of life and anxiety.

1.6 Delimitations

1. Participants consisted of over 65 years old female volunteers.
2. All participants received the same pilates exercise in experimental group.
3. Participants who had health problem and neurological problems were excluded from the study.
4. All measurements were performed using the same set-up throughout the course of testing for both groups.

1.7 Limitations

1. The study recruited volunteers aged 65 and over from residential house in Ankara.
2. The participants (exercise and control groups) were pretty good health and physical condition.
3. Visual impairment and auditory measurements were not measured.
4. The exercise intervention was through 12 week and met three times per week.

5. The study addressed only the essentials series of the Stott Pilates method.
6. Daily activities of participants were not controlled.
7. Physical activities during 1 year follow up were not controlled.

1.8 Definiton of Terms

The following terms were operationally defined during this study.

Balance : Process by which we control the body`s center of mass (COM) with respect to the base of support, whether it is stationary or moving.

Flexiblity : Range of motion around a joint or multiple joints.

Muscle Strength: Amount of force that a muscle or group of muscles can produce with a single maximum contraction; measured in newtons or newton-meters.

Reaction time :Time interval from the onset of a stimulus to the initation of a volitional response. Onset of a signal may be visual, auditory or tactiles.

Simple Reaction Time: Time interval from the onset of a simple stimulus to make a simple response.

Choice Reaction Time: Time interval between stimulus and response when a specific response is paired with a specific stimulus and the reactor has to observe the stimulus and then choose the correct response that is paired with it.

BMD (Bone Mineral Density): The mineral content in a given volume of bone, used as a measure of bony health and in the diagnosis of osteoporosis.

T score: the number of standard deviations above or below the mean for a healthy 30 year old adult of the same sex and ethnicity as the patient.

DXA (Dual energy X-ray absorptiometry): Imaging technique for obtaining bone mineral density. Two X-ray beams with differing energy levels are aimed at the patient's bones. When soft tissue absorption is subtracted out, the BMD can be determined from the absorption of each beam by bone.

Osteoporosis: Loss of bone mineral density and inedequate formation of bone.

Isometric contraction: Muscle activation in which no observable change occurs in muscle length.

Eccentric Muscle Contraction: The type of muscle contraction in which the muscles lengthens while generating force.

Concentric Muscle Contraction: The type of muscle contraction occurs when a muscle shortens in length and develops tension.

Life expectancy: Average number of years of life remaining to a person at a particular age. Usually it is expressed from birth as the average number of years of life that newborns might expect to live.

Physical Activity: Bodily movement that is produced by contraction of skeletal muscle and substantially increases energy expenditure.

Health-related quality of life: The quality of life one`s personal and mental health and the ability to react to factors in the physical and social environments.

Anxiety: A feeling of apprehension, fear, nervousness, or dread accompanied by restlessness or tension.

State anxiety: An unpleasant emotional arousal in response to perceived danger demands.

Trait anxiety: Reflects an individual`s tendency to anticipate threatening situations and to respond with state anxiety.

Linkage: Proximity of two or more markers on a chromosome; the closer the markers, the lower the probability that they will be separated during DNA recombination .

Dynamometer: Instrument that quantifies forces; generally a hand dynometer.

Biological aging: Process or group of processes that causes the eventual breakdown of mammalian homeostosis with the passage of time.

Body mass index (BMI): A number calculated from a person's weight and height that provides for most people a reliable indicator of body size.

CHAPTER 2

REVIEW OF LITERATURE

This chapter gives detailed information about the subject related studies which will provide background information that is needed to understand (1) aging, physical activity and exercise, (2) Pilates (3) dynamic balance, (4) muscle strength, (5) flexibility, (6) reaction time, (7) number of falls, (8) bone mineral density, (9) quality of life and (10) anxiety.

2.1 Aging, Physical Activity and Exercise

2.1.1 Aging and Aging Theories

Advancements in medical technology and modern life, the population aged over 65 years have been rapidly increasing. The increase in number of elderly people is demanding from health system, families, and governments all over the world.

The physical changes that occur with aging can differentiate greatly with genetic and environmental factors (Hughes, 2002).With aging appearance of the body can vary from person to person. Many researchers refer to these differences by using the term biological aging. "It refers to the physical, chemical and biological changes that occur in vital organ systems, tissues and physical appearance over time the decline in bodily systems and the resulting increased vulnerability is referred to as senescence" (Foos & Clark, 2003, p.33).

Aging can be defined as "the passage of time from birth in year" (Jones & Rose, 2005). It is associated with decreases in muscle strength, balance, reaction time, muscle mass, and daily physical activity, and an increased fat mass. Furthermore, with aging many changes occur in human body; cardiac reserve and ventilator capacity decrease, skin loses its elasticity, bone mineral density and muscle mass decrease, and body fat increases. These changes may contribute to some problems in elderly people (Brennan, 2002).

In Turkey, average life expectancy has increased dramatically during the recent century, and it is expected that it will continue to increase. Life expectancy in 2003 was 68.6 for males and 73.4 for females. In 2007, this was increased to 69.3 years and 74.2 years for males and females, respectively, and in 2050 life expectancy will be expected to be increased to 74.3 years and 80.4 years for males and females, respectively (NISBO, 2003). With this increased life expectancy, the elderly population is proportionally increasing in the total population of Turkey (table 2.1).

Table 2.1

Life expectancy in Turkey from Birth to End (Retrieved from www.spfboun.edu.tr (docs/1-Ferhundeozbay.ppt

	Life expectancy		
Years	Total (yrs)	Men (yrs)	Women (yrs)
2003	70.9	68.6	73.4
2007	71.7	69.3	74.2
2010	72.0	69.6	74.5
2020	73.5	71.0	76.5
2030	75.5	72.8	78.4
2040	76.4	73.7	79.2
2050	77.3	74.3	80.4

The maximum life expectancy for human beings ranges from 110 to 120 years but some underlying mechanisms change our physiology and life may end earlier than expected. Some theories of aging try to explain the underlying causes. Among these theories, there are genetic, damage and gradual imbalance theories.

Genetic theories; Genetic theories interested in and focused on the role of heredity in aging while determining the rate of aging within the body. Genetic theories put forward that the aging process is controlled by a biological clock. However, Hayflick`s recent theory significantly challenged this assertion because it is now known that not all cells age at the same rate. Therefore, this theory supports that longevity is related to the upper limit on cell division, which is called the Hayflick number. The limit on cell division looks like a biological clock. The most extreme genetics suggest that all process of aging is programmed by our genes (Foos & Clark, 2003; Jones & Rose, 2005; Spirduso, Francis & MacRae, 2005). Harmful genes become effective only later in life and alter the physiology of the organism, which result in its death. Genes can alter and lose their functions. These changes can be related with aging (Spence, 1995).

Damage theories; These theories are grounded on the belief that chemical reactions occur naturally in the body and start to produce some bad, defective molecules. According to these theories, the cells are damaged by an accumulation of DNA errors, waste products, glucose or free radicals. This theory is also known as cross-linkage theory. Many cross-linking agents are molecules called free radicals. These are atoms that have at least unpaired electron, making them highly reactive. Free radicals give reason for harmful oxidation that damages cell membranes and cell components of DNA and RNA synthesis and enzymes needed for cell metabolism. Finally, too much cellular damage can result in cellular damage (Jones, 2005; Spirduso, 2005).

Gradual imbalance theories; this theory suggests the gradual accumulation of some stator substances. According to these theories, body systems age at different rates, and these result in imbalances in biological functions, while focusing the central nervous system and endocrine system. These systems release hormones to help body adapt to environmental challenges, such as increases or decreases in temperature and increases in physical work or psychological threats. Gradual imbalance theories also include immunological theories. This is related to autoimmunity that protects body from the foreign substances such as viruses. With time body loses capacity to distinguish foreign antigens from normal body materials. As a result, immune system not only becomes less protective but also destroys itself (Jones, 2005; Spirduso, 2005; Spence, 1995).

2.1.2 Physical Activity and Exercise

The awareness about the importance of performing physical activity for older adults has been increasing in our country. The phrase physical activity is a broad term that includes the full range of human movement, ranging from competitive sport and exercise to hobbies, walking, cycling or activities of daily living. Staying physically active and exercising regularly can help prevent or delay some diseases and disabilities as people grow older. Four types of exercises help older adults gain health benefits: Endurance exercises improve the health of heart, lungs, and circulatory system; strength exercises build muscles and strengthen bones; balance exercises help prevent falls and falls-related injuries; and flexibility exercises help keep body limber by stretching muscles and the tissues (NIH, 2004). People who are physically active have a 50% reduced risk of developing coronary heart disease compared with those who have a more sedentary lifestyle (HDA, 2003).

> Bouchard, Blair, and Haskell (2007) explained that "physical activity refers to any bodily movement produced by the skeletal muscles that results in a substantial increase over resting energy expenditure. Energy expenditure of activity is typically only about 25% of daily energy expenditure in a sedentary person. Exercise can be defined a form of leisure physical activity that is usually performed repeatedly over an extended period of time with a specific external objective such as the improvement of fitness, physical performance" (p.12).

Physical fitness has two focused goals that can be performance or health related. Performance related fitness aims to develop motor skills, muscular strength, speed, power, motivation, endurance and nutritional status of the individual`s ability in athletic competition although health related fitness is related with habitual physical activity habits and health status. These are characterized by an ability to perform daily activities (Bouchard, 2007). Physical activity is associated with health benefits and increases health related fitness. In two robust studies, it was found that older adults are less active than younger adults and older women are less active than older men (Shephard, 2002).

Physical activity is important in maintaining function and protecting against falls as an improved strength, coordination and balance can enable an older person to prevent a slip or trip from becoming a fall. Poor bone mineral density can be a consequence of lack of weight-bearing exercise. If someone with osteoporosis falls, they are more likely to fracture thereby increasing the impact of the fall on the individual. Psychological consequences of falls may include depression, social isolation and loss of confidence. Physical activity helps people feel better through improvement in mood, reduced anxiety and enhanced self-perceptions (Bouchard, 2007; Spirduso, 2005). Iverson et al. (1990) reported that both balance and strength were positively correlated with self-reported physical activity. Binder et al. (1994) reported that frail elderly people showed improved balance after attending group exercises three times a week for only eight weeks.

There are considerable evidence to support the importance of doing physical activity regularly, regardless of type, its positive effects on balance and mobility, and negative relationship with the risk for falls. For example, resistance training seems to lead greater improvements in gait parameters, while the use of balance-specific exercises, including Tai Chi and other soft forms of martial arts, may have more influence on balance measures such as postural sway and static balance (Sattin et al., 1990).

Physiological, psychological and environmental factors determine physical activity behavior throughout the lifespan and these are become more dominant in older age. Physiological factors include aerobic capacity, speed, strength, balance, and flexibility. These factors tend to decline with aging. Moreover, they become strong determinants of activity level and selection of activity (Bouchard, 2007). In a study, Rhodes et al. (1999) defines factors that can influence physical activity among elderly people. They summarized that exercise history and education are important factors among all age groups.

Exercise has a major role to play in modifying key falls risk factors and preventing falls among older adults. There are, however, many different types of exercise, some of which are likely to result in greater reductions in falls risk than others. There is some evidence from different studies for the positive effects of various forms of exercise on key falls risk factors and functional abilities among older people (Lord, Sherrington, Menz, 2000).

Studies have shown that muscles strength decreases with increased age (Wheeler, 2002) and that reduced muscle strength is one of the major risk factors for falling. Exercise interventions aimed at improving muscle strength have been identified as a key strategy for reducing frailty and maintaining function in old age (Lord, 2000).

Regular physical exercise has been characterized as a positive health behavior with its physiological benefits. It may also bring about psychological benefits. Hassmen et al (2000) studied a study to explore the association between physical exercise frequency and a number of measures of psychological well-being in a large population-based sample. The results of this cross-sectional study suggest that individuals who exercised at least two to three times a week experienced significantly less depression, anger, cynical distrust, and stress than those exercising less frequently or not at all. Regular exercisers perceived their health and fitness to be better than less frequent exercisers did. Those who exercised at least twice a week reported higher levels of sense of coherence and a stronger feeling of social integration than their less frequently exercising counterparts.

2.2 Pilates

Pilates is an exercise system based on yoga principles with Germanic overtones embedded within it, which primarily focuses on increasing endurance and flexibility of the abdomen, low back and hips. This exercise designed by the late Joseph Pilates in the 1920s as method of rehabilitation for diseases from chronic diseases to asthma. Moreover, he designed an exercise program with the objective of increasing muscle strength, endurance, and flexibility while maintaining spine stabilization (Kloubec, 2005; Quinn, 2005; Shedden, 2006). Pilates is a contemporary, anatomically-based approach to Joseph Pilates' original exercise method which caters to people of all ages, all body types, and all fitness abilities (Byrne, 2008). It has approximately 500 exercises that are performed on mats or specialized apparatus.

The Pilates is very effective exercise that combines both eastern and the western concepts by including yoga (a mind body method), breath, flexibility, relaxation, strength and endurance. It is well designed for enhance both physical and mental well-being. Pilates training also strengthens the deep, core muscles and improve movement, efficiency and muscle control. Pilates is excellent for fitness, conditioning, and improving overall quality of life (Frediani, 2005).

Breath is one of the key elements of Pilates training and is highly synchronized and patterned. The breath originates from the upper thorax with the participants expanding the rib cage in the inhalation while leaving the lower abdominal region still. All Pilates exercises flow from the "five essentials" breathing, cervical, rib and scapular, pelvic mobility and utilizing the transversus abdominis (Kloubec, 2005). Furthermore, Joseph Pilates based his method of exercise on six principles: concentration, control, centering, flowing movements, precision and breathing (Kish, 1998; Metel, 2007). Pilates exercise can perform using mat and some instruments (Reformer, Cadillac, Stability Chair, Swiss ball or exercise ball, overball, bands and tubings) which are developed by Pilates. Mat based exercise is most popular one. Reformer, on the other hand, is a kind of bed which equipped with four exchangeable springs (each 11.34 kg) that enable person to make 50 resistance exercises while controlling reinforcement of the muscular system at a minimum risk of trauma on muscular system. Cadillac is a different bed that has tall arm-rests placed over the mat of this bed and additional springs for resistance exercises are added on it. This device is mostly used for rehabilitation. Size of Swiss ball or exercise ball should be selected for the height of participants, and the angle between the thigh and the calf should be approximately 90 degrees in sitting position. Bands and Tubings are elastic structures that permit user to perform resistance exercises. These instruments can use instead of springs on the reformer or Cadillac (Metel, 2007).

Pilates exercise system can strengthen and lengthen the spine in its natural curves using a series of callisthenic-type movements. This is a strong physical body movement that enhances mental health and productivity (Quinn, 2005). The equipments developed by Joseph Pilates allow for low-impact resistance training. The movement sequences on various Pilates exercise apparatus allow the practitioner to modify the load for facilitating efficient movement accurately.

It can be summarized that Pilates training may result in improved flexibility (Segal et al (2004), balance (Johnson et al (2006; Hall et al., 1999), and muscular strength (Petrofsky et al., 2005), decreased BMI (Jago, et al, 2006) and decrease in back pain. Graves et al. (2005) studied the influence of Pilates-based mat exercise on chronic lower back pain. Participants in their study were a group aged between 46 and 52 years who took Pilates mat exercise twice a week for 12 weeks, and a control group aged 34 to 43 who did not practice the method. All had experienced lower back pain previously. The results indicated that those practicing Pilates gained muscle strength in the lower back muscles, and improved their flexibility and range of motion. There was also a significant change in body composition of those who practiced Pilates.

Petrofsky et al. (2005) designed an observational study to compare Pilates exercises with and without a resistance band, and to compare these exercises against those performed with commercial exercise equipment. Six healthy subjects, four males and two females, (mean age=25.3 years) were volunteered to participate to their study. Muscle activity was measured during the exercises with electromyogram (EMG), and this technique was validated in other studies. They used resistance band during the Pilate exercises. Subjects first completed Pilates exercises without the resistance band, and then completed Pilates exercises with the resistance band again. Once EMG was assessed with the Pilates exercises, the subjects completed commercial equipment exercises on the quads, inner outer thigh, and hamstring machines. The weight applied on each exercise machine was compared with the results of EMG activity during the Pilates exercises completed with and without the resistance band. They found that Pilates exercises with the resistance band increased the muscle activity by at least 50%, and concluded that Pilates may be beneficial in those seeking a resistance workout that places less stress on the joints and muscles.

In another study, Segal et al. (2004) aimed to assess the effects of Pilates training on flexibility, body composition, and health status of healthy adults. Thirty one women (average age=41 years) and one man (age 42 years)) were assigned into classes of 8–12 students. All subjects participated in one-hour Pilates mat class weekly for 6 months. Exercises progressed in difficulty. Measurements were taken at baseline, 2, 4 and 6 months on flexibility (fingertip-to-floor), body composition (height, body mass index (BMI), body mass, segmental fat, and lean body mass), perception of health and function (American Academy of Orthopedic Surgeons (AAOS) outcomes questionnaire), and event log (self-report of problems with the Pilates class). They concluded that Pilates exercise may improve truncal flexibility in healthy adults.

2.3 Dynamic Balance in Elderly

Balance is defined as the ability to control the body`s center of mass (COM) relative to the base of support, whether that base is stationary or moving. There are four measure of balance: (a) static balance, (b) dynamic balance, (c) reactive postural control, and (d) sensory integration and organization. Static Balance (standing upright in space) can be measured with eyes open and eyes closed. For measuring static balance, best way is to use stabilometer or static force plate. Dynamic balance, on the other hand, is maintaining balance while moving through space and it requires in daily living activities like walking, making beds, mopping floors. Reactive postural control is the ability to respond automatically to a loss of balance and actions taken in preparation for a potential destabilizing event (i.e., preparing for the Forward motion of a bus)(Yim-Chiplis & Talbot, 2000). Finally, sensory integration and organization is an additional test of balance that can be conducted using computerized dynamic posturography (CDP) equipment. This device can test a response to an external disturbance in stability and it obtains data about person`s ability to organize sensory information provided by visual, somatasensory and vestibular systems (Jones & Rose, 2005, p.106-108).

The gradual decline in balance of older adults is well documented in the literature (Spirduso et al., 2005; Sihvonen, Sipila & Era, 2004). Brain, muscles, and bones work together to maintain balance and to prevent people from falling while walking, rising from a chair, or climbing stairs. Maintaining one’s balance depends on the integrity of the central nervous system (CNS), which receives information from sensory, the visual, vestibular, proprioceptive and musculoskeletal systems (Ankur, 2007). The central nervous system maintains balance by continuously monitoring input from sensory systems and regulating corresponding automatic and voluntary adjustments in motor output (Yim-Chiplis, 2000). Vision is an important source of sensory information that contributes to the control of balance while the vestibular system involves inner ear structures that contribute to posture and peripheral sensation to get information from the lower limbs that are important to stability (Lord & Sturnieks, 2005).

There are two types of balance: static balance and dynamic balance. Static balance is the ability to maintain balance without moving, while dynamic balance is the ability move without losing balance or falling. Static balance can be improved by challenging the ability to maintain standing balance while decreasing the base of support. Dynamic balance can be improved by decreasing the base of support while walking. For example, a way to challenge dynamic balance is to progress from the normal walking pattern to walking on a straight line and then walking heel-to-toe (Carter, 2001). Dynamic balance is the ability to anticipate changes and coordinate muscle activity in response to perturbations of stability. Dynamic balance is also used during forward, sideways, and backward leaning. Static balance is maintained in the elderly until significant functional declines occur whereas losses in dynamic balance occurs much earlier (Rogers et al., 2003).

Dynamic balance can be evaluated in clinical and field settings by asking older adults to voluntarily lean toward their maximum stability limits (Spirduso, Francis & MacRae, 2005). Maintaining balance depends on adequate muscle strength and nerve function, both of which are capable of improvement (Yim-Chiplis, 2000). In 2003, Stel et al (2003) carried out a study to examine whether easily measurable measures for balance and muscle strength predicted recurrent falling as much as sophisticated measurements did. They also examined which of the modifiable risk factors were strongest associated with recurrent falling. They asessesed balance, muscle strength, physical activity and performance tests with 439 participants. Their results showed that tandem stand and hand grip strength predicted recurring falling, and mediolateral sway was significantly associated with recurrent falling.

There are some methods to measure balance. These can be divided into clinical and laboratory techniques. Clinical methods are widely used by many researchers. For instance, the Berg Balance and Tinetti Balance Scale have been shown to have value in assessing balance and future risk of falls (Overstall, 2003; Steadman 2003; Yim-Chiplis, 2000). Moreover, laboratory measures may provide better sensitivity than clinical testing (Maughan, 2008).

Blackmon (2006) conducted a study to determine the efficacy of a clinic-based fall prevention program, in improving balance, functional strength and gait characteristics of community-dwelling older adults with balance disorders, and to determine if time spent in the program is related to changes in balance, functional strength and gait characteristics. Fifty-seven participants volunteered for this study. As a result of this study, there were significant differences in all parameters although time spent in the program, measured as number of treatments completed, were not found to be significantly correlated with the outcome measures of balance or functional strength. They concluded that although there were improvements in balance and functional strength by decreasing risk of falling, gait characteristics of participants did not change (Lord, 2005).

Previous research indicates that regular participation in physical activity has a positive impact on balance. Maughan (2008) carried out a study, using six-week balance-training program, with 60 older adults (60-87 years) to determine whether balance-specific training, in addition to regular physical activity, could improve balance of older adults, and whether there would be a dose-response to frequency of balance training. Groups were divided into three 20-minute balance-training sessions; one 20-minute balance-training session; and no additional balance training (control). The results of this study suggest that physically active older adults who exercise regularly can benefit from the addition of balance training to their current exercise program. Although three 20-minute sessions per week led to the greatest improvement, it appeared that even one 20-minute session of balance training per week may lead to improvement of balance. The results of an intervention study done by Toulott, Thevenon & Fabre (2006) provided further evidence on physical exercise. They investigated the effects of training based on static and dynamic balance in single and dual task conditions on static and dynamic balance of healthy elderly fallers and non-fallers. A group of 16 subjects were trained and evaluated 3 months before the training period, 2 days before the training period, and 2 days after the end of the training period and 3 months after the training period. All subjects performed a unipedal test with eyes open and eyes closed. Their results showed that physical training significantly improves static and dynamic balance under single and dual task conditions. It was concluded that training leads an improvement in static balance and increase in muscular strength.

In another study, Jones (2006,)examined whether balance as a risk factor for falls in the elderly can be improved using a specific exercise program. Participants were selected from two skilled Nursing facilities. One facility was control group while the other was intervention group. Intervention group divided into balance and physical therapy groups. At the end of the study the intervention group showed greater improvements in mean scores on the balance tests, but there were no significant differences between the two groups with regard to changes in balance scores.

Steadman et al. (2003) evaluated the effectiveness of a balance training program to see if it improves mobility in older adults with balance issues. The subjects were 199 patients 60 years and older who scored less than 45 on the Berg Balance Scale (BBS). The average age was 82.7 years. The subjects participated in a six week intervention of balance training with increasing difficulty specific to functional balance. The control group received physiotherapy that is typical for older adults with mobility problems. The researchers assesed with a ten meter timed walk, an activities index, a handicap index, and a quality of life questionnaire after the intervention at 6, 12, and 24 weeks. The researchers summarized their results that both groups improved in the ten meter timed walk, and there were no inter-group differences. The balance training group reported more confidence in walking both indoors and outdoors. They concluded that an exercise program can significantly improve balance and mobility in patients with balance problems and training may improve confidence and quality of life.

There are some other studies reported that a multidimensional intervention had positive effects for measures of balance, gait, mobility, and cognitive executive function. Krotish (2008) conducted a study to examine whether a multi factor intervention that incorporated a significant component of cognitive/attention processing in addition to balance, strength, power, and endurance resulted in improved balance, gait, and mobility. Thirteen community dwelling adults aged 60 and older participated to this study as intervention and control groups. As a result of this study, the intervention group demonstrated an improvement in mobility with a significant decrease in time for the Timed Up and Go (TUG) and little change for the control group.

Gehlsen and Whaley (1990), in their study, aimed to determine and compare the balance, muscular strength, and flexibility of two groups of elderly adults: one with a history of falls (HF) and one with no history of falls (NHF). Subjects were 19 men and 36 women. Static and dynamic balance was determined by a one-foot stance balance test and a backwards walking test. They found significant differences between the two groups for static balance, leg strength, and hip and ankle flexibility. They suggested that balance, leg strength, and flexibility may be factors contributing to falls in the elderly.

Karinkanta et al (2005) examined factors that are associated with dynamic balance and health-related quality of life in home-dwelling elderly women. One hundred and fifty-three healthy postmenopausal women (mean age: 72 years, height: 159 cm, weight: 72 kg) participated to their study. They used health-related quality of life questionnaire to measure Quality of life. For dynamic balance (agility) a figure-of-eight running test was used and for static balance an unstable platform was used. Maximal isometric strength of the leg extensors was measured with a leg press dynamometer. They found that figure-of-eight running time was the strongest predictor of the quality of life score, explaining 9% of the variance. They concluded that among home-dwelling elderly women good muscle strength in lower limbs is crucial for proper body balance and that dynamic balance is an independent predictor of a standardized quality of life estimate.

The improvements in balance and functional strength are associated with decreased risk of falling. Balance is very important factor for falls. Some exercises that are performed to increase leg muscle strength can increase balance in elderly. Although vigorous exercise reduces the risk of fall-related fractures among healthy seniors, people with physical limitations may require special exercise programs (NCIPC, 2002). Carter et al (2001) investigated the efficacy of a community based 10 week exercise intervention(Pilates) to reduce fall risk factors in women with osteoporosis. Static balance (computerized dynamic posturography), dynamic balance (timed figure of eight run) and knee extension strength (dynamometry) were measured. Subjects were randomized to exercise intervention (twice weekly Osteofit classes for 10 weeks) or to be in control groups. According to the results, a 10-week community based physical activity intervention did not significantly reduce fall risk factors in women with osteoporosis. However, in Pilates exercise, there were significant differences in balance and strength, and, also, exercise reduced number of falls.

2.4 Muscle Strength in Elderly

Aging is associated with a decline in musculoskeletal strength and mass. Sedentary individuals typically conserve their muscle to around 40 years of age, but thereafter they show an accelerating loss of contractile tissue, such that by the age of 80 years lean tissue mass has decreased 40% in men and 20% in women (Rogers and Evans, 1993).

One of the most important changes occurring in aging is the loss of muscle mass. Longitudinal studies suggest that during older age, muscle mass decreases about 3% to 6% per decade (Bouchard, 2007). The reduced muscle mass may be due to: (a) a reduction in total muscle fiber number; (b) a reduction in muscle fiber volume; and (c) an increase in type I fiber number and decrease in type II fiber number (Kirkendall & Garrett, 1998).

The term "muscular strength" usually refers to a measure describing an individual's ability to exert maximal muscular force, either statically or dynamically (Kell, Bell & Quinney, 2001). Three types of muscle contractions include isometric, isokinetic concentric and isokinetic eccentric contractions. All three methods determine the amount of external load that is overcome as the muscle attempts to contract against resistance. In isometric strength testing, the muscle acts against an immovable resistance at a specific joint angle. Isotonic exercise allows for a complete range of motion although maximal muscle demand occurs during only a small portion of the movement. Isokinetic strength testing does allow for full muscle tension throughout the range of motion, while holding the speed of movement constant (Kell, Bell & Quinney, 2001). Muscle strength is important in maintaining balance. According to some studies, isometric and concentric strength peaks around 25-35 years of age. Men are stronger and have greater muscle mass than women (Spirduso, 2005).

Aging is associated with physical inactivity, low energy intake, and loss of skeletal muscle mass. The age-related loss of muscle mass, strength and function called as Sarcopenia is accelerated with a lack of physical activity, especially the lack of overload to the muscle, as in resistance exercise. Physically inactive adults have greater loss of muscle mass than physically active adults. In aging the most atrophy is seen in the fast twitch (FT) fibers which are inervated during high-intensity, anaerobic movements. There are other factors which are related sarcopenia that decreased hormone levels, and decreased protein synthesis (Roubenoff, 2000; Vella & Kravitz, 2002).

It is not clear whether regular physical activity and adequate dietary protein intake can attenuate the loss of skeletal muscle mass. Starling, Ades, Poehlman (1999) hypothesized that the maintenance of physical activity and dietary protein intake would attenuate the age-related decline in total appendicular skeletal muscle mass. Total appendicular skeletal muscle mass was determined by dual-energy X-ray absorptiometry in 44 healthy, older white men aged 49-85 years. Physical activity level was determined by using a uniaxial accelerometer over a 9-d period. They concluded that maintaining regular physical activity and adequate protein intake may not offset the age-related loss of appendicular skeletal muscle mass in older men. Furthermore, they suggested that prospective studies are needed to confirm these results and to determine whether anabolic physical activity (eg, strength training) can decrease the age-related loss of muscle mass in the elderly.

Studies in active older adults suggest that activity can reduce many of the declines in various domains of physical function. In a study by Hughes et al. (2001) the longitudinal changes in isokinetic strength of knee and elbow extensors and flexors, muscle mass, physical activity, and health were examined in 120 subjects initially 46 to 78 years old. Women demonstrated slower rates of decline in elbow extensors and flexors (2% per decade) than men (12% per decade). Older subjects demonstrated a greater rate of decline in strength. The change in leg strength was directly related to the change in muscle mass in both men and women. In other study which was performed as an exercise intervention, a 12-week resistance training program that consisted of three sets of eight repetitions of seven exercises on three days per week improved leg strength (Hardman & Stensel, 2009).

Many studies examine the effects of exercise on the risk of falling in elderly. Schlicht (1999) was focused on a study to determine if an 8-week, 3-day per week intense (75% of 1 repetition maximum) strength training program, in the absence of aerobic or flexibility training, could improve postural stability in 24 subjects aged 61-87. The results of this study revealed that strength training alone does not enhance standing balance performance in active community-living older adults.

In a study by Connely & Vandertvoort (1995), the increase quadriceps muscle strength in the frail elderly women were examined. Ten women living in nursing house were participated in an 8-week strengthening training. In this study, it was found that there was a 61.4% increase in one repetition maximum strength and significant improvement in isometric quadriceps strength. Decreased lower extremity muscle strength was associated with an increase in fall risk, which is very important finding.

The effects of a 12-month moderate intensity endurance training on strength, flexibility, speed of contraction, muscular endurance, gait and balance was investigated in 50 men and women by Brown & Holloszy (1993). Participants' ages were between 60 and 70 years who had just completed a program of flexibility and strengthening exercises. They concluded that gains made during the low intensity strengthening and flexibility program in strength, range of motion and quadriceps endurance were maintained throughout the year of endurance exercise training. Additional significant improvements occurred in balance and speed of contraction with the moderate intensity exercise. Results showed that older adults can improve their functional capacity in response to exercise training. Falls are one of the main problems in aging. Many study tried to examine effectiveness of exercise in preventing falls. Most studies used combination of resistance exercise, balance or flexibility exercise or endurance or just muscle strength training exercise. For example, Moreland et al. (2004) investigated the quantitative contribution of muscle weakness to fall risk in elderly adults. Study sample conşisted of 65 years and older adults. Muscle strength considered as an individual risk factor. The authors conclude that lower-extremity weakness is a statistically significant risk factor for falls. Moreover, upper-extremity weakness is a marker for lower-extremity weakness.

In many studies lower extremity muscle weakness has been identified as a risk factor contributing to falls in older people (Lord, Clark & Webster, 1991). Daubney & Culham, (1999) conducted a study to determine the degree to which one component of postural control (muscle force) contributes to scores on 3 functional balance measures. In their study, fifty community-dwelling volunteers between 65 and 91 years of age were participated. Measures were the Berg Balance Scale (BBS), the Functional Reach Test (FRT), and the Timed Get up & Go Test (GUG). The force generated by 12 lower-extremity muscle groups was measured using a handheld dynamometer. They concluded that distal muscle force measures may contribute to the prediction of functional balance scores; however, the muscles involved in the prediction differ depending on the measure of balance.

Type of physical activity is important to increase muscle strength to gain older people living independently. Especially in literature, some strength exercises like weight bearing and using other equipments have been advised. It is well established that strength training increases muscle strength and this increase is due to both neural and muscular factors. Responses to exercise are often highly variable among individuals (Magaudda et al., 2004).

According to ACSM (ACSM, 2000) the functional benefits of strength training include the following:

- Improved muscular strength and power
- Improved posture
- Increased metabolic rate to help decrease body fat
- Increased bone mass-strength training strengthens bones as well as muscles
- Improved balance and coordination

Muscle protein is metabolically active, and the age-associated loss of muscle protein mass is related to a loss of physical function and an inability to perform activities of daily living (physical frailty). It is important to maintain adequate reserves of muscle protein and amino acids as we age.

> Yarasheski (2003), with some summarized evidence, supports the notion that: "(a) advancing age and physical frailty are associated with a reduction in the fasting rate of mixed and myosin heavy chain protein synthesis, which contributes to muscle protein wasting in advancing age; (b) this impairment can be corrected because resistance exercise acutely and dramatically increases the rate of muscle protein synthesis in men and women aged 76 years and older; and (c) resistance exercise training maintains a modest increment in the rate of muscle protein synthesis and contributes to muscle hypertrophy and improved muscle strength in frail elderly men and women. The cellular mechanisms responsible for these adaptations, as well as the role of nutrition and hormone replacement in reversing sarcopenia, require further investigation (p.918).

The age-related loss of skeletal muscle mass is attributed to a disruption in the regulation of skeletal muscle protein turnover, resulting in an imbalance between muscle protein synthesis and degradation. Physical activity and/or exercise stimulate post exercise muscle protein accretion in both the young and elderly. Prolonged resistance type exercise training represents an effective therapeutic strategy to augment skeletal muscle mass and improve functional performance in the elderly (Koopman, 2009).

Laukkanen, Heikkinen and Kauppinen (1995) examined the associations of physical capacity, as determined on the basis of self-report and physical measurements, with survival in three groups of elderly people aged 75, 80 and 75-84 years. Mobility, walking speed, hand grip strength and knee extension strength were assessed. The follow up periods ranged from 48 to 58 months. Leg extensor and handgrip strength was significantly related to walking time over 10m, and a 48-month follow-up revealed that of the fastest quartile, 9 out of the 10 participants were still alive, while in the slowest quartile 1 in 4 individuals had died. The results of their study showed that reduced physical mobility and muscle strength are a significant mortality risk. Physical performance tests are valuable tests to diagnose, prevent and rehabilitation in older people.

Muscle responds differently to different modes of exercise. In strength training, the greatest strength gains occur with low repetition and longer duration. Several adaptations occur with strength training. These adaptations occur in a time series. Strength gains often occur faster than those can be explained by mass changes. It has been suggested that early strength gains are attributed to neurologic adaptations. Five to eight weeks of strength training may increase voluntary strength without increases in evoked maximum twitch. The key to strength gains appears to be the load. Loads around 60 % of Maximal Voluntarily Contraction (MVC) do not appear sufficient to stimulate growth. Loads above 90% MVC need only be developed 1-2 times per day to invoke growth, however 5-6 repetitions does provide a better stimulus. An effective strength training stimulus involves 8-12 repetitions of 75-80% of MVC performed 3- 4 days per week (Kraemer, 1994; McComas, 1996; Wilmore & Costill, 1994). McComas (1996) suggested that the reduced strength observed in aging is not only the result of changes in muscle fiber number and volume, but is also due to reduced nerve innervations.

Hyatt et al. (1990) have studied the association of muscle strength (quadriceps, biceps, handgrip), with functional status (Barthel Index, manual dexterity, Mental Test Score, history of falls, fracture, prescribed drugs), in a sample of 92 elderly subjects. Anthropometric and hand grip strength were also measured in young controls. As a result of this study muscle area, mass and strength were significantly greater in young controls and elderly men have significantly greater differences from elderly women. Muscle weakness is associated with dependency in their sample of elderly subjects but they could not determine whether this association is one of cause, or effect.

The development of musculoskeletal fitness with long term resistance training is associated with enhanced cardiovascular function and musculoskeletal metabolism (Kell, Bell & Quinney, 2001). It is well known that exercise assists in the maintenance of personal independence and may enhance it in older adults by increasing muscular strength and endurance. Rezmovitz et al (2003) examined if a 12-week strength-training program designed to improve lower body function can also improve static balance and wellbeing. Fourtyfour women aged 70 to 86 were selected to place in either a control group (n = 22, mean age = 76 years) or a training group (n = 22, mean age = 76 years). Lower leg strength was assessed by a timed two-legged squat (TLS) and a timed chair stand (TCS). The static balance of training group was assessed using timed platform stability under six different conditions. The well-being was assessed using a questionnaire. Subjects were assigned to 1-hour exercise that consists of stretching and strengthening exercises done three times a week for 12 weeks. Results indicated that a lower body resistance training program can improve lower body function, static balance, and well-being.

The application of a resistance training program is associated with increased musculoskeletal fitness, as indicated by increased muscular strength and muscular endurance (Brown & Holloszy, 1993; Connely & Vandertvoort, 1995; Kell, 2001; Magaudda et al. 2004). It has been shown in some studies, in both young and old, resistance training has been associated with increases in one or all of the following: total muscle area, muscle fiber hypertrophy, muscle volume, total fat free mass, body composition, bone mineral density and flexibility (Hopp, 1993; Kell, 2001). Adults of all ages may increase muscle strength with regular resistance exercise (Hakkinen et al., 1996; Roth et al., 2001). Yet, it is not well examined whether Pilates exercise can improve muscle strength in elderly.

Sander (2005) was examined a study to identify if Pilates training increased lower extremity functional ability in Division II football players. Seventeen collegiate football players volunteered to participate in this study and were divided into Pilates training group and position players composed the control group. All subjects were pre and post-tested using the NASM Lower Extremity Functional Test (LEFT), the NASM Shark

Skill Test (SST), a vertical jump test, and a straight leg lowering test. The Pilates group was undergone a five week, eight session training program, with progression of exercises as needed. Results indicated that the Pilates training group improved in agility and functional ability, both of which are important components of lower extremity function. Pilates training can be beneficial for football linemen to increase agility and the ability to move horizontally. Despite a lack of significant evidence in this study regarding core strength, Pilates exercise had an influence on the lumbo-pelvic-hip complex, and led to an increase in strength and stability.

2.5 Flexibility in Elderly

Flexibility can be defined as the range of motion in a specific muscle group that is influenced by other muscles, tendons, ligaments and bones (Anderson et al., 2005). There were declines in mobility, muscle strength, power, balance, and flexibility by effecting functional performance in aging. Declines in these functions may result in increased falls, some injuries and disability (Stanziano, 2005). Flexibility has two components, dynamic or static, where dynamic flexibility is the opposition or resistance of a joint to motion, that is, the forces opposing movement rather than the range of movement itself. Static flexibility is the range of motion about a joint, typically measured as the degree of arc at the end of joint movement (Kell, 2001). Joint flexibility is crucial for effective movement. Flexibility is specific to each joint of the body, and flexibility at one joint does not necessarily indicate flexibility in other joints (Spirduso, 2005).

Flexibility for the elderly may be the most crucial element. Flexibility may be one of the factors contributing to falls in the elderly (Gehlsen &Whaley, 1990) and it is strongly associated with an independent lifestyle (Cunningham et al., 1993). Flexibility activity is recommended to maintain the range of motion necessary for daily activities and physical activity. Decrease in flexibility with aging can limits the older adult's ability to perform daily activities (Raab, Agre, McAdam & Smith, 1988). Olson (2004) noted that previous research has shown Pilates training to be effective for flexibility but limited for body composition when it is done for just once a week.

Flexibility exercises should be incorporated into the overall fitness program sufficient to develop and maintain range of motion (ROM). These exercises should stretch the major muscle groups and be performed for a minimum of 2-3 $d \cdot wk^{-1}$. Stretching should include appropriate static and/or dynamic techniques (Pollock et al., 1998). The primary effects of stretching involve the viscoelastic properties of the tendon. Stretching exercises increase tendon flexibility. Aging often results in substantial loss of tendon flexibility and limits in motion. This is related to both biochemical changes in the musculotendinous unit and mechanical factors in the underlying skeletal structure (Pollock, 1998).

Research suggests that flexibility decreases with age (about 20 to 30% between 30 to 70 years of age). Inactivity leads to an increased rate of collagen turnover, a shortening of skeletal muscle fiber, and decreased muscle mass (Kell, 2001). Flexibility (ROM) is necessary for good mobility and coordination. Brown and Holloszy (1991) conducted a study to determine effects of combined static stretching with calisthenics in an attemp to improve general strength, muscle endurance and flexibility in aged from 60 to 71 years men and women (N0=55). As a result of this study, trunk flexion, knee extension hip internal rotation and resting hip flexion improved sıgnificantly over the 12 week period.

The Benefits of exercise have been well established in many population samples. For example, Stanziano (2005) carried out a study to determine if an 8 week active assisted flexibility training program could significantly improve measures of functionality, mobility, power and range of motion in a group of residents living in an extended care facility. Seventeen participants (4 male and 13 female) over the age of 70 volunteered to participate in their study. The results of the study revealed that the experimental group demonstrated significant differences in all measurements. The author suggests that an 8 week active–assisted flexibility training program is effective method for reducing the impact of aging and for maintaining functionality in elderly persons.

In some studies improvements in physical performance have been observed with flexibility exercises (Alexander, Gross, Medell, Hofmeyer, 2001). Regular physical activity can slow or reverse deterioration in oxygen transport, strength, flexibility and balance, thus reducing biological age by ten or more years (Shephard, 2008). Long term concurrent strength training and stretching can enhance musculoskeletal fitness regardless of age or gender, and increase overall quality of life. Barbosa et al (2002), studied the effects of a 10-week resistance training program on flexibility of elderly women (n = 11) between aged 62 and 78 years. Flexibility was evaluated through the sit-and-reach test, performed both before and after the training program. The training program resulted in significant increase of flexibility in elderly women (approximately equal 13%). They concluded that weight training without performance stretching exercises does increase flexibility in elderly women.

Hopkins, Murrah, Werner, Hoeger and Rhodes (1990) conducted a study to determine the effect of low-impact aerobic dance on sedentary elderly women (N = 53). Functional fitness was measured by items from the proposed American Alliance of Health, Physical Education, Recreation, and Dance (AAHPERD) fitness test for older adults. After 12-week low-impact aerobic dance, the group improved significantly on all functional fitness components including cardio respiratory endurance, strength, endurance, body agility, flexibility, body fat, and balance.

Therapeutic effects of a short-term Tai Chi exercise program for the elderly were evaluated in a pretest-posttest quasi-experimental design by Ross et al. (1999). Changes in flexibility, balance, sway, pain, and mood after a short slow-motion exercise were evaluated in 11 elderly women. Improved balance, sway, range of motion, decreased perceived pain, and lessened trait anxiety were measured by standard goniometry, the Multiple Affect Adjective Check List, stopwatch measures of single-leg stance and a tandem walk (sway), and visual analog measurement of pain. Findings included significant improvements in trait anxiety and pain perception. Improvements in mood, flexibility, and balance may have a profound effect on the incidence of falls, injuries, resulting disability, and overall quality of life.

Increasing flexibility both maintains mobility and also improves quality of life and prolongs independence in elderly. Zakas et al. (2006) investigated the effect of the duration of static stretching on the range of motion (ROM) of the lower extremities and the trunk in elderly women, when stretching was performed once or in multiple repetitions while controlling the total amount of the time spent in one stretching session. For this aim, twenty sedentary subjects aging 65–85 years old (mean age=75.9) participated in this study. Subjects performed three static stretching protocols lasting for 60 s each, in non-consecutive training sessions. ROM was determined during hip flexion, extension and abduction, knee flexion, and ankle dorsiflexion for the right and left side of the body, as well as during trunk flexion, using a flexometer and a goniometry. As a result of this study, authors suggested that a single 60sec static stretch of the lower extremities and trunk's muscles produced the same effect as two 30sec and four 15sec stretches, during a flexibility training session involving sedentary elderly women.

Kloubec (2005) was studied a study to determine the effect of Pilates exercise on abdominal endurance, hamstring, flexibility, upper body endurance, posture and balance and psychological parameters involving adults randomized exercise or control groups. Twenty five participants were invited to this study in a 12-week series of 1 hour Pilates exercise meeting 2 times per week. As a result of study, there were significant increases in abdominal endurance, hamstring flexibility and upper body muscular endurance. There were no improvements in balance and posture. Physiological well-being data showed improvement in overall energy levels, satisfaction with physical appearance and job satisfaction.

In another study which is related Pilates and Flexibility was studied by Segal, Hein & Basford, (2004) to assess the effects of Pilates training on flexibility, body composition, and health status. Fourty seven adults (45 women, 2 men) were participated to this study. Fingertip-to-floor distance, truncal lean body mass by bioelectric impedance, health status by questionnaire and visual analog scale were assessed at baseline, 2, 4, and 6 months. They concluded that Pilates training may result in improved flexibility. However, its effects on body composition, health status, and posture are more limited and may be difficult to establish.

2.6 Reaction Time in Elderly

Aging is not an illness or symptoms of the diseases, from which the older people suffer,, rather it is a biological process which is entirely normal. Aging may lead to development of many diseases that may have impact on the quality of life. Aging may cause slow reaction time, slow visual processing speed, decreased coordination, decrease in memory, and decreased inductive reasoning. All of these factors have an impact on daily life actions such as having bath, cooking, dressing, and shopping (Owsley, Sloane, McGwin & Ball, 2002).

Reaction time is the onset of a response to an unexpected stimulus, while movement time is the relationship between the various events in a movement (Kanan Desai, 2006). There is approximately a 25% increase in simple reaction. Awareness about the importance of performing physical activity for older adults has been increasing in Turkey. There is significant slowdown in reaction time in women from their twenties to the sixties (Lord & Sturnieks, 2005).

> Reaction Time can be divided into Simple Reaction Time and Choice Reaction Time. Simple Reaction Time (SRT) represents speed of response that is for example person can move a finger or limb when almost no integration or decision making is required. SRT slows with aging so many times it is considered one of the most measurable behavioral changes. Males were faster than females in SRT and Choice Reaction Time (CRT). CRT is very complicated when several stimuli are paired with specific responses of varying degree of complexity. CRT has three components; the perceptual process of identifying stimulus; the decision process and the motor process required to initiate the response. The more complex the movement to be made, the slower the response of older adults can be seen (Spirduso, Francis, MacRae, 2005, p.162-165).

Reaction time is strongly associated with age. It increases and becomes more variable with age (Kolev, Falkenstein and Yordanova, 2006). Fallers perform significantly more slowly than nonfallers in tests of both simple and choice reaction time (Lord, 2005). In another study, MacDonald et al. (2008) found that reaction time variability in older adults was usually associated with slower reaction times. Fozard, Vercruyssen, Reynolds, Hancock and Quilter (1994) analyzed reaction time data from 1265 community dwelling volunteers who ranged in age from 17 to 96. They reported that repeated testing within participants over eight years showed consistent slowing and increased variability with age. Simple reaction time plays an important part in performing activities of daily living.

Hunter, Thompson and Adams (2001) studied changes in reaction times with age and determined the relationship among reaction time, strength and physical exercise. Their study involved 270 healthy, independent women aged 20-89. Authors found that there was a significant negative association between age and physical activity. Moreover, they found that in women between ages 20-89, reaction time (lower limb reaction) slowed at a rate of 0.57 ms/year. They concluded that physically inactive women had significantly slower reaction times than active women and stronger women had faster reaction times than weaker women. We can conclude from this study that reaction time can improve with exercise.

Choice RT refers situations in which there are two or more possible stimuli requiring different responses and is considered as a useful variable to infer the velocity of decision making processes (Nougier, 1992). In a study by Der and Deary (2006), the age differences in reaction time were modeled. They concluded that choice reaction time slows and becomes more variable throughout adulthood, although simple RT barely changes until people are approximately 50 years old. Moreover, both simple and choice RT increases more rapidly for women at older ages.

It is known that falls are one of the biggest problems for elderly. It causes some problems like accidents with results like serious injuries and fractures. Slowed reaction time may cause to leads to loss of postural instability or loss of balance leading to accidental falls in aging (Halstead and et al, 1997; Powell & Myers, 1995). Older people`s movements are generally slower, more variant, and less coordinated than their younger counterparts (Spirduso, 1975). Increased reaction time decreases falls in elderly (Green, 2000).

The total reaction time can be divided into some different components (mental processing time, movement time and device response time). Mental processing time is the time it takes for the responder to perceive that a signal has occurred and to decide upon a response. In elders, all of these components are delayed (Kanan Desai, 2006). Studies have suggested that elderly individuals were able to use stored information about a movement's characteristics to plan an action. Gender effects on CRT variability may be due to group differences in the rate at which performance improves with practice. Female RT is slower than male RTs (Reimers and Maylor, 2006). Therefore, Deary and Der (2005) reported simple and choice reaction times become slower and more variable with age. Women from age 36 to 63 show more variability in choice reaction times than men, an effect which remains after controlling for mean reaction time. Reaction time differences largely account for age differences, but not sex differences. Slowing and increased variability in late life are confirmed for simple and choice reaction time.

Studies show that reaction time can be improved by training (Trombly, C., 2004). A study by Laroche et al. (2007) was carried out to determine whether muscle power, activation time and neuromuscular stimulation are related to physical activity patterns in older women. Forty women (65-84 years) were assigned to high active and low active groups. Results of this study show that older women with a history of vigorous activity can generate force, power, and motor output in comparison with less active peers. Physical inactivity is responsible for a large portion of the loss of neuromuscular function seen in older adults. Active fit adults consistently demonstrate faster simple and choice reaction times indicating they are faster at making decisions (Rowland, 1990; Trombly, 2004). Levitt and Gutin (1971) and Sjoberg (1975) concluded that subjects had the fastest reaction times when they were exercising sufficiently to reach to heart rate of 115 beats per minute.

Intraindividual variability refers to fluctuations in performance over a short interval, as opposed to enduring changes over time (Nesselroade, 1991). The principal reason that cognitive aging researchers are interested in intraindividual variability in processing speed is its demonstrated relationships with cognitive functioning in late adulthood. Finkel and McGue (2007) was conducted a study to investigate genetic and environmental influences on intraindividual variability in reaction time. The study included 738 individuals (aged 27 to 95 years), including twin pairs. Decision time and movement time factors were measured. The results indicated that all genetic variance in the RT measures was shared among measures; environmental variance was specific to each RT measure.

Hultsch, MacDonald and Dixon (2002) studied variability in reaction time with younger and older adults. They collected data by investigating variability between persons (diversity), variability within persons across tasks (dispersion), and variability within persons across time (inconsistency). Four measures of RT were performed by a total of 99 younger adults (ages 17–36 years) and 763 older adults (ages 54–94 years. Results indicated that all three types of variability were greater in older compared with younger participants. Older adults had more uneven intraindividual profiles of performance across the four RT tasks than younger adults. The results indicate that variability of performance is an important indicator of cognitive functioning and aging.

Lajoie and Gallagher (2004) conducted a study to determine cut-off scores as well as develop a model used in the prevention of fallers within the elderly community in simple reaction time, the Berg balance scale, the Activities-specific Balance Confidence (ABC) scale and postural sway measurements. They aimed to develop a relatively simple fall predictive model. One hundred and twenty-five subjects, 45 fallers and 80 non-fallers were evaluated throughout the study and results indicated that non-fallers have significantly faster reaction times, have higher scores on the Berg balance scale and the ABC scale as well as sway at slower frequencies when compared to fallers. Furthermore, analysis and results showed that reaction time, the total Berg score and the total ABC score contributed significantly to the prediction of falls with 89% sensitivity and 96% specificity.

2.7 Falls in Elderly

Exercise intervention can reduce many intrinsic risk factors for falling. Carter, Kannus and Karim, (2001) performed a computerized literature search of the entire MEDLINE database, covering the years 1966 to the present, using the keywords: randomized controlled trials, exercise, falls and elderly. The search was not limited to the English literature, and articles in all journals were considered, as were the reference lists of the published papers. A total of 13 studies were identified that had randomized controlled trial design, participants 60 years or older, falls as an outcome and exercise as intervention. They emphasized that exercise can theoretically modify the intrinsic fall risk factors and thus prevent falls in elderly people; however, the optimal exercise prescription to prevent falls has not yet been defined.

In some studies that established the incidence of falls among women to be higher than men by 30-49% (Sattin et al., 1990). In a year prospective study of community dwelling elders (N=336) women had a relative risk of falling that was 1.2 times higher than the risk of men (Tinetti et al 1994). Lee and et al (2005) analyzed the effects of a 12-week exercise program for the prevention of fall down in elderly. Eighty community-dwelling women over 60 years old were participated to their study. Participants were selected from the participants of a cross-sectional survey defined by the experiences of fall down more than three times in one year. They suggested that exercise session program improved ability of balance, flexibility, trunk and leg strength and general motor function. Monthly education was not improved physical fitness and fear of falling in elderly.

Loss of balance and falling are critical concerns for older adults. Physical activity can improve balance and decrease the risk of falling. DiBrezzo et al. (2005) purposed to evaluate a simple, low-cost exercise program for community-dwelling older adults. Sixteen senior adults were evaluated using the Senior Fitness Test for measures of functional strength, aerobic endurance, dynamic balance and agility, and flexibility. At the completion of the program, significant improvements were observed in tests measuring dynamic balance and agility, lower and upper extremity strength, and upper extremity flexibility. They indicated that exercise programs, especially this kind, are an effective, low-cost solution to improve health and other factors that affect falling risk among older adults.

Fall-related injuries and deaths in older adults are a major health problem worldwide (Carter, Kannus, & Karim, 2001). Regular exercise may be one way of preventing falls and fall-related fractures. Brain, muscles, and bones work together to maintain your body's balance and to keep you from falling, whether you're walking, rising from a chair, or climbing stairs. Falls are the leading cause of injury-related hospitalization in persons aged 65 years and over. Depending on the population under study between 22% and 60% of older people suffer injuries due to falls; 10-15% suffer serious injuries; 2-6% of suffer fractures; and 0.2-1.5% suffer hip fractures. Femoral neck fractures are the most common injuries that require hospitalization. At least 95% of hip fractures among older adults are caused by falls (Lord, Sherrington, & Menz, 2001; Nyberg, 1996). It is estimated that nearly one third of elderly persons fall each year. Of those who fall, 50% do so repeatedly. Most fall result in bruises, strains, sprains, and psychological distress (McElhinney, Koval & Zuckerman, 1998).

Falls by the elderly may be caused by numerous intrinsic and extrinsic factors. Intrinsic causes are those that are internal, such as medical and physical problems and the effects of medications and alcohol. Moreover, trouble walking, difficulty rising from a chair, dizziness, joint pain, muscle weakness, foot problems, confusion, vision or hearing loss, malnutrition, or the side effects of medication are the some examples for it. Extrinsic causes are external, such as environmental hazards and weather conditions (Cordova, Young, Shije, & Heeter, 2004).

Most falls have multiple causes. Risk factors for falls include muscle weakness, a history of falls, use of four or more prescription medications, use of an assistive device, arthritis, depression, age older than 80 years, and impairments in gait, balance, cognition, vision, and activities of daily living. The most effective fall prevention strategies are multifactorial interventions targeting identified risk factors, exercises for muscle strengthening combined with balance training, and withdrawal of psychotropic medication. Home hazard assessment and modification by a health professional also is helpful (AGS, 2001; Rao, 2005).

Assessment of risk factors for falling may be useful in clinical practice to identify the elderly at risk. De Rekeneire et al (2003) identified factors associated with falling in elderly. Three thousand seventy five black and white men and women aged 70 to 79 elderly participated to this study. Number of falls and health status were assessed by questionnaires. Lower extremity performance, leg muscle, isokinetic strength, balance, long distance walk were analyzed. They resulted as fallers were more likely to be female; white, report more chronic diseases and medications; and have lower leg strength, poorer balance, and slower 400m walk time and lower muscle mass. They concluded that falls history needs to be screened in healthier older adults.

History of falls is determinant for future falls. Izumi, Makimoto, Kato and Hiramatsu (2002) conducted a study to identify risk factors for falls among institutionalized elderly, using the standardized risk assessment tool developed by Izumi. They examined 746 patients from three types of facilities - rehabilitation wards in four general hospitals, three long term care facilities, and three nursing homes - for up to three months. They concluded that history of falls, altered mentation, and assistance with toileting may be used to screen patients with high risk for fall at the admission. Each facility needs to carefully reassess the effect of fall history on the incidence of falls. Previous falls and treatment with antidepressants were found to be the most important predisposing factors for falls by Kalin et al (2004). Tinetti et al. (1994) carried out a study to determine if modifying known risk factors could reduce the risk of falling. Participants were over the age of 70, who had at least one risk factor for falling. For the intervention, the participants, a group of 153 subjects, received an adjustment in medications, behavioral instructions, and exercise programs to modify risk factors. The control group of 148 subjects received the usual health care visits which included a social visit. End of their study, they obtained a significant reduction in the risk of falling with a multiple risk factor intervention strategy for older community dwelling adults. During the one year follow up, 47 percent of the controls and 35 percent of the intervention group had a fall.

Lord, Menz and Tiedemann (2003) conducted a study to describe the use of a physiological profile approach to falls risk assessment and prevention that has been developed by the Falls and Balance Research Group of the Prince of Wales Medical

Research Institute, Sydney, Australia. The Physiological Profile Assessment (PPA) involves a series of simple tests of vision, peripheral sensation, muscle force, reaction time, and postural sway. They found that the PPA that uses a function-based and quantitative model, and thus provides a powerful tool for falls risk factor identification and the evaluation of interventions aimed at maximizing physical functioning.

In a study by Gill, Taylor and Pengelly, (2005) it was found that approximately 30% of older adults had experienced a fall in the previous 12 months. The characteristics of people who had fallen included those in the older age groups, with fair or poor general health and lower socioeconomic status, whose health had worsened in the last 12 months. Regular group exercises which were designed to improve Upper Limb and Lower Limb strength, gait speed, balance, joint flexibility were successful exercise programs to reduce number of falls.

Multiple risk factors for falling have been identified in community dwelling elderly women. Wheeler (2002) measured lower extremity force production in a way that is both quantifiable and has evidence of acceptable reliability. This case control study to measure several predictor variables including medication use, musculoskeletal measures, medical conditions and functional status included 116 women. Participants were classified into cases or control. Lower extremity was measured with a hand held dynamometry. The author concluded that a composite score of lower extremity muscle force production was found to be an independent risk factor for falling in community dwelling elderly women.

Resulting in falls, elderly people can be effected fear of falling and they can be stressful about whether to be future falls or not. Fear of falling may cause to limit their daily living activities and daily functioning disproportionately, and decrease quality of life (Miller, 1995). Arfker et al (1994) studied fear of falling in elderly. They supposed that the prevalence and the correlates of this fear are unknown. For this aim, prevalence of fear of falling was calculated within the 1 year follow up, using a gender stratified random sample of community-dwelling elderly people. Fear of falling with quality of life, frailty and failing were assessed. They concluded that fear of falling is common in elderly and it is associated with decreased quality of life, increased frailty and recent experience of falls.

People over the age of 65 have the highest mortality rate from injuries and the largest single cause of injury is falls, followed by motor vehicle accidents and suicide in elderly (Black & Wood, 2005). In a study by Dunn et al (1992), the relationship between falls and both mortality and functional status in 4270 respondents whose ages were 70 and over were investigated. They reported that multiple falls in older persons increase risk of functional falls and this may indicate underlying conditions that increase risk of death.

Snyder (2006) conducted a study to evaluate the functional fitness of individuals residing in independent living and assisted living facilities using a series of physical tests to assess strength, balance, flexibility, and aerobic endurance. Participants were women (n= 21) between 70 and 92 years of age, residing in either independent living (n= 12) or assisted living (n= 9). All participants took part in a functional fitness assessment. Six components of functional fitness were measured: lower body strength, upper body strength, aerobic endurance, lower-body flexibility, upper body flexibility, and balance and agility. No significant differences were found in the components of functional fitness and no relationship was found in relation to the frequency of categorization using the Katz Index of ADL. Their findings suggest that residents in both assisted living and independent living were at an increased risk for loss of functional mobility in various components of functional fitness. Developing specific activity programs targeting functional fitness parameters may aid in improving limitations in functional fitness, such as upper body flexibility and lower body flexibility.

2.8 Bone Mineral Density in Elderly

Osteoporosis can be defined as "a disease characterized by low bone mass, micro architectural deterioration of bone tissue leading to enhanced bone fragility, and a consequent increase in fracture risk" (WHO, 1994). In another definition by NIH (2000), "osteoporosis is defined as a skeletal disorder characterized by compromised bone strength predisposing a person to an increased risk of fracture. Bone strength primarily reflects the integration of bone density and bone quality". Bone density is expressed as grams of mineral per area or volume and in any given individual is determined by peak bone mass and amount of bone loss. Bone quality refers to architecture, turnover, damage accumulation (e.g., microfractures) and mineralization. Osteoporosis is diagnosed when the bone mineral density is less than or equal to 2.5 standard deviations below that of a young adult reference population. This is translated as a T-score.

Table 2.2

World Health Organization BMD Classification (WHO, 1994)

Classification	T-score
Normal	-1 or higher
Osteopenia("Low Bone Mass")	Between -1 and -2.5
Osteoporosis	-2.5 or lower
Severe Osteoporosis	-2.5 or lower and personal history of fragility fracture

$$\text{T score} = \frac{\text{(Patient's BMD)} - \text{(Mean Young-Adult BMD)}}{\text{(1 SD of Young-Adult BMD}}$$

A T-score is the standard deviation (SD) variance of the patient's BMD compared to a healthy young-adult reference population and expressed as g/cm^2. A Z-score is the standard deviation (SD) variance of the patient's BMD compared to an age- and sex-matched reference population, and should not be used to diagnose osteoporosis. The T-score cutoff of -2.5 for diagnosing osteoporosis was selected because it identified approximately 30% of postmenopausal Caucasian women as having osteoporosis, which is roughly the same as the lifetime risk of clinical fragility fractures in this population (WHO, 1994). The most important number on the DXA printout is the T score. This is the number that is used to diagnose osteoporosis or osteopenia. DXA is now commonly used to measure bone density, predict fracture risk, and monitor the effects of therapy for osteoporosis (Faulkner, 2005). Among different bone measurement tests performed at various anatomical sites, bone density measured at the femoral neck by dual energy x-ray absorptiometry (DXA) is the best predictor of hip fracture. Risk of fracture increases steadily and bone density decrease, with no threshold (USPSTF, 2002).

BMD that is obtained using DXA is still most reliable and preferable to measure both the spine and proximal femur sites. The spine consists of 70% cancellous bone and is consequently often the most sensitive site for assessing early postmenopausal bone loss. The main purpose of measuring BMD is to predict the risk of fracture (Adams & Lukert, 1999, p.136).

Osteoporosis increases the risk of bone fractures, which are linked to an increased risk of mortality. The mortality rate following a hip fracture in the elderly is about 50% (Kell, 2001). Low bone density at any skeletal site is predictive of fractures at any skeletal site. Fracture risk increases with age, even when BMD remains the same (Cummings, et al., 1995). In addition to bone density, age, and previous fracture, other clinical risk factors also play a role. These can include family history of hip fracture, poor health, low body weight, and frailty. Most hip fractures occur as a result of a fall. The risk of falling is affected by factors that include mobility, strength, reaction time, visual impairment, medications, and cognitive impairment (Lewiecki, 2003).

Osteoporosis is a silent disease with no symptoms until a fracture occurs. Lewiecki (2003) referred as prevalence of osteoporosis in women by age:

• 60s: 20%
• 70s: 30%
• 80+: 70%;

The prevalence of osteoporosis in white female nursing home residents is 64% for those age 65-75, and 86% for those over age 85. A 50 year-old woman has a 40% lifetime risk of any osteoporotic fracture and a 17% risk of hip fracture, while a 50 year-old man has a 13% lifetime risk of any osteoporotic fracture and a 7% risk of hip fracture. Women who are very physically active have a 36% decrease in fracture risk compared to sedentary women. In women, the lifetime risk of hip fracture is greater than the risk of breast, endometrial, and ovarian cancer combined. The most important risk factor for fracture, independent of bone mineral density, is a previous fragility fracture. This history increases the risk of future fractures (Lawrence, 2005; Lewiecki, 2003).

The risk factors for Osteoporosis are; age, to be female, to be Caucasian, Asian, to be dementia, to have low body weight, personal history of fragility fracture, bad nutrition, low calcium intake, smoking, inactive life style, and lack of exercise (NOF, 2003). Elderly women and men who were chronically inactive (i.e., rare stair climbing, gardening, or other weight-bearing activities) have more than twice as likely to sustain a hip fracture as those who were physically active (ACSM, 2004). It is estimated that a 10% increase of peak bone mass reduces the risk of an osteoporotic fracture during adult life by 50% comparison either between parents and children or between monozygotic and dizygotic twins suggest that genetics accounts for 60 to 80% of the variability in individual peak bone mass (Bonjour, 2001).

Exercise decreases the risk of osteoporosis. It also improves muscle strength, balance and coordination, which help to prevent falls and bone fractures. Any form of exercise is better than no exercise. Yoga and Pilates, when done at a vigorous level, can improve bone health (Katz, Sherman 1998).

Lack of exercise and immobility can reduce bone mineral density, general strength, and fitness. Osteoporotic fractures present an enormous health burden on an expanding elderly population. Nelson et al (2002) reviewed to evidence on the benefits and harms of screening postmenopausal women for osteoporosis. MEDLINE (1966 to May 2001), HealthSTAR (1975 to May 2001), and Cochrane databases, reference lists, and Experts were reviewed. They concluded that population screening would be based on evidence that the risk for osteoporosis and fractures increases with age, that the short-term risk for fracture can be estimated by bone density tests and risk factors, and that fracture risk can be reduced with treatment. The role of risk factor assessment and different bone density techniques, frequency of screening, and identification of subgroups for which screening is most effective remain unclear.

In a study performed by Kronhed (2003), The Vadstena Osteoporosis Prevention Project (VOP) was conducted to determine Physical activity in relation to bone density, fall prevention, and the effect of training programs in community dwelling elderly. Participants who were aged 40–70 years and had low forearm bone mineral density (BMD) values were invited to take part in a one-year weight-bearing training study. Thirty of those individuals were included in the investigation. Additional bone mass measurements were performed at the hip and the lumbar spine, and balance and aerobic capacity were also tested. The training program was performed twice a week. As a result of study, the exercise group (n=15) in the weight-bearing training study showed increases in BMD, one-leg stance balance with the eyes closed and coordination tests and aerobic capacity. It was concluded that a community-based intervention program must be regarded as a long-term project and should preferably be monitored over an extended post-intervention period.

Siris et al (2006) evaluated the effect of age and bone mineral density (BMD) on the absolute, excess, and relative risk for osteoporotic fractures at the hip, wrist, forearm, spine, and rib within 3 years of peripheral BMD testing in postmenopausal women over a wide range of postmenopausal ages. They found that age-effect was most evident for hip fracture and at any given BMD, not only the absolute fracture risk but also the excess fracture risk increased with advancing age. Relative risk of fracture for low bone mass was consistent across all age groups from 50 to 99 years.

In 2000, the number of osteoporotic fractures was estimated at 3.79 million, of which 0.89 million were hip fractures (179,000 hip fractures in men and 711,000 in women). The total direct costs were estimated at 31.7 billion (£21.165 billion), which were expected to increase to 76.7 billion (£51.1 billion) in 2050 based on the expected changes in the demography of Europe (Kanis, Johnell, 2005). The number of hip fractures (actually a fracture of the head of the femur in the thigh) is expected to double in the next 20 years due to increasing population and increased life expectancy.

Broe et al. (2000) conducted a study to determine the ability of a single BMD measurement to predict the risk of subsequent fracture in long term care residents. Total

252 Caucasian nursing home residents (mean age was 88 years) were recruited between 1992 and 1998. They resulted as subjects in the lowest age-specific quartile of femoral neck BMD had over 4 times the incidence of fracture compared with those in the highest quartile. Their study showed also, BMD at the hip and radius is predictive of fracture risk in long-term care residents, independent of cognition, falls and other fracture-related risk factors.

Multiple studies have shown that aerobics, weight bearing, and resistance exercises can maintain or increase BMD in postmenopausal women. Weight-bearing physical activity has beneficial effects on bone health (ACSM, 2004). Many researchers have attempted to pinpoint which types of exercise are most effective at improving BMD and other metrics of bone quality; however, results have varied. Treadmill walking, gymnastic training, stepping, jumping, endurance, and strength exercises all resulted in significant increases of L2-L4 BMD in osteopenic postmenopausal women.

Impact exercises included high-impact aerobics, running and jump training. Non-impact exercises included stretching, resistance training and weight-lifting. Bone loss in the lumbar spine was 1.5% lower in the group participating in impact exercises and was 1.2% lower in those in the non-impact exercise group. Physical activities designed to improve strength and endurance or the strength of specific muscles that act on the bone. Brisk walking, dancing and jumping appear to slow or prevent bone loss in postmenopausal women, although the results are not entirely consistent (Brown & Josse, 2002). Several meta-analyses have been conducted on the effect of physical activity on bone loss in postmenopausal women. Wolff et al., (1999) concluded that physical activity prevented or reversed almost 1% of bone loss per year in both the lumbar spine and femoral neck.

Health Related Quality of Life was lower in the physical functioning domain in women and the role physical domain in men who sustained main fractures at the hip. The physical, psychological and social consequences of osteoporotic fractures can profoundly influence health-related quality of life (HRQL) and should be considered when quantifying the impact of this disease. It should be recognized that fractures are likely to be only one of the many medical conditions that influence HRQL. Osteoporotic fractures generally affect people later in life (Adachi et al., 2001). Adachi et al. (2001) indicated that HRQL was significantly lower in participants who have experienced prevalent main fractures attributable to osteoporosis as compared with subjects.

2.9 Quality of Life and Anxiety in Elderly

2.9.1 Quality of Life in Elderly

Health-related quality of life covers physical, mental, and social well-being. Good health is an important aspect of quality of life. Healthier people are also happier, more socially active and more satisfied with life (Foos & Clark, 2003). Physical health has three dimensions that related to quality of life: physical condition, functional status, and subjective health. Quality of life has become a major criterion for evaluating health, physical and medical interventions (Kutner et al, 1992). Physical condition is the presence of health problems with person faced, like chronic disease, cardiovascular disease and etc. Many elderly has some of this illnesses because natural way of aging. Functional status is degree to which these physical conditions prevent persons from being able to do some daily activities (self care, ADL) and subjective health is the personal evaluation that individual make about their own health. Quality of life refers to health related quality of life factors and it can be defined as the measuring way to how individuals function and how they feel about the way that they function (Spirduso, Francis & MacRae, 2005).

In some studies it was found that physical exercise had good effect on Quality of Life in elderly. Lyons et al (1994) aimed to determine whether the Short-form 36 Health Status Questionnaire (SF-36) is suitable for use in an elderly population. The SF-36 was administered by interview to a random sample of 827 adults. As a result of their study, it was found that the SF-36 was suitable for use with an elderly population when used in an interview setting.

Takata et al (2009) conducted a study to evaluate the association of quality of life (QoL) in an 85-year-old population with physical fitness measurements assessed at age 80 and 85 years. Two hundred seven individuals (90 males, 117 females) at the age of 85 underwent the Short Form-36 (SF-36) questionnaires for QoL assessment and physical fitness measurements. They found that the several physical fitness measurements, leg-extensor strength and the walking speed of 85-year-olds, and the stepping rate of 80-year-olds were most closely associated with QoL. In a very elderly population of 80- and 85-year-olds, significant associations were found between QoL by SF-36 and physical fitness measurements. They suggested that improving physical fitness level even in aging can increase Quality of life.

Peker et al (2004) conducted a study to investigate the differences in the various domains of QOL between the women and men with osteoporosis. Thirty women and 28 men who had osteoporosis were included in their study. Bone mineral density (BMD) was measured by using Dual- Energy X-Ray Absorptiometry (DEXA). Mean age for women and men with osteoporosis was 61.80 years and 62.86 years respectively. QOL was measured by using the Short Form 36 (SF-36). The SF-36 physical function scores were significantly lower in patients with osteoporosis. They reported that the impairment in the physical function, physical role and pain domains in women with osteoporosis was significantly greater than those in men.

A study by Eyigor, Karapolat and Durmaz (2007) was carried out to determine the effect of a group-based exercise program on the physical performance, muscle strength and quality of life (QoL) in older women. Twenty women performed an exercise program for 8 weeks and a 4-m and 20-m walk test, a 6-min walk test, stair climbing and chair rise time, timed up and go test, isokinetic muscle testing of the knee and ankle, and the short form-36 (SF-36) and geriatric depression scale (GDS) questionnaires were applied. They concluded that this exercise program, when applied to older women, resulted in improved physical performance, increased muscle strength measured in both the knee and ankle, and improvement in the scores, estimating the QoL.

The study by Gillison et al (2009) provides an overview of the effect of exercise interventions on subjective quality of life (QoL) across adult clinical populations and well people, and to systematically investigate the impact of the exercise setting, intensity and type on these outcomes. They got data from a systematic search of six electronic databases, 56 original studies were extracted, reporting on 7937 sick and well people. Three to 6 months post-baseline, a moderate positive effect of exercise interventions was found for overall QoL in rehabilitation patients, but no significant effect for well or disease management groups. However, physical and psychological QoL domains improved significantly relative to controls in well participants.

Vuillemin et al. (2005) pointed out that there were few data on the relationship between health-related quality of life (HRQoL) and leisure time physical activity (LTPA) in the general population. Their study was conducted for investigating the relationships of meeting public health recommendations (PHR) for moderate and vigorous physical activity with Health related quality of life in French adult subjects. They assessed 2333 men and 3321 women using the French versions of the Modifiable Activity Questionnaire (MAQ) and the SF-36 questionnaire. According to the results of their study, subjects who attended PHR for physical activity had better HRQoL than those who did not. This study emphasizes the importance to promote at least moderate physical activity.

Physical fitness can be related with wellness and quality of life. Garatachea et al (2009) conducted a study to investigate, in a sample of Spanish elderly, whether measures of physical activity and physical function are related to feelings of well being, and whether level of dependence is a moderator in the relation of well being, physical activity and physical function. 151 elderly people aged 60–98 years completed surveys including demographic characteristics, and measures of physical activity (Yale Physical Activity Survey, YPAS), instrumental activities of daily living (Barthel Index, BI) and well being. Components of the physical function were measured by the Senior Fitness Test (SFT). Upper and lower body strength, dynamic balance, and aerobic endurance; self-reported weekly energy expenditure and physical activity total time were significantly correlated with both Material and Subjective well being. They concluded that physical function and physical activity are related to feelings of well being, and their results emphasize the positive functional and psychological effects of physical activity in dependent subjects.

Lee, Ko and Lee (2006) performed a descriptive-correlation study to explore the relationship between health promotion behaviors and QoL in Korean elderly living in the community. 2000 community residents who were over 65 years old and cognitively intact were selected from 32 senior centers and 242 public health centers in Korea. Their results of the study showed that there were statistically significant differences in QoL of the elderly related to exercise participation, alcohol abstinence and blood pressure (BP) check-up. They advised that health care professionals should assess the elder's own perception of their health and identify interventions to improve their health perception.

Matsuo et al (2003) evaluated Quality of life (QOL) and personality in two groups of elderly subjects with and without activity participation. A survey was conducted with 321 elderly subjects over 65 years of age using a 24-item questionnaire regarding personality and depressive inclination and the visual analogue scale-happiness to measure QOL. Their results suggested that the QOL of the activity participation group was significantly higher than the non-activity participation group as expected.

In another study, Arslantas and et al. (2007) aimed to determine the relationship between QoL and activities of daily living (ADL) of elderly people in rural areas of Eskisehir, and to identify applicable factors in this regard. Cross-sectional study managed to reach 1301 (81.3%) of elderly people. the WHOQOL-BREF QoL scale and questionnaire were applied to evaluate daily life activities, as well as instrumental activities all of which contained socio-demographic features. They concluded that in cases where medically diagnosed diseases were present, quality of life in women that were dependent somehow in daily activities was worse.

In sum, it can be concluded that in many studies above that quality of life appeared as related to independent daily activity living, physical activity level, health, and socioeconomic status of elderly people.

2.9.2 Anxiety in Elderly

Anxiety is significantly prevalent causes of physical illness, psychosocial impairment and mortality throughout the world. It affects the quality of life in seniors, particularly by restricting their social life and gradually reducing their independence (Antunes, 2005). "Anxiety is considered to be a negative emotional state characterized by feelings of nervousness, worry, and apprehension and by activation or arousal of the body" (Carron, Heather & Estabrooks, p. 39). Anxiety is commonly described as state anxiety and trait anxiety. State anxiety refers to the immediate psychological and physiological response to a conscious or unconscious perceived threat. Trait anxiety is personality characteristics that people reflect same all the time

Exercise has been shown to have a direct effect on anxiety (Lavie et al., 1999). There are many studies that were about exercise effects on Anxiety. DiLorenzo et al (1999) showed the positive effects of short term and long term effects on psychological parameters. In their study, following completion of a 12-week aerobic program (and through 12 months of follow-up), 82 adult participants completed the Beck Depression Inventory, Profile of Mood States, State-Trait Anxiety Inventory, and the Tennessee Self-Concept Scale. They found that exercise participants experienced a positive fitness change and psychological improvement over the initial 12-week program compared to a control group. At 1 year follow-up, physiological and psychological benefits remained significantly improved from baseline. They concluded that exercise induced increases in aerobic fitness have beneficial short-term and long-term effects on psychological outcomes.

Another study by Hassmen, Koivula & Uutela (2000) aimed to explore the association between physical exercise frequency and a number of measures of psychological well-being in a large population-based sample. The authors suggested that individuals who exercised at least two or three times a week experienced significantly less depression, anger, cynical distrust, and stress than those exercising less frequently or not at all. Their results also support the association between enhanced psychological well-being, as measured using a variety of psychological inventories, and regular physical exercise.

Antunes et al (2005) conducted a study to examine the effects of fitness-endurance activity (at the intensity of ventilatory threshold) in depression, anxiety and quality of life scores in seniors. 46 sedentary seniors aged 60-75 who were randomly allocated to two groups. Experimental group took part in an aerobic fitness program consisting of ergometer cycle sessions 3 times a week. Subjects were submitted to a basal evaluation using the geriatric depression screening scale and SF-36 (quality of life scale). They concluded that there were a significant decrease in depressive and anxiety scores and an improvement in the quality of life in the experimental group, but no significant changes in the control group and it means an aerobic exercise program promote favorable modifications in depressive and anxiety scores to improve the quality of life in seniors.

Cassidy et al (2004) conducted a study to investigate the association between potentially modifiable lifestyle factors and cognitive abilities and depressive symptoms among community-dwelling women aged 70 years and over. Lifestyle variables assessed included smoking, alcohol consumption, physical activity, nutrition and education. The mental health measures of interest were depression, anxiety, quality of life and cognitive function. Physically active women were half as likely to be depressed (BDI score $\geq$ 10) and anxious (BAI score $\geq$ 8) as compared to their physically inactive counterparts. The results of this study are consistent with the hypothesis that depression is directly associated with heavy smoking and inversely associated with physical activity.

Bahar, Tutkun and Sertbas (2005) prepared a study to find out the level of the old age depression and their anxiety in a group of 71 elderly women living in the nursing home. Measures were geriatric Depression and Beck Anxiety scales. Results revealed that the period of remaining in the nursing home of old people, the state of perceiving and the level of chronic illness increased the level of anxiety in the nursing home. Thıs, the authors advised that the spare time and planning of the social activities would affect the level of depression and anxiety in positive ways.

2.10 Summary

Mean life expectancy has increased dramatically during the present century, and it is expected that it will continue to increase in Turkey. Although this may be considered as a positive development, there are a number of serious health problems in elderly. These health problems can affect countries` economy by increasing health costs. With aging, physical changes such as impairment in flexibility, muscle strength, balance impairment and slowing reaction time may occur. Regular lifetime physical activity appears to delay these factors. Researchers have been investigating which exercise is more effective to manage with these problems. In literature, there are many studies that conducted on different type of exercise like strength exercise, balance and flexibility exercise and calisthenics exercises. These exercises had benefits on bone density, quality of life, anxiety and reaction time.

In aging, other important problem is falling. Exercise has effective way to decrease number of falls by developing muscle strength, flexibility and balance. In this study, pilates exercise was chosen because it has positive effects on dynamic balance, muscle strength and flexibility. This exercise was developed by Joseph Pilates in the 1920s as a method of rehabilitation for diseases from chronic diseases to asthma but nowadays it is used as exercise. Pilates is a contemporary, anatomically-based approach similar to Joseph Pilates' original exercise method which caters to people of all ages, all body types, and all fitness abilities. It has approximately 500 exercises that are performed on mats or specialized apparatus. Pilates exercise can increase muscle strength, endurance, and flexibility and balance. This exercise was used by dancers, soccer players, young people and healthy adults and by physiotherapist in rehabilitation centers.

CHAPTER 3

METHOD

3.1 Participants

Participants were recruited from female volunteers living in a residential house. Inclusion criteria were to be healthy and aged over 65. Participants were informed on the possible significant risks, which mainly included muscular soreness. They were sedentary for at least a year prior participating to this study. The control group comprised of healthy subjects living in the same residential house. All participants signed an informed consent form. Ethical committee aproval was obtained from a public hospital.

A total number of 168 individuals volunteered for the study. At screening (general health screening questionnaire (Appendix A) and physician advice) 68 volunteers failed to meet the criteria for participation. A total of 100 volunteers passed the screening phase and attended the study. Upon completion of screening and assessment procedures, participants were randomized into either the exercise (n=30) or control (n=30) group using a coin toss. The remaining 40 participants were included to the study for the correlation of the dependent variables. Two participants were lost at follow up due to death (fig. 3.1).

Participants in the control group were asked to maintain their current level of activity throughout the duration of the study and to refrain from beginning any exercise program or activities during this time. In this study, an orthopedic surgeon, a psychologist a physiotherapist and two sports scientist measured and evaluated the variables.

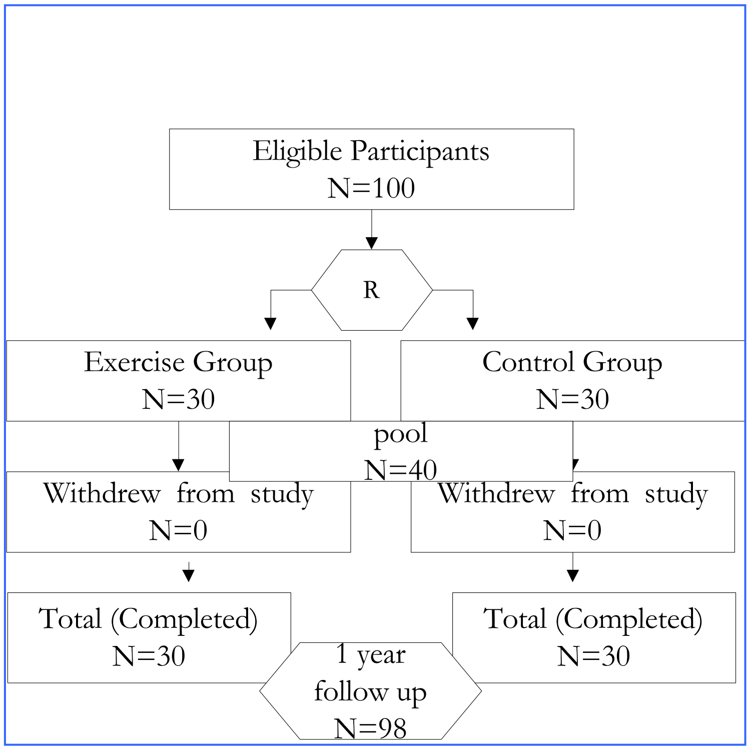


Fig 3.1 Number of Participants

3.1.1 Exclusion Criteria

Volunteers were excluded from participation in either group if any of the following were present:

- ✓ if any significant general health problem or orthopedic problems that would affect their full participation in intervention protocol and lead to the inability to attend at least 80% all training sessions;
- ✓ A self-reported medically diagnosed neurological disorder (i.e. Parkinson's disease, multiple sclerosis, head injury, peripheral neuropathy, stroke, vestibular disorder);
- ✓ Cognitive impairment;
- ✓ Taking medication which may cause unsteadiness (sedatives, antidepressants, or hypnotic medications);
- ✓ A self-reported musculoskeletal disorder (i.e. joint replacement, amputation, or physically limiting arthritis).

3.1.2 Inclusion Criteria

Volunteers were considered for inclusion in the study if they met the following criteria:

- ✓ 65 years of age or over at the time of the study;
- ✓ Independently living in the Residential House;

Table 3.1

Demographics of Participants (N=100).

	Demographics
	Percent (%)
Marital Status	
-Married	8
-Single	18
-Divorced	17
-Widow	57
Education level	
-University	24
-High School	25
-Middle School	19
-Primary School	15
-Literate	17
Perceived SES	
-Upper	18
-Middle	66
-Lower	16

Many of participants were widow (57%) and graduated from high school (25%), and university (24%). These results show that participants were well educated and living alone and participant's perceived socio economic statuses were middle (66%).

3.2 Study Design

A randomized prospective study was designed. This study had two phases. In the first phase, the Pilates exercise was initiated for 12-weeks. In the second phase, participants were followed up for a year. All measurements were repeated. The dependent variables were dynamic balance, simple and choice reaction time, trunk flexibility and tigh muscle strength, bone mineral density of the hip and spine, anxiety scores, quality of life scores; as well as body height and weight were measured in all subjects (fig 3.2).

Participants joined a 12-week series of one hour Pilates exercise three times per week. Each exercise session lasted for about 60 min and was led by a certified Pilates instructor. Modifications of exercises were consistent with those detailed in the Stott Pilates Comprehensive Matwork Manual (2001). Modified Pilates based exercises (Appendix B) were divided three parts. In first part (4 week), mat exercises (Segal et al., 2004; Stott Pilates, 2001), in the second part thera-band exercises and in the third part Pilates ball exercises for beginners (Latey, 2002) were performed. Some of the exercises in the protocol are shown in Fig. 3.4, Fig. 3.5 and Appendix B. Measurements and tests were aplied before Pilates exercise and completed on the same day to the control group. Instruments for testing were calibrated and used by the same researcher to control possible inter-tester variation. Prior to the testing, a standardized 5 min warm-up was completed.

Falls during follow-up were questioned with a set of monthly fall calendars, which subjects were asked to fill in each day and return to the physiotherapist at the end of each month. Subjects were asked to write (F) on the calendar if they had a fall on that day and (N) if they did not fall. Subjects who had not returned a calendar within 10 days of the end of the month were reminded by the physiotherapist and asked about their falls for the previous month. Subjects provided data on falls for 12 months (n=98). At the baseline, all measurement (dynamic balance, muscle strength, flexibility, reaction time, bone density, quality of falls and beck anxiety scale) were assessed. After one year, all tests were repeated to examine the time differences.

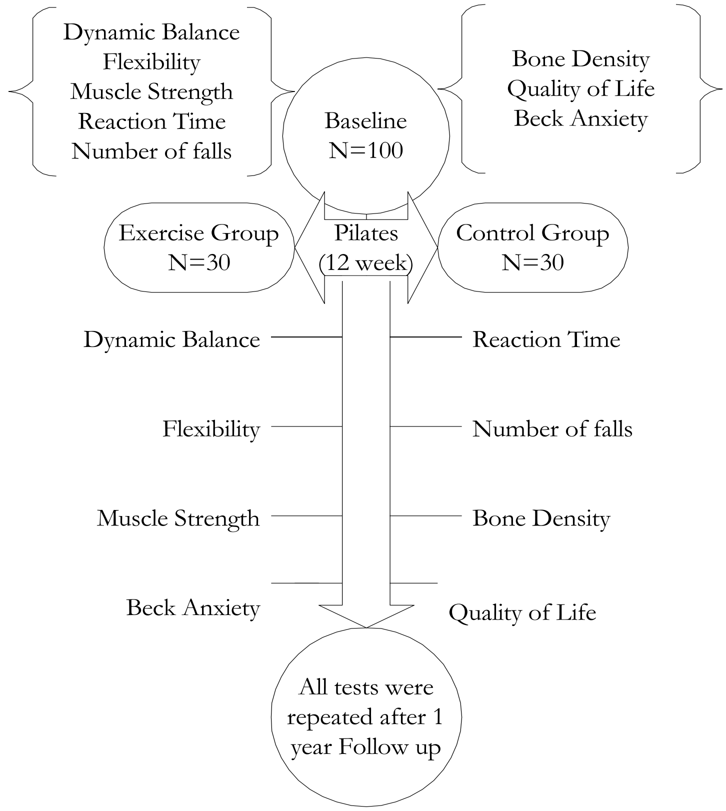


Fig 3.2 Study Design and Measured Parameters Throughout the Study

3.2.1 Data Collection

Instruments for testing all variables were calibrated and used by the same researcher to control possible inter-observer variation. Prior to testing, a standardized 5 min warm-up was completed. Prior to each exercise session, heart rate and blood pressure were measured.

Body weight was measured on a digital balance scale, and body height was determined using a stadiometer. BMI was calculated as weight/ (height squared) (kg/m2) (WHO, 1997). Dynamic balance was assessed using the MED-SP 300 Dynamic Stability Measurement Platform. This device can do measurements in three levels; hard, medium and easy. In this study, measurement mean value was obtained from the MED-SP 300 level of easy. A circular platform that is free to move in the anterior-posterior and medial-lateral axes simultaneously, which permits Rank Value (an overall) stability index (RVSI) to be obtained. It has 15° measuring ability in all directions. Measures were obtained from 30-sec trials Measures were performed from 30-sec trials and during these trials participants maintained an upright standing position on their limbs on the unstable surface of the MED-SP 300. In our measurements, a safe cage was used to prevent any accidents in elderly women. An examination of measures obtained that the MED–SP 300 produced reliable measures as indicated by R = .91 (RVSI). Validity measures as indicated by R=.87 (Irez et all, 2006); Cug et all, 2007). This dynamic balance measurement platform is portable, cheap, and suitable for measuring dynamic balance.

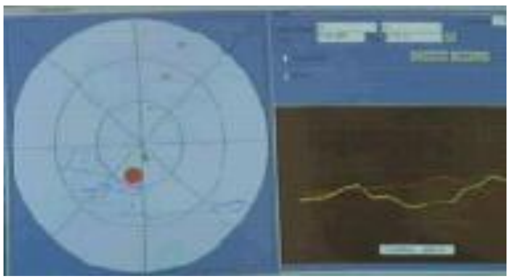


Fig 3.3 MED-SP 300 (Retrieved from www.sportexpert.biz/product_medsp300.htm)

Reaction time was measured with the reaction time measuring device (New Test-2000, Co, and Finland) using light and sound stimuli. Time was measured in milliseconds (ms).The subjects were asked to press the button on the index finger as quickly as possible when they observed the light or heard the sound stimulus on the panel placed in front of them. Measurements were repeated 3 times and averages of them were recorded.

Muscle Strength was measured the sum of breaking forces of hip flexion, hip abduction, and hip adduction (MPLS) by Proximal Leg Strength. Nicholas Manual Muscle Tester (MMT), Lafayette Company, Model 01160) was used in this measurement. The average of three trials in which a maximum effort was supplied some practice trials gives the most reliable results. It was allowed at least 15 seconds between trials (Kendall et al., 1971). Kendall Method was used. Each test was performed in a similar manner. The subject raised the limb to the specified height and maximally resists the examiner’s efforts to depress it. The MMT was placed between the examiner’s hand and the subject’s limb, taking care not to grasp the stirrup of the MMT. A downward force was gradually applied over one second to allow the subject to adjust and recruit the maximum amount of muscle contraction begins to break and the limb begins to lower (Kendall, H.O. 1971). A break test technique was used for abduction and adduction by using the positions delineated by Kendall.

Abduction muscle strength was tested with the subject in the side lying position. The player was asked to abduct her top leg above horizontal and a breaking force was applied distally and the side-lying position was also used for testing adduction muscle strength. The participant was asked to straighten her bottom leg and then lift the straight leg. Muscle strength assessment with a handheld dynamometer has been shown to be a valid and reliable method of measuring strength. Bohannon (1986) demonstrated test-retest correlation coefficients of 0.84 to 0.99 for hip strength measurements, indicating good-to-high reproducibility. The same investigator performed all strength measurements for the study.

Flexibility was measured by the sit and reach test (Clark et al. 1989). To perform the sit and reach test the participants removed their shoes and sat on the floor facing the flexibility box with their heels touching the side of a box after warm up. Their finger tips were on the 0 cm edge of the box that was vertically marked in centimeters towards the opposite edge. The farthest test score of three trials was recorded. The sit-and-reach test was conducted to measure flexibility of the hamstrings and lower back.

Bone mineral density (g/cm^2) at the hip region (trochanter,Ward's triangle, and femoral neck) and the lumbar spine (L2–L4) were assessed by dual-energy X-ray absorptiometry (DXA) (Lunar DPX-IQ, Lunar Corp., Madison,WI) performed at the Middle East Technical University Health Center before and after the training period and 1 year follow up. The precision of this instrumentation is within the 1% range (Sievanen H. et al. 1992). During the test, participant lied down on padded table. A central DXA scans the hip and spine, the two areas most vulnerable to osteoporotic fractures. The measurement procedure takes about 10 minutes and involves no injection. This scan is a very low-dose x-ray using device. The participants lied fully clothed except for metal equipments like belt etc. There is no preparation for the test. The World Health Organization (WHO) recommended that the diagnosis of osteoporosis be made when the T score on bone-mineral-density measurement by dual-energy x-ray absorptiometry is 2.5 or lower (Genant et al., 1999).

Beck anxiety scale is a 21-question self-report scale that is used to gauge the severity of a person's anxiety. The questions ask the individual about how she has been feeling in the last week, expressed as common symptoms of anxiety. Such symptoms include hot and cold sweats, numbness, or feelings of dread. All the 21 questions have the same set of four possible answers that are arranged in columns and the person needs to answer them by marking the right answer with a cross. The answers are rated on a four-point scale, ranging from “not at all” (0) to “severely” (Beck, 1990).

Furthermore, the Beck anxiety scale has scores from 0 to 63. The lower the score means the lower the anxiety level and the higher the score, the more the anxiety. A score between 0 and 7 denotes minimal level of anxiety while a score between 8 and 15 shows that the person's anxiety level is mild. If a person's score lies in the range 16-25, her anxiety is moderate, but if someone scores between 26 and the maximum of 63, participants must be suffering from severe anxiety. A healthy person should have a score below 21 (Beck, 1990). In this study, the Beck Anxiety Inventory proved highly internally consistent (cronbach's Alpha = .88).

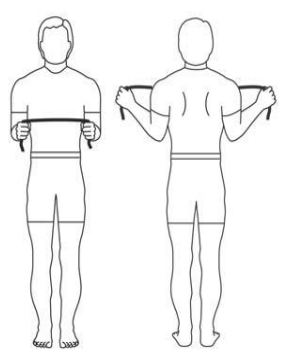
In quality of life measurement, a 36-item short-form (SF-36) was used. SF-36 includes 36 items and assesses eight domains of functional status: physical functioning (PF), role - physical (RP), role emotional (RE), bodily pain (P), general health (GH), vitality (V), mental health (MH) and social functioning (SF). Some researchers use two general domain scores also: Physical Component Summary (general physical = PCS) and Mental Component Summary (general mental = MCS) domain scores. The instrument has good cross validations with other generic Qol measures. It has been validated for Turkish version in 1999 (Kocyigit, et al., 1999). For each quality of life domain tested, item scores were coded, summed, and transformed into a scale from 0 (worst) to 100 (best). Scale scores represent the average for all items in the scale that the respondent answers. We used total score.

3.2.2 Pilates Equipments

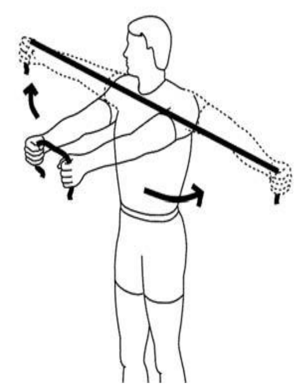
In Pilates exercise, there are different equipments to use for different aims. We used thera band or elastic bands, and Pilates or exercise ball. The Thera-Band resistance exercises strengthen the chest, arms, and help with abdominal strength as well. The Thera band or Elastic bands are portable, inexpensive and can be used in the seated, standing, supine or prone position. Elastic resistance usually is provided in a color coded progression from light to heavy resistance. These are yellow, red, green, blue, black and silver, tan and gold. Elastic bands can accommodate exercisers of varying ages and abilities (Phillip et all 2003). We used blue, red and green color exercise band. We decided type of resistance bands after muscle strength measurements.

Pilates or exercise ball ideal for individual or group exercise programs to improve spinal mobility; strengthen the trunk, upper body or lower body; to improve balance and coordination; and for increasing flexibility. Pilates ball sizes are ranges between 45 cm (yellow) to 85cm (grey) and also 55 cm (red), 65 cm (blue). We used red, blue and green colors ball.

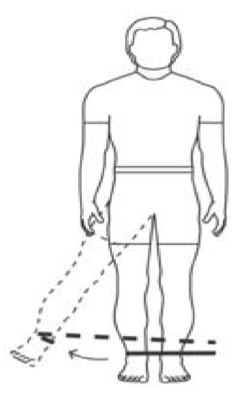
Scapular Retraction



Reverse Flies



Hip abduction



Hip extension

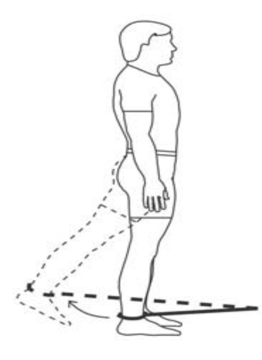


Fig 3.4 Some Examples for Thera-band Exercises (Received from www.uwex.edu/ces/flp/.../06_current_concepts_Graf_manual.pdf)

Figure 3.5a

Figure 3.5b

Figure 3.5c

Figure 3.5d

Fig 3.5 Some Examples of Pilates Ball or Exercise Ball Exercises (Photos taken by author)

3.3 Statistical Analyses

All data were analyzed using SPSS Version 17. Repeated measure MANOVA's with mixed design were performed to examine dynamic balance, flexibility, reaction time, muscle strength, number of falls, bone density, quality of life and anxiety. Mixed design repeated MANOVAs with group as a between subject factor were then conducted separately for physiological measures, bone density and psychological measures of exercise and control groups. The significant main and interaction effects were examined by follow up univariate analyses. A hierarchical multiple regression was conducted to address the relationship between the dynamic balance and described variables. Moreover, paired sampling t- test was used to evaluate differences between pre-test (a year ago) and after a year follow up in all parameters.

CHAPTER 4

RESULTS

The independent variable of the study consisted of 12 week Pilates exercises. The dependent variables of the study were dynamic balance, reaction time, flexibility and muscle strength, bone mineral density, Beck anxiety, Quality of life questionnaire and the number of falls.

4.1 Demographic Findings

Exercise and control groups' age, height, weight and BMI means were given in table 4.1. The Pilates exercise group completed training sessions throughout the total 36 training sessions (92% participation rate).

Table 4.1

Physical Characteristics of the Exercise and the Control Groups

	Pilates Group(N=30)	ControlGroup(N=30)	All Participants(N=100)
Variable	Mean±SD	Mean±SD	Mean±SD
Age	72.80±6.74	78.03±5.73	75.64±9.83
Height (m)	156.10±6.44	156.53±5.17	157.24±11.21
Weight (kg)	67.20±9.59	67.83±10.96	67.57±10.74
BMI (kg/m²)	27.5±5.6	27.6±5.4	27.4±5.4

To test initial differences between groups for the physiological and psychological measurements multivariate ANOVA's were conducted. The analyses revealed no significant differences in any of the physiological measurements of Dynamic balance, flexibility, muscular strength, reaction time, and bone density (Wilks' Lambda=.84, $F_{(1, 58)} = 1.66$, $p > 0.05$) as well as anxiety and quality of life and number of falls (Wilks'Lambda=.96, $F_{(1, 58)}$

= 1.19, p >0.05) among groups. It can be said that all baseline values of groups in the present study did not differ from each other.

4.2 Physiological Parameters

A 2x3 (exercise/controlxpre/post/follow up test) mixed design repeated measure MANOVA was conducted to examine the effects of Pilates exercise on dynamic balance, flexibility, muscle strength, reaction time and number of falls parameters of elderly women.

Results revealed significant multivariate main affect for Time (Pillai's Trace= 0.94, $F(6, 53) = 61.13$, $p < 0.05, \eta^2 = .94$, power= .99) and a Time x Group interaction (Pillai's Trace =.87, $F(6, 53) = 26.01$, $p < 0.05$, $\eta^2 = .87$, power= .99) and main effect for Group (Pillai's Trace =.60, $F(6, 53) = 13.457$, $p < 0.05$, $\eta^2 = .60$, power= .99). Paired t-test which was conducted to detect which pairs of time levels are significantly different from each other.

Table 4.2

The Changes in Dynamic Balance, Flexibility, Reaction time, Muscle Strength and Number of Falls

	Groups					
	Exercise			Control		
	Pre- test	Post- test	After1year	Pre- test	Post- test	After1year
Variables	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd
DynamicBalance [c]	10.98±1.5*	8.99±1.5	10.59±1.2	11.40±1.81	11.23±2.1	13.20±1.5
Sit and reach (flexibility)[a]	12.75±4.4*	15.88±5.1	13.70±4.2	10.80±3.84	10.40 ±3.6	8.48±3.4
MuscleStrength [b]	23.34±5.7*	32.71±7.0	20.93±1.5	20.98±8.90	20.72±8.6	11.39±4.9
Reaction Time						
Simple RT[d]	0.34±.09*	0.26±.05	0.35±.08	0.38±.09	0.39±.08	0.61±.1
Choice RT[d]	0.69±.20*	0.55±.1	0.71±.15	0.72±.16	0.73±.1	0.94±.1
# of falls	1.87±1. 4*	0.37±0.5	0.63±.80	1.63±1.21	1.30±0.4	1.67±.6

a centimeter
b kilogram
c angle
d ms
*p<0.05

4.2.1 Dynamic Balance

The result of the analysis on dynamic balance indicated that the Pilates group produced significantly better balance values than the control group in the post-test (Table 4.2).. Moreover, in Pilates group, there were small increase in dynamic balance between pre-test (M=10.98±1.55) and 1 year follow up (M=10.59±1.29). Pilates exercise group showed more improvement regarding dynamic balance (t (df=29) =11.63, p<0.05) than did the control group.

Results of the mixed design repeated MANOVA test revealed a significant interaction effect for group and measurements. Follow up ANOVA's indicated significant time interactions for dynamic balance ($F_{(1, 58)} = 81.89$, $p < 0.05$, $\eta^2 = .67$, power= .99); and for time X group effects dynamic balance ($F_{(1, 58)} = 348.69$, $p < 0.05$, $\eta^2 = .50$, power= .99) and for group effects dynamic balance ($F_{(1, 58)} = 19.63$, $p < 0.05$, $\eta^2 = .25$, power= .99).

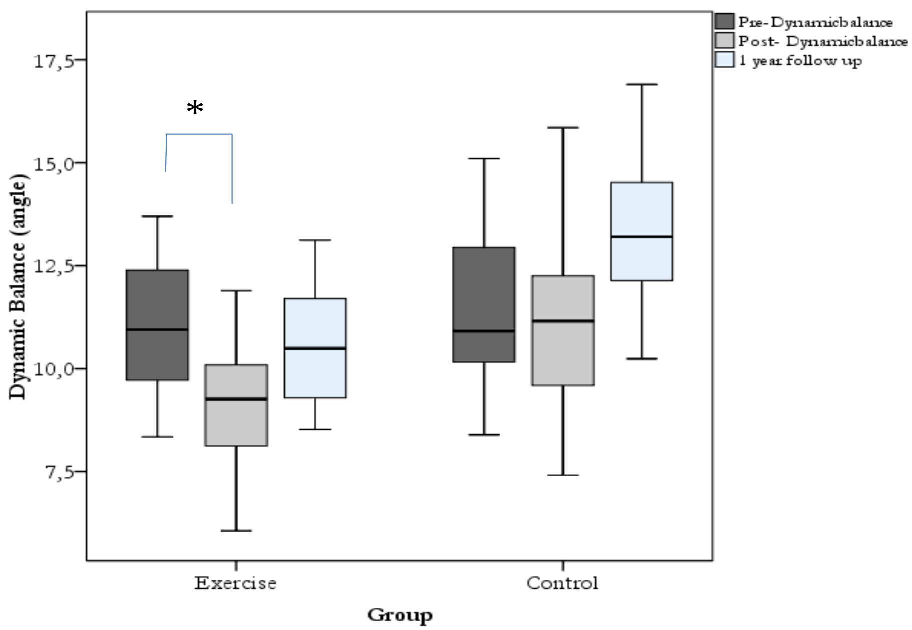


Fig 4.1 Dynamic Balance Pre-Post Tests and Follow up Tests of Exercise Group (pre test, M=10.98±1.55; post test, M=8.99±1.51; follow up, M=10.59±1.29) and Control group (pre test, M=11.40±1.81; post test, M=11.23±2.09; follow up, M=13.20±1.55).

4.2.2 Flexibility (Sit and Reach)

Results of the mixed design repeated MANOVA indicate that there was a significant difference between pre- and post-measurements of flexibility (t (df=29) =-9.19, p<0.05) only for the exercise group (Table 4.2). In Pilates group, there were less increase in flexibility between pretest (M=12.75±4.40) and 1 year follow up (M=13.70±4.22) and in control group there were much decrease in muscle strength between pretest (M=10.40 ±3.68) and 1 year follow up (M=8.48±3.49). Pilates exercise group showed more improvement regarding flexibility than did the control group (Table 4.2).

Follow up ANOVA's indicated significant time interactions for flexibility ($F_{(1, 58)} = 5.81$, $p < 0.05$, $\eta^2 = .09$, power= .66) and for time X group effects ($F_{(1, 58)} = 12.06$, $p < 0.01$, $\eta^2 = .17$, power= .93) and for group effects ($F_{(1, 58)} = 17.44$, $p < 0.05$, $\eta^2 = .23$, power= .99).

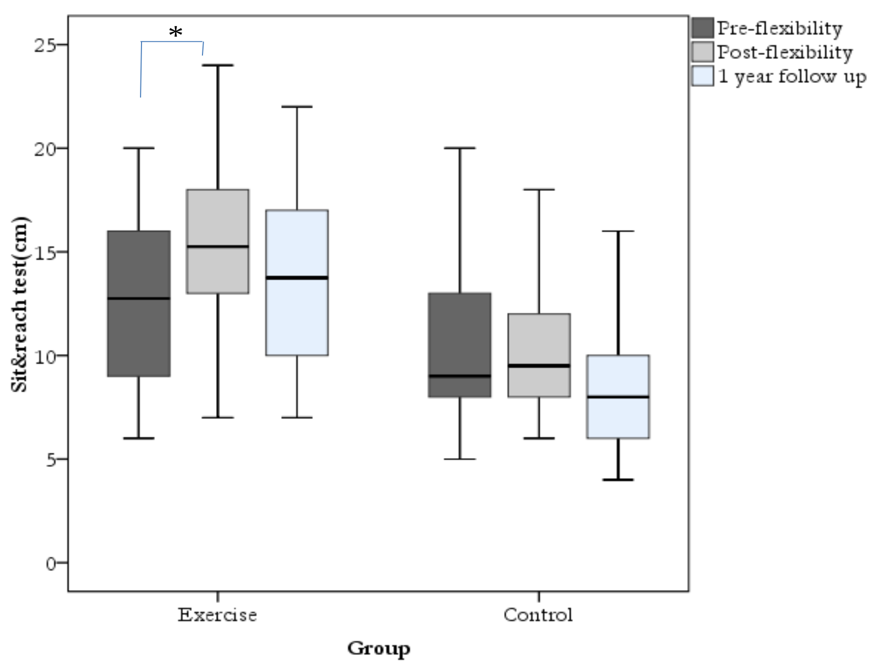


Fig 4.2 Flexibility Pre-Post Tests and Follow up Tests of Exercise Group (pre test, *M*=12.75±4.40; post test, M=15.88±5.17; follow up, M=13.70±4.22) and Control Group (pre test, M=10.80±3.84; post test, M=10.40±3.68; follow up, M=8.48±3.49).

4.2.3 Muscle Strength

There was a significant difference between the pre- and post-measures of muscle strength (t (df=29) =-6.41, p<0.005) for the exercise group after 12 week Pilates exercise. Pilates exercise had positive effects to increase muscle strength. In Pilates group, there were decrease in muscle strength between pretest (M=23.34±5.70) and 1 year follow up (M=20.93±1.51) although in control group there were decrease in muscle strength between pretest (M=20.98±8.90) and 1 year follow up (M=11.39±4.97).

Follow up ANOVA results revealed that there was a significant time interactions for muscle strength ($F_{(1,\ 58)}$ = 24.47, p <0.05, η^2 = .66, power= .99)and time X group effects interactions ($F_{(1,\ 58)}$ = 25.62, p <0.01, η^2 = .32, power= .99) for group effects ($F_{(1,\ 58)}$ = 24.27, p <0.05, η^2 = .29, power= .99)(Table 4.2), (Fig4.3). Pilates exercise group showed more improvement regarding muscle strength than did the control group after 12 week Pilates exercise.

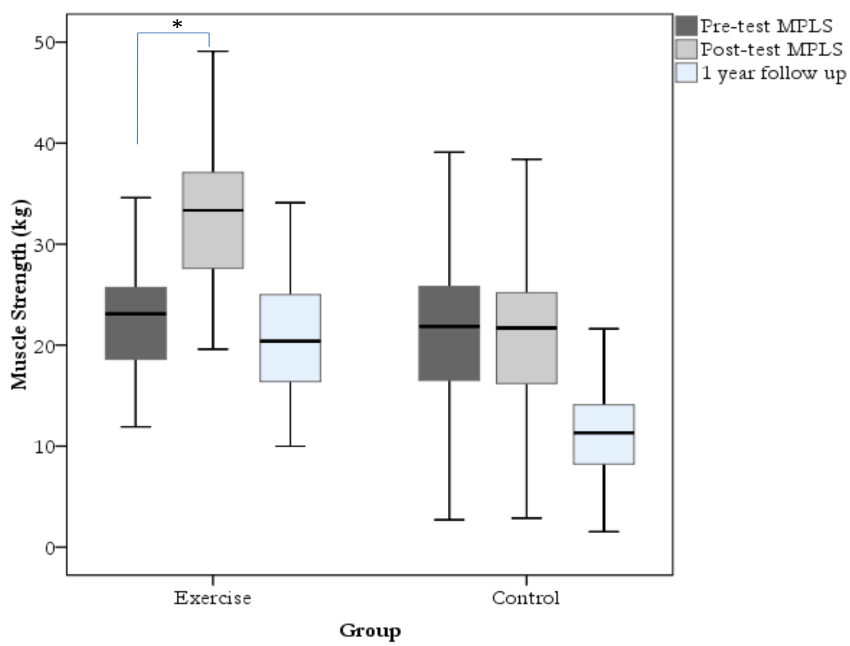


Fig 4.3 Muscle Strength Pre-Post Tests and Follow up Tests of Exercise Group (pre test, M=23.34±5.70; post test, M=32.71±7.07; follow up, M=20.93±1.51) and Control Group (pre test, M=20.98±8.90; post test, M=20.72±8.64; follow up, M=11.39±4.97).

4.2.4 Reaction Time

Results of the mixed design repeated MANOVA indicate that there was a significant difference between pre- and post-measurements of Simple reaction time (t (df=29)=6.53 ,p<0.05) and choice reaction time (t (df=29)=6.26 ,p<0.05) only for the exercise group (Table4.2). In Pilates group, there were increase in Simple RT between pretest (M=0.34±.09) and 1 year follow up (M=0.35±.08) although in control group there were much more increase in Simple RT between pretest (M=0.38±.09) and 1 year follow up (M=0.61±.16). Furthermore, there were similar results for Choice reaction time (pretest (M=0.69±.20) and 1 year follow up (M=0.71±.15) in exercise group and there were increases in control group`s result.

Follow up ANOVA results revealed that there was a significant time interactions for simple reaction time ($F_{(1, 58)}$ = 63.83, p <0.05, η^2 = .52, power= .97), choice reaction time($F_{(1, 58)}$ = 79.31, p <0.05, η^2 = .58, power= .94)and for time X group effects simple reaction time($F_{(1, 58)}$ = 38.367, p <0.05, η^2 = .40, power= .97), choice reaction time($F_{(1, 58)}$ = 23.65, p <0.01, η^2 = .29, power= .72).(Table 4.2) Pilates exercise group showed more improvement regarding both simple and choice reaction time than did the control group.

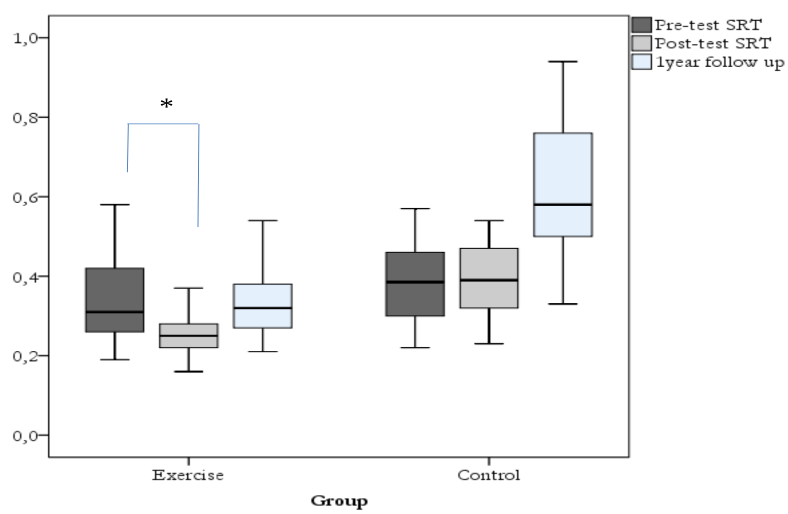


Fig 4.4 Simple RT Pre-Post Tests and Follow up Tests of Exercise Group (pre test, M=0.34±.09; post test, M=0.26±.05; follow up, M=0.35±.08) and Control Group (pre test, M=0.38±.09; post test, M=0.39±.08; follow up, M=0.61±.16).

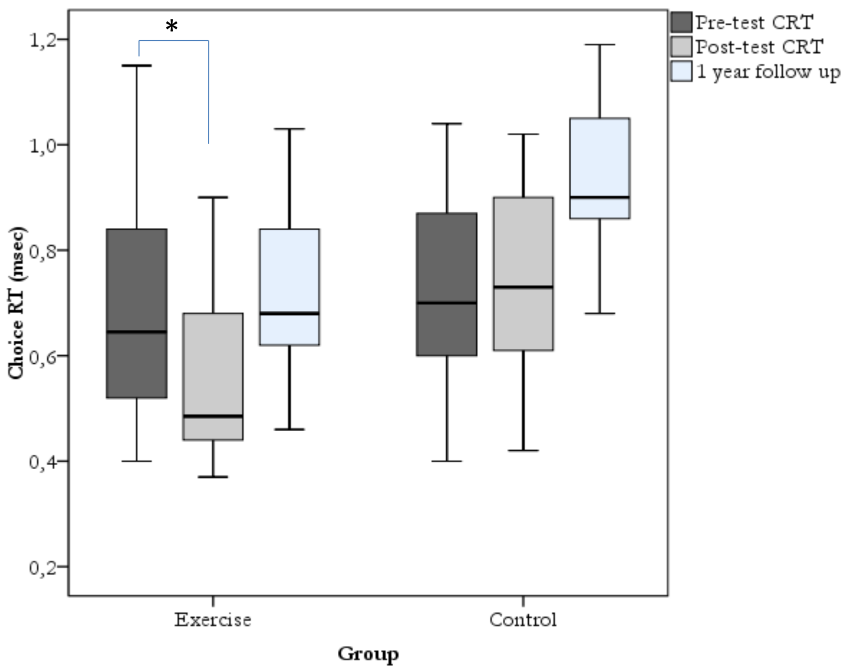


Fig 4.5 Choice RT Pre-Post Tests and Follow up Tests Exercise Group (pre test, M=0.69±.20; post test, M=0.55±.16; follow up, M=0.71±.15) and Control Group (pre test, M=0.72±.16; post test, M=0.73±.16; follow up, M=0.94±.13).

4.2.5 Number of falls

Results of the mixed design repeated MANOVA indicate that there was a significant difference between pre- and post-measurements of number of falls (t (df=29)=6.28 ,p<0.05) only for the exercise group. In Pilates group, there were decrease in Simple RT between pretest (M=1.87±1.45) and 1 year follow up (M=0.63±.80) although in control group there were increase in number of falls between pretest (M=1.63±1.21) and 1 year follow up (M=1.67±.66).

Follow up ANOVA results revealed that there was a significant time interactions for number of falls ($F_{(1, 58)}$ = 28.40, p <0.05, η^2 = .33, power= .99)and time X group effects interactions ($F_{(1, 58)}$ = 16.25, p <0.01, η^2 = .22, power= .99) for group effects ($F_{(1, 58)}$ = 8.87, p <0.05, η^2 = .14, power= .99)(Table 4.2 and Fig4.6). Pilates exercise group showed decrease in number of falls than did the control group after 12 week Pilates exercise.

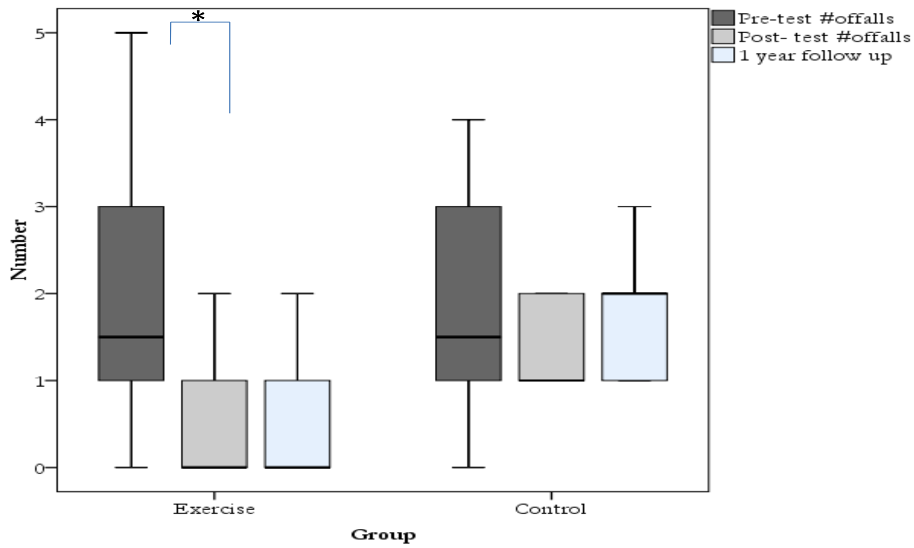


Fig 4.6 Number of Falls Pre-Post Tests and Follow up Tests Exercise Group (pre-test, M=1.87±1.45; post-test, M=0.37±0.55; follow up, M=0.63±.80) and Control group (pre-test, M=1.63±1.21; post-test, M=1.30±0.46; follow up, M= 1.67±.66).

4.2.6 Bone Mineral Density

A 2x3 (exercise/controlxpre/post/follow up test) mixed design repeated measure MANOVA was conducted to examine the effects of Pilates exercise on bone density parameters of elderly women. Pilates exercise group showed more improvement regarding all bone density measurements than did the control group (Table 4.3).

In Pilates and control group, there were decreases in lumbar spine BMD between (exercise) pretest (M=1.05±0.2) and 1 year follow up (M=0.99±0.2) and lumbar spine t-score (exercise) pretest (M=-1.21±1.3) and 1 year follow up (M=-1.31±1.4), femur BMD (exercise) pretest (M=0.88±0.1) and a year followup (M=0.86±0.1) and femur t-score (exercise) pretest (M=-0.95±0.9) and a year follow up (M=-0.97±1.0). There were prominent decreases in bone mineral density in control group versus exercise group after a year follow up.

Table 4.3

Changes in Bone Mineral Density

	Groups					
	Exercise			Control		
	Pre- test	Post- test	Follow up	Pre- test	Post- test	Follow up
Variables	X± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd
L2-L4 BMD(g/cm^2)	1.05±0.2	1.07±0.2	0.99±0.2	1.02±0.2	1.01±0.2	0.92±0.1
L2-L4 T score (g/cm^2)	-1.21±1.3	-1.04±1.4	-1.31±1.4	-1.27±1.3	-1.28 ±1.3	-1.65 ±1.0
Femur BMD(g/cm^2)	0.88±0.1	0.90±0.1	0.86±0.1	0.82±0.1	0.80±0.1	0.77±0.1
Femur T score (g/cm^2)	-0.95±0.9	-0.88±1.0	-0.97±1.0	-1.38±.9	-1.37±.8	-1.68±1.0

*p<.05

Results revealed significant multivariate main affect for Group (Pillai's Trace =.18, $F(1, 58) = 3.19$, $p > 0.05$, $\eta^2 = .99$, power= .19)(Table 4.3). Significant differences was obtained for Time (Pillai's Trace = .53, $F(1, 58) = 7.15$, $p < 0.05$, $\eta^2 = .53$, power= .71) and a Group x Time interaction (Pillai's Trace =.31, $F(1, 58) = 2.87$, $p < 0.05$, $\eta^2 = .31$, power= .88).

Follow up ANOVA's for L2-L4BMD parameter indicated significant Time interactions for L2-L4 T score ($F_{(1, 58)} = 7.07$, $p <0.05$, $\eta^2=.11$, power=.76), and significant for L2-L4BMD ($F_{(1, 58)}=19.64$, $p <0.05$, $\eta^2=.25$, power=.99), Femur BMD ($F_{(1, 58)}=8.55$, $p <0.05$, $\eta^2 =.13$, power=.90), and non-significant for Femur T score ($F_{(1, 58)}=5.73$, $p <0.05$, $\eta^2 =.09$, power=.65); for Group x Time effects there was non-significant univariate main affect for L2-L4 BMD ($F_{(1, 58)}=1.38$, $p <0.05$, $\eta^2 = .02$, power= .29), and for main affect for L2-L4 T score ($F_{(1, 58)}=1.23$, $p <0.05$, $\eta^2 = .19$, power= .88); Femur BMD ($F_{(1, 58)}=2.38$, $p <0.05$, $\eta^2 =.04$, power= .38) and femur T score($F_{(1, 58)}=3.12$, $p <0.05$, $\eta^2=.05$, power=.44).

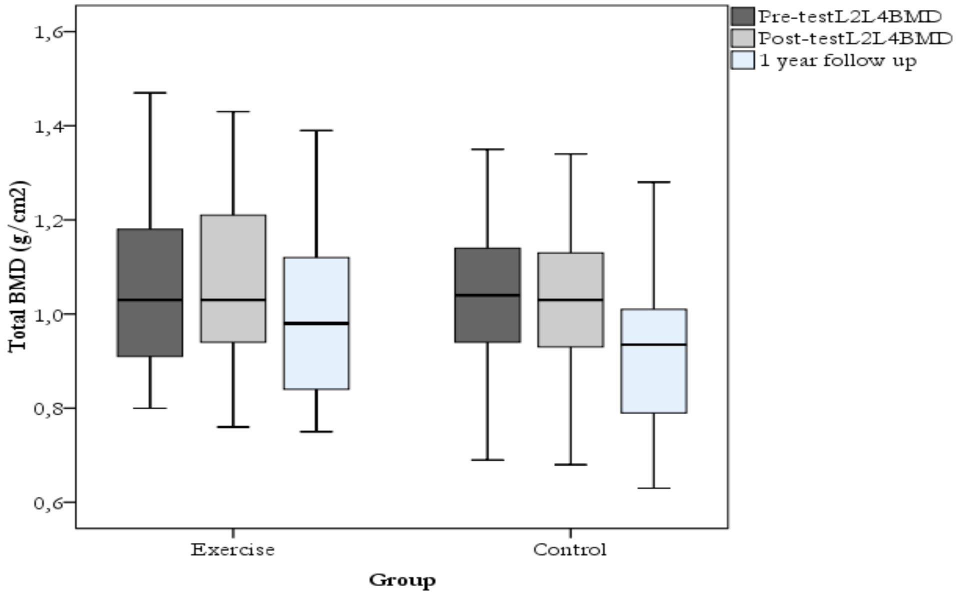


Fig 4.7 Lumbar Spine BMD Pre-Post Tests and Follow up Tests of Exercise Group (pre-test, M=1.05±0.2; post-test, M=1.07±0.2; follow up, M=0.99±0.2) and Control Group (pre-test, M=1.02±0.17; post-test, M=1.01±0.2; follow up, M=0.92±0.1), respectively

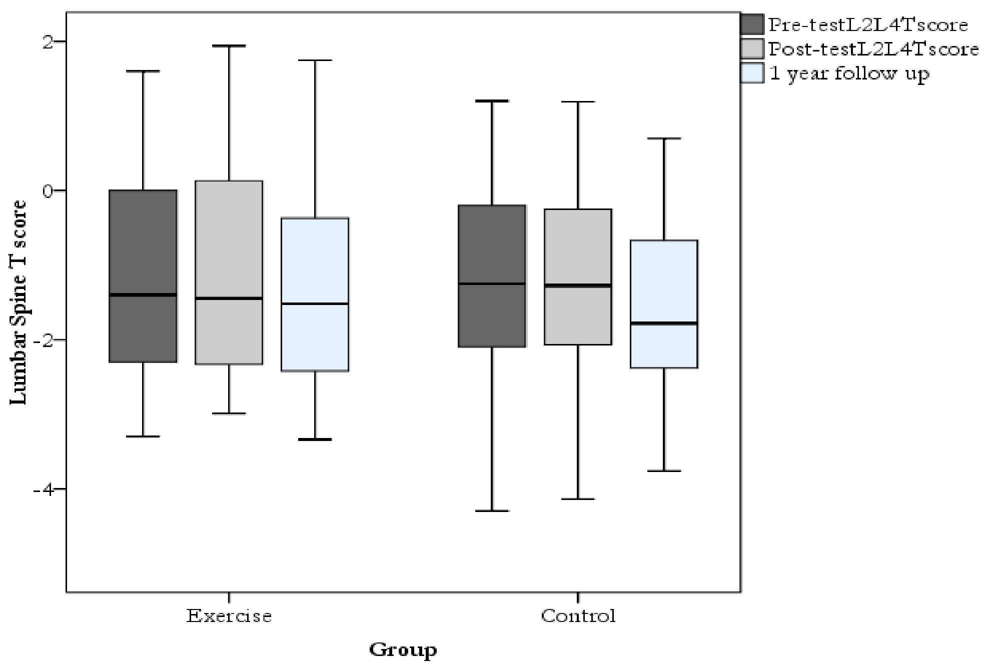


Fig 4.8 Lumbar Spine t-score Pre-Post Tests and Follow up Tests of Exercise Group (pre test, M=-1.21±1.3; post test, M=-1.04±1.4; follow up, M=-1.31±1.4) and Control Group (pre test, M=-1.27±1.3; post test, M=-1.28±1.3; follow up, M=-1.65 ±1.0), respectively.

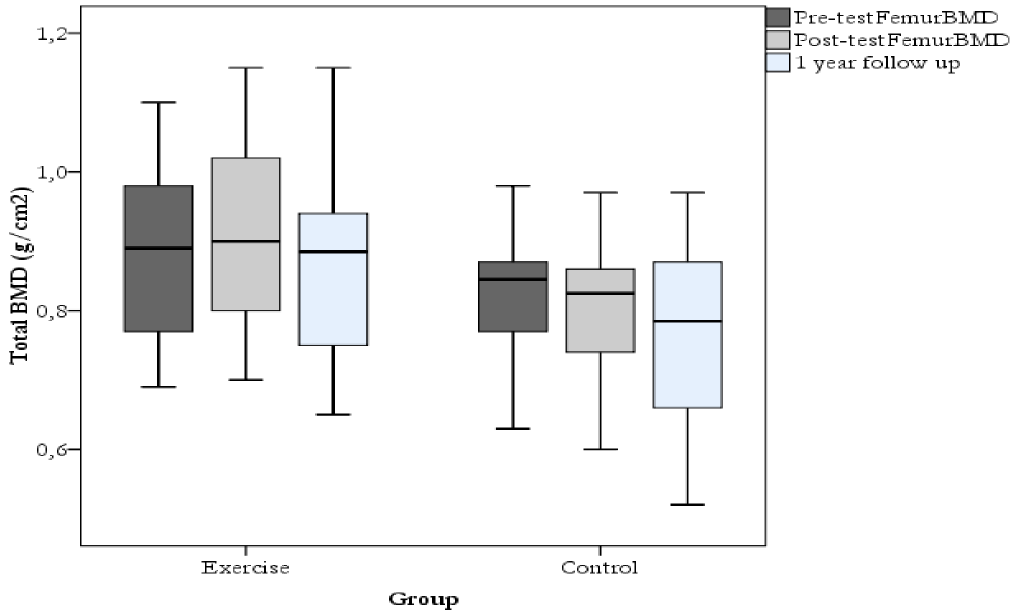


Fig. 4.9 Femur BMD Pre-Post Tests and Follow up Tests of Exercise Group (Pre, M=0.88±0.1; Post, M=0.90±0.1 and follow up, M=-0.86±0.1), and Control Group (pre test, M=0.82±0.1; post test, M=0.80±0.1; follow up, M=0.70±0.1,) respectively.

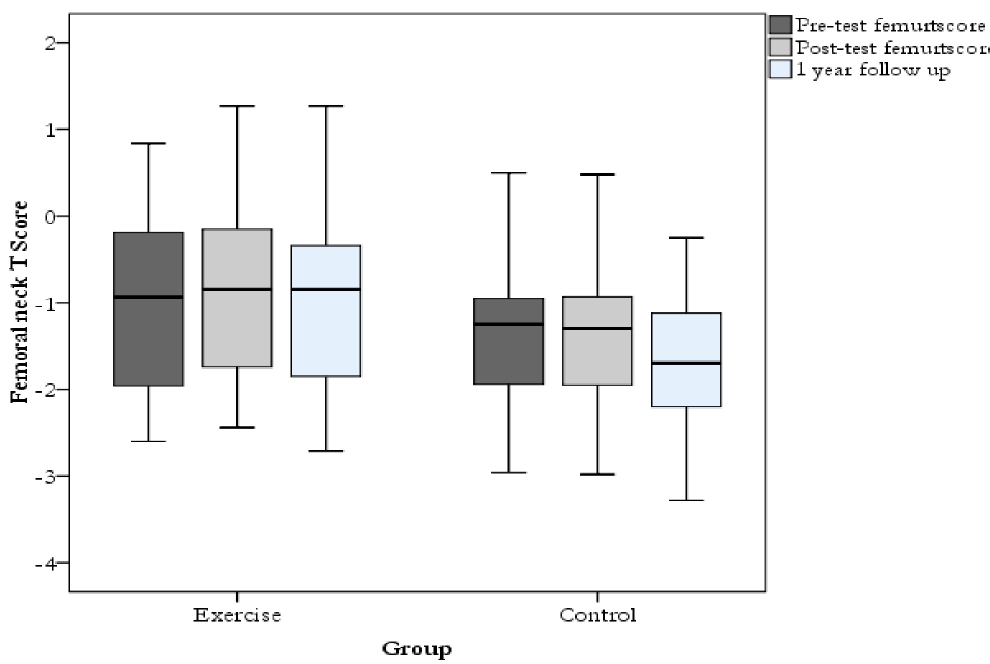


Fig 4.10 Femur t-score Pre-Post tests and Follow up tests of Exercise Group (Pre, M=-0.95±0.9; Post, M=0.88±1.0 and follow up, M=-0.97±1.0), and control Group (Pre, M=-1.38±.9; Post, M=-1.37±.8 and follow up, M=-1.68±1.0), respectively.

4.2.7 Quality of Life (SF-36) and Beck Anxiety

A 2x3 (exercise/control x pre/post /follow up) mixed design repeated measure MANOVA was conducted to examine the effects of Pilates exercise on quality of life and beck anxiety scores of elderly women. There were significant differences for beck anxiety (t (df=29) =5.33, p<0.05) and quality of life (t (df=29)=-4.99 ,p<0.05)in exercise group. Pilates exercise had positive effects on quality of life and anxiety.

The reliability test was performed and the Cronbach`s alpha coefficient for the beck anxiety scale was .88.

In Pilates group, there were decrease in anxiety between pretest (M=9.90±4.6) and 1 year follow up (M=8.03±3.9) and increase quality of life total score pretest (M=67.1±17.5) and 1 year follow up (M=75.2±15.6) although in control group there were increase in anxiety between pretest (M=8.60±3.4) and 1 year follow up (M=9.26±3.6) and decrease quality of life between pre-test (M=63.4±15.4) and 1 year follow up (M=50.5 ±18.9).

Table 4.4

Changes in Quality of life and Beck Anxiety

	Groups					
	Exercise			Control		
	Pre- test	Post- test	Follow up	Pre- test	Post- test	Follow up
Variables	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd
Beck anxiety	9.90±4.6*	5.66±3.9	8.03±3.9	8.60±3.4	8.58±3.6	9.26±3.6
Quality of life	67.1±17.5*	84.5±9.0	75.2±15.6	63.4±15.4	61.4 ±18.9	50.5 ±18.9

*p<0.05

Results revealed significant multivariate main affect for group (Pillai`s Trace= 0.30, $F(2, 57) = 12.36$, $p < 0.05$, $\eta^2 = .30$, power= .99); main affect for time ( Pillai`s Trace= 0.52, $F(2, 57) = 15.17$, $p < 0.05$, $\eta^2 = .52$, power= .68) a and a Group x Time interaction (Pillai`s Trace =.40, $F(2, 57) = 9.34$, $p< 0.05$, $\eta^2 = .40$, power= .99). Follow up ANOVA's for beck anxiety parameter indicated significant Time x Group interactions for beck anxiety ($F_{(2, 57)}$ =6.37, p <0.05, η^2 = .17, power= .89), quality of life ($F_{(2, 57)}$ = 11.93, p <0.05, η^2 = .17, power= .98)); for time effects beck anxiety ($F_{(2, 57)}$ =6.68, p <0.05, η^2 = .10, power= .84), quality of life ($F_{(2, 57)}$ = 9.71, p <0.05, η^2 = .14, power= .95), and indicated significant group effects quality of life ($F_{(2, 57)}$ = 24.51, p <0.05, η^2 = .30, power= .99), while beck anxiety is non-significant ($F_{(2, 57)}$ =1.360, p <0.05, η^2 = .02, power= .20 (Table 4.4). In quality of life and beck anxiety measurements there were positive development at Pilates exercise group than did the control group. To evaluate the univariate analysis we should adjust the value. According to this study there were two dependent variables; therefore, adjusted α value was .025.

For reliability analysis of quality of life Cronbach's statistics were estimated for the eight subscales of the SF-36. Physical function (r=.80), Role physical function (r=.90), Role emotional function (r=.83), Vitality (r=.75), Social function (r=.73), Mental function (r=.85), pain (r=.71), General health perception (r=.93). The SF-36 obtained very good internal consistency for 65+ years old women.

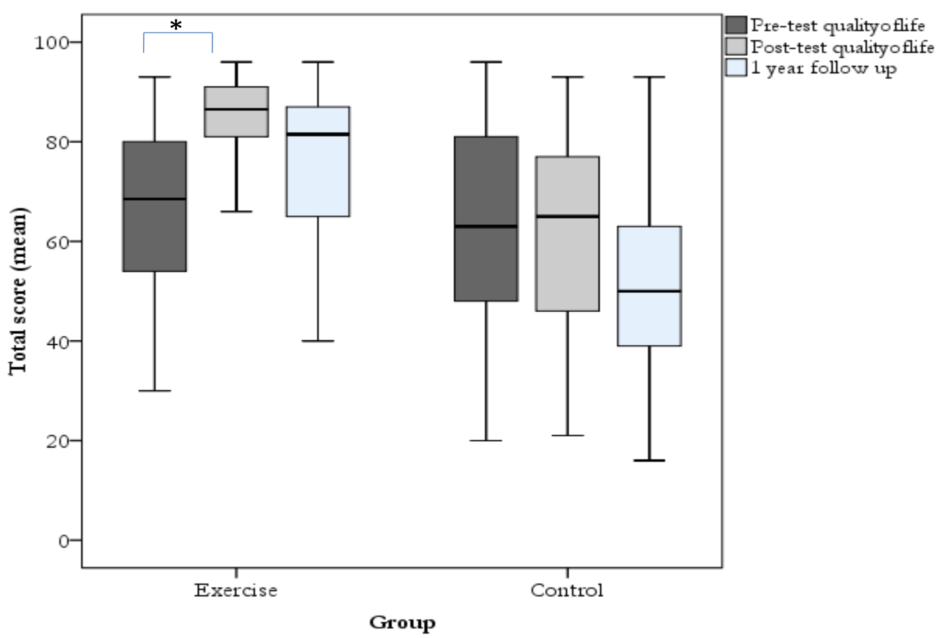


Fig 4.11 Quality of Life Pre-Post Tests and Follow up Tests of Exercise Group (pre-test, M=67.1±17.5;post-test,M=84.5±9.0; M=75.2±15.6) and Control Group (pre-test, M=63.4±15.4; post-test=61.4 ±18.9;M=50.5 ±18.9), respectively.

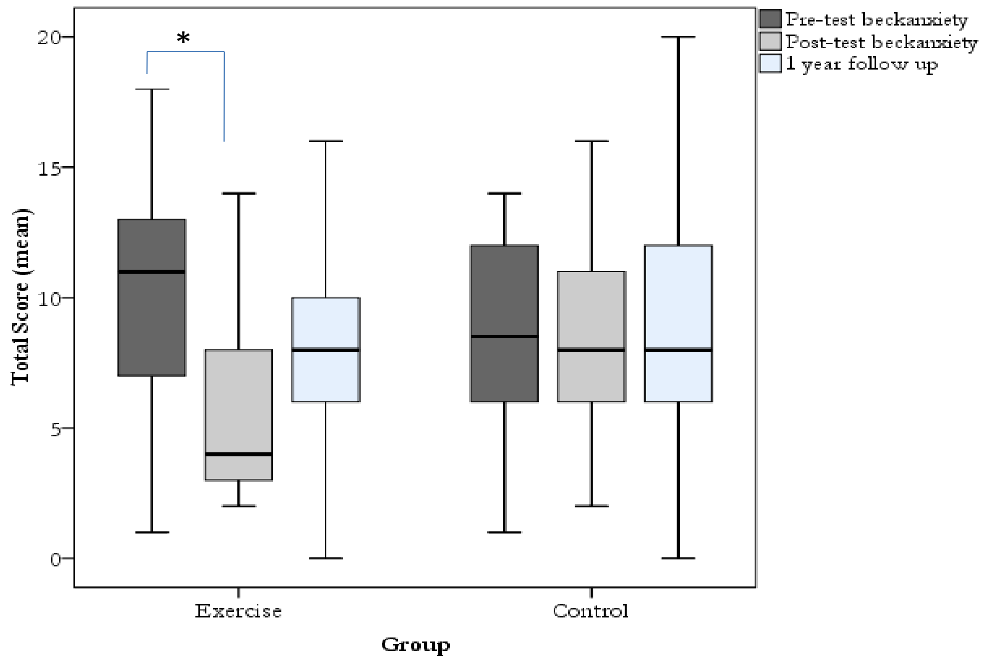


Fig 4.12 Beck Anxiety Pre-Post Tests and Follow up Tests of Exercise Group (pre test, M= 9.90±4.6; post test, M=5.66±3.9; follow up, M=8.03±3.9) and Control group (pre test, M=8.60±3.4; post test=8.58±3.6; follow up, M=9.26±3.6), respectively.

4.3. Differences in all Parameters after 1 Year Follow up.

It is assumed that differences between paired scores are normally distributed in the population and the pairs of scores have been randomly and independently sampled. Assumptions for paired t-test were checked by using histogram, skewness and kurtosis and the normality test. It is assumed that population distribution is normal.

The result from the analysis indicate that there is a significant difference in the Dynamic balance, t(df=97)=-4.90, p<0.005; muscle strength, t(df=97)=10.18 ,p<0.005; simple reaction time, t(df=97)=-7.64, p<0.005; number of falls, t(df=97)=3.11, p<0.005 and L2-L4 BMD, t(df=97)=3.72, p<0.005; L2-L4 T score, t(df=97)=3.13, p<0.005; Femur BMD, t(df=97)=5.72, p<0.005; Femur T score, t(df=97)=4.70, p<0.005; quality of life, t(df=97)=3.35, p<0.005 and there was no significant difference in beck anxiety result (t(df=97)=.18, p>0.005) in 1 year follow up. The mean values indicate that significantly muscle strength was decreased after 1 year follow up (%31); Dynamic balance was changed negatively (%9); Simple reaction time (%33) and Choice reaction time (%20), Lumbar spine

BMD (%7)and Lumbar spine t score (%19); femur t score (%21) and femur BMD (%7) were changed negatively. Moreover, number of falls (%20) and quality of life (%12) were decreased after 1 year follow up though beck anxiety didn`t change so much (table 4.5.

Table 4.5

Paired t Test for One Year Follow up (N=98).

	Pre-test	1 year follow up				
Variables	Pre-test (N=98)	Post-test (N=98)				
	X ± Sd	X ± Sd	df	t	p	% Diff.
Weight(kg)	67.4±10.5	67.54±10.01	97	-,359	.721	0,1
Dynamic Balance	11.15±1.9	12.20± 2.1	97	-4.90	.000*	9
Flexibility	11.76±5.55	10.62±5.75	97	3.77	.000*	9
Muscle Strength	21.28±7.1	14.55±7.4	97	10.18	.000*	31
Simple reaction time	.39±.11	.52 ±.20	97	-7.64	.000*	33
Choice reaction time	.75±.20	.90±.21	97	-8.47	.000*	20
Number of falls	1.72±1.3	1.37±1.0	97	3.11	.002*	20
L2-L4 BMD	1.01±.18	.93±.18	97	3.72	.000*	7
L2-L4 T score	-1.38±1.3	-1.65±1.2	97	3.13	.002*	19
Femur BMD	.84±.12	.78±.14	97	5.72	.000*	7
Femur T score	-1.28±.97	-1.55±.98	97	4.70	.000*	21
Quality of Life	63.8±18.8	56.0±19.5	97	3.35	.000*	12
Beck Anxiety	10.1±6.2	10.0±5.5	97	.18	.856	0.1

4.4 Relationship between Balance and Muscle Strength, Flexibility, Reaction Time, Number of fall and Bone Density in Elderly Women Over 65 Years Old.

A hierarchical multiple regressions was conducted to address the relationship between the dynamic balance and described variables, and to explore whether these variables could predict dynamic balance of elderly women ages over 65.

Analyses were performed using SPSS (17.0) Regression and SPSS Explore for evaluation of assumptions. Primarily, descriptive statistics were conducted; means, standards deviations and bivariate correlations between variables were detected. Assumptions for regression analysis were controlled appropriate test procedures.

4.4.1 Descriptive Statistics and Bivariate Correlations for the Study Variables

The correlation of dynamic balance scores (*M*=11.15, *SD*=1.9) with the muscle strength (*M*=21.28, *SD*=7.11, *r* (100) =-.36, $p<.05$); anxiety (*M*=10.1, *SD*=6.2, *r* (100) =-.26, $p<.05$) negative correlations and with the choice reaction time (*M*=0.75, *SD*=0.2, *r* (100) =.37, $p<.005$); simple reaction time (*M*=0.39, *SD*=.15, *r* (100) =-.22, $p<.05$) indicates positive correlations. In dynamic balance measurement, low balance score, result in increase balance performance. Results suggested that relative contribution of each predictor to the regression equation could be anticipated a closer inspection to bivariate correlations.

Table 4.6

Descriptive Statistics and Bivariate Correlations for Dynamic Balance Scores and Predictor Variables (N=100)

	Bivariate Correlations for Predictor Variables											
Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Dynamic Balance scores	11.1	1.9	1.00									
2. Muscle Strength(MPLS)	21.3	7.11	-.36*	1.00								
3. Simple Reaction Time	0.39	0.15	.22*	-.13	1.00							
4. Choice Reaction Time	0.75	0.2	.37*	.22*	.37*	1.00						
5. Flexibility	11.7	5.55	-.09	-.22*	-.15	-.08	1.00					
6. Number of Falls	1.72	1.3	.16	.06	-.02	- .04	-.05	1.00				
7. Femur BMD	0.84	0.12	-.04	.04	-.05	-.23*	-.02	-.04	1.00			
8. Lumbar BMD	1.01	0.18	.10	-.18*	0.00	-.02	-.35*	-.02	0.32*	1.00		
9.Anxiety	10.1	6.2	-.26*	.01	-.06	-.15	-.08	.10	-.02	-.10	1.00	
10.Quality of Life	63.8	18. 8	-.16	.05	-.14	-.09	.16	-.03	.16	.07	.01	1.00

Note. R^2_{adj}=.263 for Model 1; R^2_{adj}=.268 for Model 2, and R^2_{adj}=.328 for Model 3, *p<.005

Table 4.7

Hierarchical Regression Analysis Summary for Dynamic Balance

	B	*SEB*	β	sr^2	*t*	*R*	R^2	ΔR^2	ΔF
Model 1						.513*	.263	.223	6.58*
Muscle Strength(MPLS)	-.109	.033	-.299	0.084	-3.28*				
Simple Reaction Time	1.207	1.669	.070	0.004	.723				
Choice Reaction Time	2.020	.658	.322	0.073	3.07*				
Flexibility	-.012	.044	-.026	0.004	-.283				
Number of Falls	.290	.151	.172	0.029	1.92				
Model 2						.517	.268	.211	.26
Muscle Strength(MPLS)	-.106	.034	-.292	0.078	-3.12*				
Simple Reaction Time	1.226	1.687	.072	0.005	0.73				
Choice Reaction Time	2.101	.681	.311	0.019	3.08*				
Flexibility	-.004	.047	-.009	0.000	-.09				
Number of Falls	.296	.152	.176	0.028	1.94				
Femur BMD	.767	2.018	.038	0.000	.38				
Lumbar BMD	.709	1.593	.047	0.002	.44				
Model 3						.573	.328	.260	3.97*
Muscle Strength(MPLS)	-.107	.033	-.294	0.078	2.78*				
Simple Reaction Time	.922	1.643	.054	0.021	.56				
Choice Reaction Time	1.856	.667	.274	0.057	2.78*				
Flexibility	-.013	.047	-.026	0.000	-.27				
Number of Falls	.327	.148	.194	0.001	2.20*				
Femur BMD	1.021	1.965	.050	0.000	.52				
Lumbar BMD	.293	1.570	.019	0.000	.19				
Anxiety	-.097	.038	-.231	0.048	-2.56*				
Quality of Life	-.014	.013	-.101	0.008	-1.11				

Note. R^2_{adj}=.263 for Model 1; R^2_{adj}=.268 for Model 2, and R^2_{adj}=.328 for Model 3, **p*<.005

According to the results showed in Table 4.7, multiple correlation coefficients between the linear combination of 5 predictors (Physical fitness parameters and balance variables) and balance variables scores is .513. The combination of these five predictors accounts for 26.3% of the variation in balance scores. In model 1, inconsequential contribution of simple reaction time, flexibility and number of falls variables to the variance in dynamic balance scores was negligible with insignificant result of ($sr^2 = 0.004$), t (100) = 0.72, p>.05, of ($sr^2 =$ 0.004), t(100) = -0.28, p>.05, of ($sr^2 = 0.029$), t (100) = 1.92, p> .05, respectively. On the other hand, muscle strength variable uniquely accounted for 8.4% (sr^2 = .084) of the variation having significant contribution to prediction equation t (100) = -3.28, p<.05; and choice reaction time variable uniquely accounted for 1.9% (sr^2 = .019) of the variation having significant contribution to prediction equation t (100) = 3.08, p<.001 in dynamic balance scores. These findings indicate that muscle strength and choice reaction time are the best predictors for the dynamic balance score.

In Model 2, after controlling for the effects of fitness parameters (muscle strength, simple reaction time, choice reaction time, flexibility and number of falls), multiple correlation coefficient between the linear combination of two predictors (the femur BMD and lumbar BMD) and dynamic balance scores increased to .517. Model 2 was not significantly predicted dynamic balance, F (5, 100) = 0.26, p>.005, R^2=.268, R^2_{adj} = .211. The combined measures fitness parameters and bone density accounted for 26.8% of the variance in dynamic balance scores, ΔR^2 = .001, ΔF (5, 100) = 0.026, p<.005, after controlling physical fitness parameters. Based on these results, bone density (femur and lumbar) measurements did not have any significant contribution to the prediction equation t (100) = 0.38, p>.05, t (100) =.44 p>.05, respectively.

In Model 3, after controlling for the effects of fitness parameters (muscle strength, simple reaction time, choice reaction time, flexibility and number of falls), and bone density, multiple correlation coefficient between the linear combination of two predictors (anxiety and quality of life) and dynamic balance scores increased to .573. Based on these result, anxiety had significant contribution to the prediction equation t (100) = -2.56, p<.05, respectively.

CHAPTER 5

DISCUSSION

Thus, the main purpose this study was to determine if Pilates exercises could improve dynamic balance, flexibility, and reaction time and muscle strength and decerase number of falls in elderly women. Secondly, to identify differences after one year follow up in these all parameters. and Finally, to investigate the relationship between dynamic balance, flexibility, reaction time, muscle strength, bone density, anxiety, quality of life and number of falls

5.1. Differences in Physical Fitness Parameters after Pilates Exercise and one Year Follow up in Elderly Women

Our findings indicated that there were significant differences ($p<0.05$) in dynamic balance, muscle strength, flexibility, reaction time, number of falls after twelve weeks Pilates training in 65+ older women who were living in a residential house. Thereofere, after a year follow up period, there were significant differences in all physiological parameters. It was found that control group has more negatively changes after 1 year versus exercise group. This can be related with the exercise effects of Pilates exercise during three months. We have not information or control whether they continued or stopped doing exercise. Other finding of this study was four fractures (hip fracture=2; wrist fracture=1 and knee fracture=1) were reported after a year follow up.Attendance and adherence is clearly an important factor that influences the effectiveness of Pilates exercise. In our study, participants attended almost full part of the exercise session. This might gained positive effects to our study.

One of the major finding of this study was that reaction time improved with exercise. A positive training effect was demonstrated on dynamic balance, flexibility, muscle strength, reaction time and number of falls.

Muscular strength and flexibility of the Pilates group were significantly higher in the follow-up tests than that of the control group, which supported previous findings in the relevant literature (Mitchell et al.1999). Another study by Petrofsky et al. (2005) studied to compare Pilates exercises with and without a resistance band. They found Pilates exercise with a resistance band can increase effectively muscular strength when compared to Pilates exercises without resistance bands. In line with this study we, used a resistance band and we found a positive effect on muscle strength in exercise group. In contradistinction to their study, exercise ball or Pilates ball exercises were added to Pilates exercise program. We concluded that Pilates ball exercises can increase dynamic balance in elderly women. As it mentioned before, there are some stdudies that were conducted to investigate the effects of Pilates. One of them (Schroeder et al (2002) was studied the effects of Pilates exercise on flexibility. They found an acute Pilates reformer session for novice individuals appears to positively influence measures of flexibility. Their result supports our findings with together in the relevant literature.

In previously studies, the effect of exercise on reaction time has been studied (Laroche et al., 2007; Rowland, 1990; Trombly, 2004). Although in literature, there was lack of evidence about positive effects of Pilates on reaction time, in this present study, we observed that this exercise is very effective way to develop reaction time in elderly women. In future studies, with Pilates exercise, this parameter should be identified in detail. Studies show that reaction time can be improved by training (Trombly, C., 2004).

Exercise can affect reaction time positively. In elderly, with the slowing down of reaction time, number of falling and some accidental problems occurs frequently. In a study, Kashihara and Nakahara (2005) found that vigorous exercise did improve choice reaction time and Collardeau et al. (2001) found that exercise improved reaction time during the exercise.Kaesler et al. (2007) examined the effectiveness of a novel Pilates inspired exercise program specifically designed to improve balance in an upright position, referred to as postural stability, in older adults. Participants for this pilot study were eight community-dwelling men and women aged 66–71 years. The exercise regimen was undertaken twice weekly for 8 weeks and pre- and post subject assessment included postural sway (static and dynamic), the timed get up and go test (TGUGT), sit-to-stand (timed one repetition and repetitions over 30 s) and a four stage balance test. They reported that there was a significant improvement ($P<0.05$) in some components of static and dynamic postural sway (8–27%) as well as the TGUGT (7%) following training. In their study they suggested for future studies to consider the variation of specific balance training techniques, primarily movement re-education compared to speed and reaction time, to improve postural stability and reduce falls risk. In our study, participants were over 65 years old like this study and we measured also reaction time. We couldn't find any study in literature about the effects of Pilates exercise on reaction time, separately. We conducted also reaction time by measuring both simple and choice reaction time. Yoga exercise has similarities with Pilates. We know from literature (Bhavanan et al (2003) Yoga may effects reaction time positively. Previous studies on yoga have shown that regular practice of yoga can significantly decrease Visual RT and Auditory RT (Madanmohan, 1992). For preventing falls, reaction time has very important role.

Results of the study also showed that dynamic balance and muscle strength has increased in Pilates group after 12 week exercise. There are some studies which were conducted to investigate effects of Pilates exercise on muscle strength and balance. Johnson et al. (2007) studied the effects of Pilates-based exercise on dynamic balance in healthy adults. After completing 10 Pilates-based exercise sessions a significant change ($P=.01$) in dynamic balance was found in functional react test (FRT) mean scores in the exercise group ($n=17$, mean age 27.5). The control group ($n=17$, mean age 27.3) demonstrated no significant change ($P=.54$). The results suggest that Pilates-based exercise improved dynamic balance as measured by the FRT in healthy adults. Similar findings were interpreted in this present study, we found that dynamic balance positively increased after Pilates exercise. In their study participants mean age was 27.4 and in our study participants age was over 65. Moreover, they used functional reach test to evaluate dynamic balance although we used new developed dynamic balance device.

In another study by Hall et al., (1999) were investigated 31 men and women ages 65- 85 years and they applied 10 weeks Pilates exercises , as a result of their study, they observed significant differences in balance measurements between experimental and control groups test results. In our study, the same results were found for the elderly women over 65 years old. As it mentioned earlier, there are limited number of studies about Pilates in elderly people. One of them was studied by Wolkodoff (2008). Author developed a study to determine the training effects of a Pilates program. There were 13 participants in the Pilates exercise program, and six subjects in the control group, with an age range of 23 to 64 years. Testing included height, weight, body composition using skin folds, VO2 peak and associated measures, isokinetic endurance (for eight separate muscle groups, including trunk flexion and extension), three flexibility measurements, dynamic balance, posture and self-reported stress. Total exercise time was 40 minutes per session, with three sessions per week. After the eight-week program, parametric and independent samples revealed statistically significant ($p<0.05$) gains and improvements in VO2, anaerobic threshold, body fat, low-back/hamstring flexibility, combined hip flexion and combined torso rotation. Sit and reach flexibility gained tremendously, probably due to the low-back and hamstring movements normally used in Pilates. In our study, we found that there were significant differences in flexibility, balance and muscle strength. In their study number of participants were small. On the contrary, in this present study, number of participants were one of the largest which related Pilates in elderly women.

Carter et al., (2001) investigated the efficacy of a community based 10 week exercise intervention to reduce fall risk factors in women with osteoporosis. Static balance (computerised dynamic posturography), dynamic balance (timed figure of eight run) and knee extension strength (dynamometry) were measured. Subjects were randomized to exercise intervention (twice weekly Osteofit classes for 10 weeks) or control groups. A 10 week community based physical activity intervention did not significantly reduce fall risk factors in women with osteoporosis. Opposite to their study, we found that there were significant differences in balance and strength and we concluded that Pilates exercise may reduce number of falls. Other leading factor could be related with the number of osteoporotic participants. In our sample, there were normal, osteopenic and osteoporotic participants.

Previous research indicates that regular participation in physical activity has a positive impact on muscle strength (Maughan, 2008; Daubney & Culham, 1999). In a pilot study, Donahoe-Fillmore and et al., (2007)performed a study to determine the effects of a video-based Pilates mat home exercise program on core strength, muscular endurance, and posture in healthy females. They resulted that Pilates mat home exercise program has no significant effect on abdominal strength and posture but both flexor and extensor endurance appeared to be improved. Eleven healthy women between the ages of 20 and 35 were drawn from a sample of randomly separated two groups (exercise group (n = 6) or a control group (n = 5). The exercise group performed a Pilates mat exercise program 3 times per week for 10 weeks. Results showed no differences on described variables. This may be related with small number of participants. In our study, our sample size was much bigger than their study. Moreover, in Pilates mat video exercise group, they couldn`t control the participating rate although in our study we controlled whether performed or not all movements by participants.

Topp et al (1993) applied a study to determine whether a 12-week dynamic resistance strength training program can change gait velocity and improve measures of balance among adults age 65 and older. Fifty-five community-dwelling adults mean age 71.1 were randomized into an exercise (n = 25) or control (n = 30) group. Exercise group completed three bouts of strength training per week for 12 weeks using elastic tubing. At the end of the study, exercise group demonstrated slower gait velocity, enhanced balance, and an improved ability to walk backward, although none of these posttest measures was significantly different from the control group. In our study we used exercise elastic bands; it is almost similar with the elastic tubes. We found positive effects of Pilates exercise on all parameters.

Sekendiz et al. (2004) was examined the effects of Pilates exercise on abdominal and lower back strength, abdominal muscular endurance and posterior trunk flexibility of sedentary adult females. Participants consisted of 21 women (mean age: 30±6.6 range 26–47) of the exercise and 17 women (mean age: 30±8.6 range 26–47) of the control groups. They were assessed abdominal and lower back strength, posterior trunk flexion and extension data were obtained concentrically on a Biodex isokinetic dynamometer at speeds of 60° and $120° s^{-1}$. They concluded that there was a positive effect of Modern Pilates mat exercises on abdominal and lower back muscular strength, abdominal muscular endurance and posterior trunk flexibility in sedentary adult females regardless of the fact that the body weight and fat percentages did not differ significantly. These results are parallel with our results. We found positive improvements in flexibility.

In many studies muscle strength increased with regular exercise. For example, Fitt et al (1994) examined differences after a seven-week program that included one hour per week of resistance exercise on a Pilates apparatus and daily Pilates floor exercises similar to those used in this protocol. Twenty-nine experienced dancers (15 controls, 14 exercisers) completed the training. In another study, Christopher et al. (2006) investigated the effects of a core stability-training program on core strength in females. They randomly assigned 17 female volunteer participants to an exercise or control group. They measured maximum isometric strength of the hip abductors, abdominals, and back extensors, before and after ten weeks of Pilates exercise. The exercise group met three times weekly for 40 minute supervised exercise sessions. A repeated measures MANOVA revealed no strength differences between groups from the start to the end of the intervention ($F = 0.435$, $p = 0.87$, $1-\beta = 0.117$). Both groups showed increases in measured strength over the course of the intervention ($F = 5.041$, $p = 0.017$, $1-\beta = 0.867$). Opposite to this study, we found significant differences in muscle strength after 12 weeks Pilates exercise. They reported this results as the lack of power to detect between-group differences and a questionable effect size.

The study done by Rogers and Gibson (2009) investigated responses of adult, novice practitioners (n=9) to an 8-week traditional mat Pilates program that met one hour in a day three times in a week. Participants were selected voluntarily from healthy adults who were physically active. Mean age was 24.5 years. They measured some physical fitness components (sit and reach, shoulder reach, curl-up and low back extension as well as circumferences at the waist, chest, and arm). Similar to our study, they found positive differences in all selected physical fitness parameters while they couldn't see any differences in control group. They summarized their results as after 8 week there was significant differences in body composition, muscular endurance and flexibility. Our findings support this review.

Segal et al. (2004) conducted an observational repeated measures study to assess the effects of Pilates training on flexibility, body composition and health status of healthy adults. Total 31 women with average age 41 years and one man who aged 42 years were volunteered 1-h weekly Pilates mat exercises. They found no change in the body composition of their participants after six months. The authors concluded that Pilates exercise may improve truncal flexibility in healthy adults. In line with their study, we concluded that Pilates exercise may improve flexibility after 12 weeks exercise and also we couldn't find any change in the Body Mass Index.

There is a decline in joint flexibility and stability relating to changes in the joint components of cartilage, ligaments, and tendons. The overall loss of flexibility due to aging of the muscle and joints is estimated at 25% to 30% by age 70 (Norman, 1995). Research also documents the improvement of muscle flexibility in older individuals with exercise. The same results that occurred in our study and flexibility were increased after exercise.

Mallery et al. (2003) conducted a study to compare participation and adherence with traditional physiotherapy sessions that consisted of passive movements to maintain range of motion (ROM) in hospitalized acutely-ill older patients. In this study, they used a Pilates exercise program to help maintain muscle mass and range of motion. However, the focus of the study was not reported as improvement in strength, range of motion, and flexibility. The participation and adherence in the Pilates group was significantly lower to the passive ROM group (71% versus 96%, and 95% versus 63%, respectively). This difference was attributed to the increased intensity level and difficulty of the Pilates exercises compare to the passive ROM exercises.

Kloubec (2005) was investigated to determine the effect of Pilates exercise on abdominal endurance, hamstring, flexibility, upper body posture, balance and psychological parameters involving adults to randomize either a treatment or control group to evaluate the outcome. Twenty five participants were invited to participate 12 week series 1-h Pilates instruction meeting two times per week. This study demonstrated that in middle-aged men and women exposure to Pilates exercise for 12 week was enough to stimulate statistically significant increases in abdominal endurance, hamstring flexibility and upper body muscular endurance. Participants did not demonstrate improvements in either posture or balance when compare to control group. Physiological well-being data showed improvement in overall energy levels, satisfaction with physical appearance and job satisfaction. Opposite to their study, we found improvements in balance measurements. In their study, author reported that the problem may have been in the testing instrumentation rather than outcomes in their discussion section.

Tinetti et al (1994) investigated the effects of a multi-factorial intervention including exercise to reduce the risk of falling among community dwelling elderly people and to identify risk factors for falls. 301 subjects who at least 70 years of age participants were randomly assigned to either an intervention (n=153) or control group (n=148). Data on the incidence of falls was collected for one year by a researcher. Data on the incidence of falls was collected for one year by a researcher. During the one year of follow-up, 35 percent of the intervention group fell as compared with 47 percent of the control group. In our study, we found also a decrease in number of falls.

Lord et al. (1994) designed one year prospective study to determine the prevalence of impaired vision, peripheral sensation, lower limb muscle strength, reaction time, and balance in a large community-dwelling population of women aged 65 years and over, and to determine whether impaired performances in these tests are associated with falls. Four hundred fourteen women aged 65 to 99 years (mean age 73.7 years, SD = 6.3) were randomly selected from the community; 341 of these women were included in the 1-year prospective study. In the year following assessment, 207 subjects (60.7%) experienced no falls, 63 subjects (18.5%) fell one time only, and 71 subjects (20.8%) fell on two or more occasions. Number of fallers were larger than non-fallers. This result can be related with age factor. In our present study, participants ages were between 65 to 85 years old. They implied that reaction time, muscle strength, and balance were related with falls. We concluded that also similar findings.

Leung-Wing et al. (2006) investigated the impact of incident falls on the balance, gait, and Activities of Daily Living functioning in community-dwelling older adults. This was a population-based, 1-year prospective cohort study in older adults. They performed baseline assessment of potential predictors, the 1-year occurrence of falls, and then 1-year reassessment of the following outcome measures: the Barthel Index (BI), Lawton's Instrumental Activities of Daily Living (IADL) scale, gait speed, and Tinetti Balance and Gait Evaluation's total mobility score (TMS). Of the 1517 participants, 93.5% (n=1419) completed the 1-year follow-up reassessment of BI and IADL. For gait speed and TMS, respectively, 88.2% (n =1338) and 88.3% (n=1339) completed the 1-year outcome assessment. Fallers, particularly recurrent fallers, experienced significantly greater 1-year declines in the four functional measures. Multivariate logistic regression analyses showed that an incident fall was a significant independent predictor for decliners in the BI, Lawton's IADL score, gait speed, and TMS after adjustment of all significant confounding factors.

In a study Wolf et al., (1996) determined exercise effects of Tai Chi and computerized balance training in community-dwelling women at moderate risk of falls. In their result of study, they found that Tai Chi reduced the rate of falls during a short follow-up period of 4 months although a computerized balance training program did not reduce falls. In our study, we applied 3 months Pilates exercise resulted as decreasing number of falls and also increasing balance.

BMI pre- and post-data were also assessed as secondary outcomes of this study, although no significant changes were noted. One of the leading reasons for this outcome may be due to the fact that the Modern Pilates mat exercises were practiced by the subjects for a period of 12 weeks that can be considered to be a short interval to effect the BMI measures. Another reason might be low level of Pilates exercise like aerobic dance or step dance exercises. In a study by Baltaci et al (2005), Pilates exercise could affect weight loss in thirty-four females with bilateral knee Osteoarthritis. They resulted that the decrease of body fat percent was higher in the Pilates group, 5.5% (4.1 to 8.84%; $P<0.05$).They concluded that Pilates might be of advantage to control weight because of the rapidity of weight loss and a more significant loss of body fat. Oppositely with their result, we couldn`t find any significant differences after given 12 week treatment although they applied only 4 week Pilates exercise while in 5 days in a week.

5.2 Differences in Bone Density after Pilates exercise and a year follow up in Elderly Women

In this present study, we found that Pilates exercise has positive effects on bone mineral density. Our results revealed that there was no significant difference in bone mineral density ($p > 0.05$). Besides, we obtained that there was no noticeable decrease after 1 year follow up in the Pilates exercise group despite the prominent changes in control group.

Karacan and et al (2004) performed a study to determine the range of bone mineral density. (BMD) in a normal Turkish female population and to compare them to USA and Northern BMD measurements were performed at four sites (anterior-posterior spine, femur, ultra distal radius, total body) in 339 women aged 20-79 years using a Lunar DPX densitometer at 19 different centers from different areas of the country. In comparison with USA and Northern European data, BMD values in Turkish women were lower at lumbar spine, whereas their femoral BMDs were similar to USA values but lower than Europeans in the 5th and 7th decades. In our study we didn`t compare bone densities with the other countries but also determined low bone density in our participants. Moreover, after Pilates exercise there were positive developments in bone density measurements both lumbar spine and femur.

In this study, it was found positive increases in L2-l4 BMD and Femur Bone Density (BMD). Many studies demonstrate strength training's ability to increase bone mass, especially spinal bone mass.

In a recent study on bone density and exercise, older women who did high-intensity weight training two days per week for a year were able to increase their bone density by 1.0 percent, while a control group of women who did not exercise had a bone density decrease of 1.8 to 2.5 percent. The women who exercised also had improved muscle strength and better balance, while both decreased in the non exercising control group (Veracity, 2005).

Ling Qin et al. (2002) studied the potential benefits of regular Tai Chi Chuan exercise on the weight-bearing bones of postmenopausal women. Postmenopausal women (age range, 50–59y), including 17 self-selected regular Tai Chi Chuan exercisers with over 4 years of regular exercise, and non- exercising controls. The follow-up measurements showed generalized bone loss in both groups although, result show that regular Tai Chi Chuan exercise may help retard bone loss in the weight-bearing bones of postmenopausal women. In Pilates exercise, we used weight bearing exercise by using elastic band and Pilates ball. This may be reason for increasing bone density in elderly.

In another study, Chow, Harrison, & Notarius (1987) studied the effect of two structured exercise programs on the bone mass of 48 healthy postmenopausal white women aged 50-62 was studied after one year. Volunteers were randomized to group 1 (control), group 2 (aerobic exercise), or group 3 (aerobic and strengthening exercises). After one year, both of exercise groups had higher levels of fitness and greater bone mass than controls. Moreover, Wallace and Cumming (2000) were done systematically review and Meta-analyze randomized trials of the effect of exercise on bone mass in pre- and postmenopausal women. A "MEDLINE" search was conducted for the between 1966–1997 years. Thirty meta-analytic methods were used to statistically pool results of studies of the effect of impact (e.g., aerobics) and non-impact (e.g., weight training) exercise on the lumbar spine and femoral neck. Their review of randomized trials showed that both impact and non-impact exercise has a positive effect at the lumbar spine in pre- and postmenopausal women. Impact exercise probably has a positive effect at the femoral neck. We conducted three months Pilates exercise. This exercise has both impact and non-impact type. Our result showed improvement both femur and spine bone density.

Hourigan et al. (2008) conducted a study to determine the effects of a workstation balance training and weight-bearing exercise program on balance, strength and bone mineral density (BMD) in osteopenic women. Randomly selected 98 women (aged 41-78) were participated during 20 weeks to this study. Assessments at baseline and post-intervention included balance testing (five measures), strength testing (quadriceps, hip adductors / abductors / external rotators and trunk extensors), and DXA scans (proximal femur and lumbar spine). At the end of this study, the intervention group showed markedly significant better performances in balance (unilateral and bilateral stance sway measures, lateral reach, timed up and go and step test) ($p < 0.05$) with strong positive training effects. Similarly there were gains in strength of the hip muscles (abductors, adductors, and external rotators), quadriceps and trunk extensors with training effects between 9% and 23%. They concluded as specific workstation exercises can significantly improve balance and strength in osteopenic women. In parallel, in our study, we found significant differences in balance and muscle strength and bone density pre and post measurement of Pilates exercise group in elderly women but we did not separate our subjects as osteopenic or not.

In Pilates exercise, some different equipments (Swiss ball or exercise ball, reformer, elastic tubes, elastic bands, small balls, medicine balls and etc.) have been using. In our study, we used both exercise ball and elastic bands which can be use instead of weight-bearing exercise or strength exercises. Rhodes et al (1999) studied the effects of one year of progressive resistance exercise (PRE) on dynamic muscular strength and the relations to bone mineral density (BMD) in elderly women. Participants were included Forty four healthy sedentary women (mean age 68.8 years) assigned to either the exercise or the control group. The exercise circuit included three sets of eight repetitions at 75% of one repetition maximum focused on the large muscle groups. BMD was measured by dual energy *x* ray absorptiometry (Lunar DPX) at the lumbar spine and at three sites in the proximal femur. Other selected parameters of physical fitness (body composition, flexibility, muscle strength) were also measured. As a result of their study, they detected significant differences in muscle strength and bone density. An increase in muscle strength significantly influence bone density. We got significant differences after Pilates exercise, it might be related to increase muscle strength.

5.3 Differences in Quality of Life (SF-36) and Beck Anxiety afterPilates exercise and a year follow up in Elderly Women

In this study, results revealed that significant differences in Quality of life pre (67.16±18.48) and post (81.30±15.41) tests and in Beck anxiety pre (9.47±5.21) and post tests (6.23±5.15) results while control group had no significant differences. Pilates exercise may be effective for increasing health related quality of life and decreasing anxiety level of elderly women who were living in Nursing Houses.

In some studies exercise has positive effects on quality of life and anxiety. Cassidy et al (2004) conducted a cross-sectional study of 278 community-dwelling women aged 70 years and over to investigate the association between potentially modifiable lifestyle factors and cognitive abilities/depressive symptoms in community-dwelling women aged 70 years and over. Beck Depression Inventory (BDI), Beck Anxiety Inventory (BAI), SF-36, and the Cambridge Cognitive Examination for Mental Disorders of the Elderly (CAMCOG) were used to assess depression, anxiety, quality of life and cognitive function. Physically active women were half as likely to be depressed (BDI score $\geq$10) and anxious (BAI score $\geq$8) when compared to their physically inactive counterparts. In parallel to their study we obtained a decrease in anxiety level in Pilates exercise group.

Thomas, DiLorenzo, et al. (1999) designed a study to address a number of limitations while examining the short- and long-term psychological effects following completion of a 12-week aerobic fitness program using bicycle ergo-meter. 82 adult participants completed the Beck Depression Inventory, Profile of Mood States, and State-Trait Anxiety Inventory after 12 months follow –up. As a result of their study, exercise group had positive psychological effects after 12 week intervention. Moreover, results indicate that exercise- induced in aerobic fitness have beneficial short-term and long-term effects on psychological outcomes. In line with their study, we revealed positive changes in anxiety scores of exercise group after 12 week Pilates exercise. In another study, Khan and et al (2008) examined the physiological and psychological responses in adults, aged 43.9±10.9 years, to a 12-week ‘Body Balance’ exercise program. An exercise intervention group (n = 17) undertook three 1-h classes, each week for 12 weeks while the control group (n = 17) attended three 90-min ‘health lectures’. They suggested that mind-body exercise programs like Body Balance could significantly benefit state-anxiety as well as strength, flexibility, and anthropometry around the trunk. Nevertheless, we didn’t study state-anxiety, we interpreted good result in beck anxiety scores in exercise group.

Eyigor and et al. (2007) aimed to determine the effect of a group-based exercise program on the physical performance, muscle strength and quality of life (QoL) in older women. A 4-m and 20-m walk test, a 6-min walk test, stair climbing and chair rise time, timed up and go test, isokinetic muscle testing of the knee and ankle, and the short form-36 (SF-36) and geriatric depression scale (GDS) questionnaires were applied to 20 women performed an exercise program for 8 weeks. They concluded after exercise program all of the physical performance tests and the SF-36 scores for the participants showed statistically significant improvements ($p < 0.05$). We performed health related quality of life questionnaire and we found significant differences in SF-36 after Pilates exercise. Differently with this study we also used Beck anxiety inventory to identify effect of exercise on anxiety. There are positive effects of exercise on both quality of life and anxiety, but there were no clear study especially which kind of exercise would be the most effective in increasing the physical performance and QoL. The findings of our study suggest that Pilates may be one of the good exercises to improve Quality of life and decrease anxiety level in elderly women aged over 65.

5.4 Relationship between balance and muscle strength, flexibility, reaction time, number of falls and bone density, quality of life and anxiety in elderly women over 65 years old.

The result of hierarchical regression analyses revealed that there was correlation between dynamic balance and muscle strength, choice reaction time and anxiety. These foundings show similarities with the literature, though there were a few studies that were conducted to find correlation in these parameters.

Moreland et al. (2004) evaluated and summarized the evidence of muscle weakness as a risk factor for falls in older adults. They searched in MEDLINE and CINAHL (1985-2002) under the key words aged and accidental falls and risk factors. They summarized that thirty studies met the selection criteria; data were available from 13. For lower extremity weakness, the combined Odds ratio (OR) was 1.76 (95% confidence interval (CI) =1.31-2.37) for any fall and 3.06 (95% CI=1.86-5.04) for recurrent falls. For upper extremity weakness the combined OR was 1.53 (95% CI=1.01-2.32) for any fall and 1.41 (95% CI=1.25-1.59) for recurrent falls. In their study, they concluded that muscle strength (especially lower extremity) should be one of the main factors to treat and assess in older adults at risk for falls. In our study, we chose lower extremity strength to evaluate muscle strength and we concluded that muscle strength is related with falls.

Moreover, in a study by Conway (1999) was examined the association between lower extremity strength, balance, and functional outcome in functionally-limited, community-dwelling elders. Total 131 moderately disabled elders who were in community-dwelling (ages 60-89) were completed in home and laboratory testing of strength, balance, gait and the timed "Up and Go" basic mobility test. Lower extremity strength was measured with a hand held dynamometer. As a result of this study, it was found that all of the lower extremity strength measures, gait velocity and balance measures were significantly associated with timed "Up and Go" performance. Author concluded that the effects of strength on functional mobility appears to be five times greater than the effect of balance and this study provides evidence to support a link between impairments of strength and balance and the ability to perform basic mobility skills in the elderly. In our study, strength was powerful determinants for balance impairment.

In a study performed by Yim Chiplis (2005), was found that there were no significant relationships between lower extremity muscle strength and each of the six Sensory Organization test (SOT) balance scores for the sample as a whole and for each of the age groups. Conversely, we investigated relationship balance and muscle strength and furthermore, in our study we found there was relationship with balance and muscle strength.

CHAPTER 6

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

6.1 Summary

The results of this study indicated that Pilates exercise for 12 weeks, for three 60 minute sessions per week was enough to stimulate statistically significant differences in dynamic balance ($p<0.05$), flexibility ($p<0.05$), simple reaction time ($p<0.05$), choice reaction time ($p<0.05$), muscle strength ($p<0.05$), and decrease number of falls ($p<0.05$), although there were no improvements in any of these parameters in control group.

The results demonstrated that there were increases in bone mineral density in Pilates exercise group. Finally, we found that there was significant differences in quality of life and anxiety scores of exercise group`s pre and post test result in elderly women. We assessed all parameters after a year follow up. There were significant differences in dynamic balance, muscle strength, flexibility, bone mineral density, number of falls, and quality of life whereas there was no differences in anxiety mean scores. Due to the exercise effects on treatment group, there were no prominent decreases compared with the control group. It was not cared or controlled whether Pilates group continued any type of exercise or not during a year . Exercise adherence of Pilates exercise may had been a habitual role in their daily life.

Futhermore, it was found that decrease in muscle strength, choice reaction time and anxiety were related with decrease in dynamic balance. Pilates exercise may be suitable to increase quality of life by increasing muscle strength, flexibility and balance in elderly women.

6.2 Conclusions

The following conclusions were based on the present investigation of the effects of the Pilates exercise on elderly women. This study supports the following points: 1) The Pilates Method improves dynamic balance, flexibility, reaction time, muscle strength, 2) It decreases number of falls and increases quality of life, 3) and moreover, Pilates exercise may increase bone mineral density, 4) there is relationship with balance, muscle strength and reaction time and anxiety. Furthermore, in aging, physical fitness parameters is not going very well with time. In this study there were declines in all physical fitness parameters in elderly women.

6.3 Recommendations and Implications

After 12 weeks Pilates exercise, exercise group participants reported that they felt much better physically, mentally, and emotionally while we did not quantify these parameters and therefore, in the beginning of the study, they had difficulty or no capability to stand up from the mat by themselves. We helped to participants who had difficulty in moving to stand up from the sitting position and after 12 week Pilates exercise they could stand up by themselves. We believe they are evidence for a training effect especially after increased muscle strength and balance. The results of this study represented all nursing home residents in one residential house and moreover, the findings may not be generalized to the entire country. In future studies, number of residential houses should be increased.

In this study, we chose women participants. In future studies may be preferred men participants with large number.

Pilates exercise can be integrated in older adults exercise program both in fitness centers and rehabilitation centers. Residential houses can recommend to Pilates exercise to their residents. Beside exercise professionals, this exercise should be use by physiotherapist and geriatrics.

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APPENDICES

Appendix A: The Information Form

BİLGİ FORMU

İsim : yaş :

Kilo : Boy:

Aşağıdaki sorulardan size en uygun olan cevapları daire içine alınız.

1. Son 12 ay içinde bir veya birde fazla düşme olayı yaşadınız mı? Evet/ Hayır
(cevabınız evet ise, nasıl ve nerde gerçekleşti)

--- ---

2. Hiç ciddi bir yaralanma yada sakatlığa neden olan bir düşme olayı yaşadınız mı? Evet/ Hayır

2. Doktorunuz sizin herhangi bir nörolojik rahatsızlığınız olduğunu yada olma riski olduğunuzu söyledi mi?(örn; parkinson, MS,beyinle ilgili prob. v.b) Evet/ Hayır

Varsa belirtiniz...

4. Kalp rahatsızlığınız var mı? Evet /Hayır

5. Diabetiniz var mı? Evet/ Hayır

6. Ortopedik bir rahatsızlık yaşadınız mı?(diz yada kalça çıkığı yada kırığı, diziniz de, sırtınızda yada boynunuzda rahatsızlık gibi) Evet / Hayır

cevabınız evet ise ne kadar süre önceydi belirtiniz.
----

7. Geçen yıl herhangi bir nedenle hastanede yattınız mı? Evet /Hayır
(cevabınız evet ise nedenini belirtiniz.)
----

8. Şu an herhangi bir tedavi görüyor musunuz? Evet/Hayır
(cevabınız evet ise, ne tedavisi olduğunu belirtiniz),
----

9. Geçmişte yada son zamanlarda aşağıdaki rahatsızlıklardan bir yada bir kaçını yaşadınız mı?

- baş dönmesi Evet/ Hayır
- göz kararması Evet/ Hayır
- düşüyor gibi olma Evet/Hayır

Cevabınız evet ise tam olarak ne olduğunu açıklayınız...

10. Gözlerinzde görmenizi zorlaştıracak ciddi bir rahatsızlık var mı? Evet/Hayır

11. Yürürken yada ayakta dururken herhangi bir ağrı falan hissediyormusunuz? Evet/Hayır

12. Yürürken size yardımcı olacak herhangi bir araç kullanıyormusunuz Evet/Hayır

13. Kulaklarınızın duymasında ciddi bir problem var mı? Evet/ Hayır

Cevaplarınız için teşekkür ederiz.

Appendix B: Pilates Exercise List

Exercise	Equipments	Repetitions
Warm-up		
1. Breathing	No equipments	10
2. Imprint and release	No equipments	10
3. Spinal rotation	No equipments	10
4. Cat stretch	No equipments	10
5.Hip rolls	No equipments	10
6. Scapula isolation	No equipments	10
7. Arm circles	No equipments	10
8.Scapula elevation	No equipments	10
Exercises		
1.Standing side bends	No equipments	8
2.calf strengthener	No equipments	8
3. Spine stretch	No equipments	8
4. The hundred	Mat	8
5. The roll up	Mat	8
6. Single leg stretch	Mat	8
7.Rolling like ball	Mat	8
8.Spine stretch forward	Mat	8
9.low back stretch	Mat	8
10.Roll overpreparation	Mat	8
11.Shoulder bridge	Mat	8
12.crisscross	Mat	8
13.Single straight leg stretch	Mat	8
14.Scissors	Mat	8
15.Double leg stretch	Mat	8
16.the saw	Mat	8
17.Mermaid	Mat	8
18.Standing side bends	Elastic Bands	10
19.standing extension	Elastic Bands	10
20.Seated row	Elastic Bands	10
21.Long sitting ankle plantar flexion	Elastic Bands	10
22.The Frog	Elastic Bands	10
23.Rowing	Elastic Bands	10
24.Shoulder abduction to 90º	Elastic Bands	10
25.Shoulder flexion to 90º	Elastic Bands	10
26.shoulder stretch	Elastic Bands	10
27.Inner thigh flexion	Elastic Bands	10
28.Bilateral upper extremity exercise	Elastic Bands	10
29.Trunk extension	Elastic Bands	10
30.Biceps curl	Elastic Bands	10

31.Reaching back	Elastic Bands	10
32Double arm raises	Pilates Ball	8
33.Seated bounce on ball	Pilates Ball	8
34.Seated leg rotations	Pilates Ball	8
35.Ball and raise up	Pilates Ball	8
36.Ball and raise reach sides	Pilates Ball	5
37.Gluteal stretch	Pilates Ball	5
38.Diagonal arm raises	Pilates Ball	8
39.Lateral trunk rotations	Pilates Ball	8
40.Single leg raises	Pilates Ball	8
41.Inner thigh ball press	Pilates Ball	8
42.Side lying inner thigh	Pilates Ball	8
43.Bridge	Pilates Ball	8
44.Abdominal crunch basic	Pilates Ball	8
45.Reverse curl	Pilates Ball	8
46.Lying curl and flex	Pilates Ball	8
47.Combination stretch	Pilates Ball	8
48.Upper back rotation	Pilates Ball	8
49.Leg press seated on the ball	Pilates Ball&Elastic band	10
50.Prone flexion	Pilates Ball&Elastic band	10




Appendix C: Informed Consent Form

BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU

Vücudumuzun şeklini veren ve hareket etmemizi sağlayan iskelet ve kas sistemimizde yaşlandıkça sorunlar görülmeye başlanır. Kemiklerimizde meydana gelen sorunların başında sessiz hastalık olarak tanımlanan ve günümüzde erkeklerde de görülen **osteoporoz hastalığı** sayılabilir. Bu hastalık özellikle 65 yaşından sonra pek çok soruna neden olur. Bunlardan biride düşmelerden kaynaklanan kırıklardır. Düşmeye neden olan etkenler önceden saptanır ve gerekli önlemler alınırsa bu kötü durum kontrol altına alınabilir.

OSTEOPOROZ NEDİR?

Osteoporoz, kemiklerimizin minerallerini yitirmesinin yanısıra yapılarının da bozulmasıyla birlikte daha kolay kırılabilir duruma gelmesidir. Osteoporoza bağlı kırıklar yaygın olarak omurga, el bileği ve kalça kemiklerinde görülmektedir.

Osteoporozun erkenden tanınması ve önlenmesi önemlidir. Önemli boyutta genetik olarak belirlenen osteoporoz hastalığında kalsiyum yönünden zengin beslenme (süt ve süt ürünleri, yeşil sebzeler, tarhana çorbası, kaşar peyniri gibi) ve genç yaşta yapılan egzersiz önemlidir. Ostoporoz ayrıca kahve, alkol ve sigara tüketenlerde de fazlaca görülmektedir. Osteoporozu önlemede veya yavaşlatmada yapılan düzenli egzersizlerin etkisi büyüktür. Birçok araştırma güçlü kemiklerin güçlü kaslarla parallel geliştiğini ve kaslarını çalıştıran bireylerde o kaslarının bağlandığı kemiklerinde de kemik yoğunluğunu koruduğunu bulmuştur.

Bu noktadan hareketle osteoporozu daha hassas olarak tanıyabilecek ve kişiye zarar vermeyen yöntemlerin üzerindeki araştırmalar sürdürülmektedir. Bu çalışmanın amacı kas kuvveti, denge, reaksiyon zamanı ile kemik yoğunluğunu ilişkilendirmek ve bu ilişkinin derecesini saptamaktır. Yaklaşık 100 kişinin katılacağı bu çalışmada denge, reaksiyon zamanı ile kas kuvvetiniz ölçülerek kemik yoğunluğu ve kırılma riski ile ilişkilendirilecektir.

Bu ölçümler sırasında kullanılacak aletler sırası ile Nicholas Manual Muscle Tester (MMT)-Kendall kas kuvvetini belirlemek için, Tümer mühendislik denge platformu statik ve dinamik denge, Newtest 1000 reaction timer ise reaksiyon zamanını belirlemede ve esneklik ölçümü için otur-eriş esneklik ölçümü sehpasıdır. DEXA cihazında röntgen ışınları kullanılmakla birlikte aldığınız ışıma toplam olarak bir adet diş röntgenine eşdeğer olup her iki aletinde insan vucudu için herhangi bir tehlikesi ve zararı yoktur.

Bu ölçümsizin isteğinize bağlı olarak yapılacaktır.**Dilediğiniz takdirde diğer ölçümlerinizi yaptırıp, DXA ölçümünü yaptırmama hakkına sahipsiniz.**

Çalışmamıza konuk olma süreniz bir gün ile sınırlıdır. Bu çalışma sonucunda kas gücünüzü, denge, reaksiyon zamanınızı ve kemik yoğunluğunuzu ücretsiz olarak öğrenebilir ve osteoporoz için alınması gereken önlem varsa önceden haberdar olabilirsiniz. Tetkikleriniz sonucunda rahatsızlığınızın olduğu anlaşılırsa bağlı bulunduğuıuz Sağlık kurumunda tedavi olmaya yönlendireceksiniz

Çalışmaya katılmak için formumuza sizin için en uygun ölçüm tarihini belirleyerek imzalaynıız lütfen. Bu araştırmaya katılmayı red etme hakkına sahip olduğunuzu ve istediğiniz anda bırakabileceğinizi hatırlatırız.

Katıldığınız için teşekkür ederiz

Prof.Dr. Feza KORKUSUZ

Başhekim

Ben ....yukarıda okuduğum Çalışma ile ilgili belgeler bana sözlü olarak da iletildi. Bu çalışmaya gönüllü olarak kendi rızamla katılmak istiyorum.

Katılacak kişinin ADI:
SOYADI: Tel:

Gönüllünün yakını: ADI:
SOYADI: Tel:

Katılacağı Tarih:

Appendix D: Ethical Report

T.C.
Sağlık Bakanlığı
Ankara Atatürk Eğitim ve Araştırma Hastanesi
"Yerel Etik Kurul Karar Defteri"

1. Kurumun Adı : T.C. Sağlık Bakanlığı Ankara Atatürk Eğitim ve Araştırma Hastanesi
2. Kurumun Adresi : Bilkent Yolu No : 2 Çankaya/ ANKARA
3. Telefon : 0.312.291 25 25 Faks: +90.312 291 27 26 E-Posta: www.ataturkhastanesi.gov.tr.

- **Hastanemiz Yerel Etik Kurulu (YEK) toplandı.**

4. Tarih : 30.03.2006
5. Karar No. : 2006/03/42
6. Çalışmanın Tam Adı :

    a) Acil Servise Başvuran İntoksikasyon Vakalarının Prospektif Analizi ,
    b) Ambliyop Hastalarda Tedavinin Binoküler Fonksiyon ve Nötral Dansite Filtresi İle Değerlendirilmesi,
    c) Yaşlılarda Kırık Riski Belirlemede Denge, Kinestetik Algılama, Kas Kuvveti, Reaksiyon Zamanı ve Kemik Yoğunluğu.

KARAR: a) Sorumlu araştırmacı Uzm.Dr. Cemil KAVALCI ve araştırmacı Op.Dr. Mehmet ÖZER'e ait "Acil Servise Başvuran İntoksikasyon Vakalarının Prospektif Analizi" adlı çalışmanın protokol, usul, yaklaşım ve yöntem yönünden **ETİK** Değerlendirmesinde **UYGUN OLDUĞUNA** katılanların **OY BİRLİĞİ** ile karar verilmiş, hastanemiz bilgi ve belgelerinin kullanılmasına YEK Kararı ile izin verilmiştir.

b) Sorumlu araştırmacı Doç.Dr. Şaban ŞIMŞEK, Doç.Dr. Ayşe Gül KOÇAK ALTINTAŞ ve araştırmacılar Op.Dr. Hasan Basri ÇAKMAK ve Dr. Mehti Çağatay TÜRKER'e ait "Ambliyop Hastalarda Tedavinin Binoküler Fonksiyon ve Nötral Dansite Filtresi İle Değerlendirilmesi" adlı çalışmanın protokol, usul, yaklaşım ve yöntem yönünden **ETİK** Değerlendirmesinde **UYGUN OLDUĞUNA** katılanların **OY BİRLİĞİ** ile karar verilmiş, hastanemiz bilgi ve belgelerinin kullanılmasına YEK Kararı ile izin verilmiştir.

c) Sorumlu araştırmacı Prof.Dr. Feza KORKUSUZ ve araştırmacılar Prof.Dr. Erdal ZORBA, Doç.Dr. Murat BOZKURT, Yrd.Doç.Dr. Sadettin KİRAZCI, Op.Dr. Ali ÖÇGÜDER, Uzm.Dr. Nuray BOZKURT ve Arş.Gör. Gönül BABAYİĞİT İREZ'e ait "Yaşlılarda Kırık Riski Belirlemede Denge, Kinestetik Algılama, Kas Kuvveti, Reaksiyon Zamanı ve Kemik Yoğunluğu" adlı çalışmanın protokol, usul, yaklaşım ve yöntem yönünden **ETİK** Değerlendirmesinde **UYGUN OLDUĞUNA** katılanların **OY BİRLİĞİ** ile karar verilmiş, hastanemiz bilgi ve belgelerinin kullanılmasına YEK Kararı ile izin verilmiştir.

7. **YEK Üyesi Araştırmacı:** Yok.
8. **YEK Üyelerinin Ad, Soyad, Unvan ve İmzaları:**

Op. Dr. Ahmet KUŞDEMİRİ (Başkan)* 2.Genel Cerrahi Klinik Şefi	Doç.Dr. Murat SÜHER(Başkan Yrd.)* İç Hastalıkları Klinik Şefi	Prof.Dr. N. Serdar UĞRAŞ Patoloji Uzmanı
Doç.Dr.Mehmet BİLGE Kardiyoloji Klinik Şefi	Uzm.Dr. İsmet TAŞ Radyoloji Klinik Şefi	Uzm. Dr. Pervin BARAN Biyokimya Uzmanı
Uzm.Dr. Ekmel OLCAY Farmakoloji Uzmanı	Dr. Hasan ALAÇA Hukukçu	Şengün ERTEN Eczacı
Seyhan DEMİR Eğitim Hemşiresi	Uzm. Dr. Nurhan ERYILMAZ Başhekim Yardımcısı Biyokimya Uzmanı YEK Sekreteri	

T.C.
Sağlık Bakanlığı
Ankara Atatürk Eğitim ve Araştırma Hastanesi
"Yerel Etik Kurul Karar Defteri"

9. **İmzası Bulunmayan Üyeler:** : Prof.Dr. N.Serdar UĞRAŞ ve Uzm.Dr. Ekmel OLCAY izinli olmaları nedeniyle toplantıya katılmamışlardır.

10. **Yerel Etik Kurul Başkanı Adı, Soyadı, Ünvanı, İmzası:**
Op.Dr. Ahmet KUŞDEMİR (20836) Genel Cerrahi Klinik Şefi.

11. **Kurum Sorumlusu Adı, Soyadı, Ünvanı, İmzası:**
Prof. Dr. Nihat TOSUN (E00853) 1. Ortopedi ve Travmatoloji Klinik Şefi, BAŞHEKİM

ASLI GİBİDİR

Appendix E: SF-36

SF 36 SAĞLIK DURUMU ANKETİ

Adı Soyadı: Tarih:

Yönerge: Bu anket sizin şu anki ve geçtiğimiz haftalardaki sağlık durumunuzla ilgili görüşlerinizi sorgulamaktadır. Lütfen her soruyu cevaplayın. Bazı sorular biri birine benziyor gibi görünebilir. Ancak her biri farklıdır. Her soruyu dikkatle okuyarak size en yakın olan cevabın altındaki daire işaretini doldurun.

1.Genel olarak sağlığınızı nasıl değerlendirirsiniz?

Mükemmel	**Çok iyi**	**İyi**	**Fena değil**	**Kötü**
O	O	O	O	O

2. Geçen seneyle karşılaştırıldığında, şimdiki sağlığınızı nasıl değerlendirirsiniz?

Bir yıl öncesine göre şimdi çok daha iyi	**Bir yıl öncesine göre şimdi daha iyi**	**Hemen hemen aynı**	**Bir yıl öncesine göre daha kötü**	**Bir yıl öncesine göre çok daha kötü**
O	O	O	O	O

3. Aşağıdakiler normal olarak gün içerisinde yapıyor olabileceğiniz bazı faaliyetlerdir. Sağlığınız **şu anda** bu faaliyetler bakımından sizi kısıtlıyor mu? Kısıtlıyorsa ne kadar?

	Evet çok kısıtlıyor	**Evet biraz kısıtlıyor**	**Hayır kısıtlamıyor**
a. **Kuvvet gerektiren faaliyetler**, örneğin, ağır eşyalar kaldırmak, futbol gibi sporlarla uğraşmak	O	O	O
b. **Orta zorlukta faaliyetler**, örneğin masa kaldırmak, süpürmek, yürüyüş gibi hafif spor yapmak	O	O	O
c. Çarşı – pazar torbalarını taşımak	O	O	O
d. **Birkaç kat** merdiven çıkmak	O	O	O
e. **Bir** kat merdiven çıkmak	O	O	O
f. Eğilmek, diz çökmek, yerden bir şey almak	O	O	O
g. **Bir kilometreden fazla** yürümek	O	O	O
h. **Birkaç yüz metre** yürümek	O	O	O
i. **Yüz metre** yürümek	O	O	O
j. Yıkanmak ya da giyinmek	O	O	O

4. **Geçtiğimiz bir ay** (4 hafta) içerisinde işinizde veya diğer günlük faaliyetlerinizde bedensel sağlığınız nedeniyle, aşağıdaki sorunların herhangi biriyle karşılaştınız mı?

		Evet	Hayır
a.	İş ya da iş dışı uğraşlarınıza **verdiğiniz zamanı** kısmak zorunda kalmak	O	O
b.	Yapmak istediğinizden **daha azını** yapabilmek? (bitmeyen projeler, temizlenmeyen ev gibi)	O	O
c.	Yapabildiğiniz iş türünde ya da diğer faaliyetlerde kısıtlanmak	O	O
d.	İş ya da diğer uğraşları yapmakta zorlanmak	O	O

5. **Geçtiğimiz bir ay** (4 hafta) içerisinde işinizde veya diğer günlük faaliyetlerinizde duygusal problemleriniz nedeniyle (üzüntülü ya da kaygılı olmak gibi) aşağıdaki sorunlardan herhangi biriyle karşılaştınız mı?

		Evet	Hayır
a.	İş ya da iş dışı uğraşlarınıza verdiğiniz zamanı kısmak zorunda kalmak.	O	O
b.	Yapmak istediğinizden daha azını yapabilmek (bitmeyen projeler, temizlenmeyen ev gibi...)	O	O
c.	İş ya da diğer uğraşları her zaman gibi dikkatlice yapamamak	O	O

6. Son bir ay (4 hafta) içerisinde bedensel sağlığınız ya da duygusal problemleriniz, aileniz, arkadaşlarınız, komşularınızla ya da diğer gruplarla normal olarak yaptığınız sosyal faaliyetlere ne ölçüde engel oldu?

Hiç	**Biraz**	**Orta derecede**	**Epeyce**	**Çok fazla**
O	O	O	O	O

7. Geçtiğimiz bir ay (4 hafta) İçerisinde ne kadar bedensel ağrılarınız oldu?

Hiç	**Çok hafif**	**Hafif**	**Orta hafiflikte**	**Şiddetli**	**Çok şiddetli**
O	O	O	O	O	O

8. Son bir ay (4 hafta) içerisinde ağrı normal işinize (ev dışında ve ev işi) ne kadar engel oldu?

Hiç	**Biraz**	**Orta derecede**	**Epeyce**	**Çok fazla**
O	O	O	O	O

9. Aşağıdaki sorular geçtiğimiz bir ay (4 hafta) içerisinde kendinizi nasıl hissettiğinizle ve işlerin sizin için nasıl gittiğiyle ilgilidir. Lütfen her soru için nasıl hissettiğinize en yakın olan cevabı verin. Geçtiğimiz 4 hafta içindeki sürenin ne kadarında...

	Her zaman	**Çoğu zaman**	**Epeyce**	**Ara sırada**	**Çok ender**	**Hiçbir zaman**
a. Kendinizi hayat dolu hissettiniz?	O	O	O	O	O	O
b. Çok sinirli bir kişi oldunuz?	O	O	O	O	O	O
c. Sizi hiçbir şeyin neşelendirmeyeceği kadar moraliniz bozuk ve kötü oldu?	O	O	O	O	O	O
d. Sakin ve huzurlu hissettiniz?	O	O	O	O	O	O
e. Çok enerjiniz oldu?	O	O	O	O	O	O
f. Mutsuz ve kederli oldunuz?	O	O	O	O	O	O
g. Kendinizi bitkin hissettiniz?	O	O	O	O	O	O
h. Mutlu ve sevinçli oldunuz?	O	O	O	O	O	O
i. Yorgun hissettiniz?	O	O	O	O	O	O

10. Geçtiğimiz bir ay (4 hafta) içerisinde, bu sürenin ne kadarında bedensel sağlığınız ya da duygusal problemleriniz, sosyal faaliyetlerinize (arkadaş, akraba ziyareti gibi...) engel oldu?

Her zaman	**Çoğu zaman**	**Bazen**	**Çok ender**	**Hiçbir zaman**
O	O	O	O	O

11. Aşağıdaki her bir ifade sizin için ne kadar DOĞRU yada YANLIŞ?

	Kesinlikle doğru	**Çoğunlukla doğru**	**Emin değilim**	**Çoğunluk la yanlış**	**Kesinlik le yanlış**
a. Başkalarından biraz daha kolay hastalandığımı düşünüyorum	O	O	O	O	O
b. Ben de tanıdığım herkes kadar sağlıklıyım	O	O	O	O	O
c. Sağlığımın kötü gideceğini sanıyorum	O	O	O	O	O
d. Sağlığım mükemmeldir	O	O	O	O	O

Tesekkurler…

Appendix F: Beck Anxiety

BECK kaygı ölçeği

Aşağıda, insanların kaygılı ya da endişeli oldukları zamanlar da yaşadıkları bazı belirtiler verilmiştir. Lütfen her maddeyi dikkatle okuyunuz. Daha sonra, her maddedeki belirtinin (bugün dahil) son bir haftadır sizi ne kadar rahatsız ettiğini aşağıdaki ölçekten yararlanarak maddelerin yanındaki cevabı yuvarlak içine alarak belirleyiniz.

0.Hiç 1.Hafif derecede 2. Orta derecede 3. Ciddi derecede

Sizi ne kadar rahatsız etti?

1) Bedeninizin herhangi bir yerinde uyuşma veya karıncalanma 0…..1…..2…..3
2) Sıcak / ateş basmaları 0…..1…..2…..3
3) Bacaklarda halsizlik, titreme 0.…..1…..2…..3
4) Gevşeyememe 0…..1…..2…...3
5) Çok kötü şeyler olacak korkusu 0…..1…..2…..3
6) Baş dönmesi veya sersemlik 0…..1…..2…..3
7) Kalp çarpıntısı 0…..1…..2…..3
8) Dengeyi kaybetme duygusu 0…..1…..2…..3
9) Dehşete kapılma 0…..1…..2…..3
10) Sinirlilik 0…..1…..2…..3
11) Boğuluyormuş gibi olma duygusu 0…..1…..2…..3
12) Ellerde titreme 0…..1…..2…..3
13) Titreklik 0…..1…..2…..3

14) Kontrolü kaybetme korkusu	0…..1…..2…..3
15) Nefes almada güçlük	0…..1…..2…..3
16) Ölüm korkusu	0…..1…..2…..3
17) Korkuya kapılma	0…..1…..2…..3
18) Midede hazımsızlık ya da rahatsızlık hissi	0…..1…..2…..3
19) Baygınlık	0…..1…..2…..3
20) Yüzün kızarması	0…..1…..2…..3
21) Terleme (sıcağa bağlı olmayan)	0…..1…..2…..3

Appendix G: Assumption Checks

1. Assumption check for Mixed Designs repeated MANOVA

Mixed design multivariate analysis of variance was performed to investigate Pilates exercises effects on pre-test and post-test results of elderly women. 6 dependent variables were used: dynamic balance, reaction time, muscle strength, flexibility and number of falls and separate mixed design repeated measures MANOVA was used to examine Pilates exercises effects of bone mineral density and separately performed another statistic was beck anxiety and quality of life. Preliminary assumption testing was conducted to check for covariance normality, linearity, univariate and multivariate outliers, and homogeneity of variance, covariance matrices and multicollinearity with no serious violations noted. There were significant differences in experiment groups' variables.

Normality: Skewness and kurtosis statistics indicate that data are relatively normally distributed across groups.

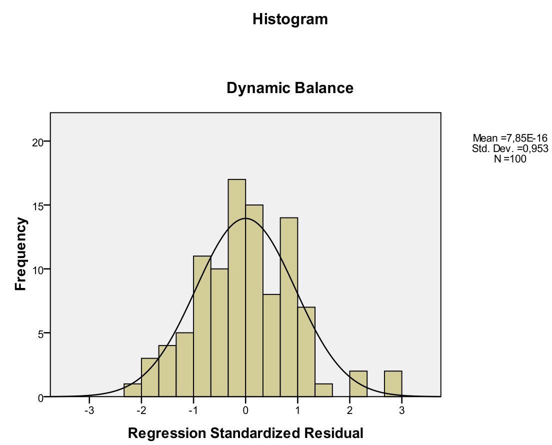
Homogeneity of variance-covariance matrices; In evaluating the necessary assumptions we find that Box`s M statistic is significant ($p<.005$) and thus we have violated the assumption of homogeneity of variance-covariance matrices. Pillai`s Trace criterian is considered to have acceptable power and to be the most robust statistics so we used Pillai`s Trace (Field, 2005). Levene`s test was not significant ($p>.005$) and thus indicates that not violated the homogeneity of variances assumption.

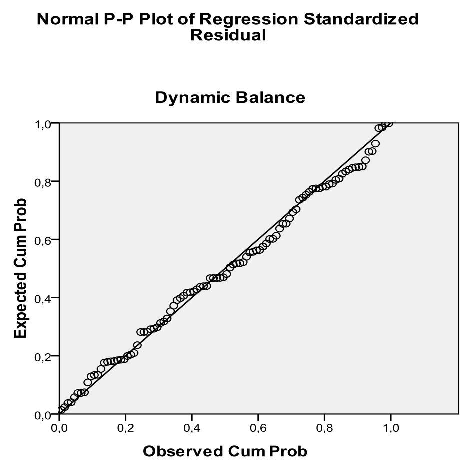
The sphericity assumption was checked with Mauchly's test. The hypothesis of sphericity was rejected as Mauchly's W is significant; for number of falls $W(3) = 0.495$, $p < .05$, for dynamic balance $W(3) = 0.823$, $p < .05$; for Simple reaction $W(3) = 0.352$, $p < .05$ and choice reaction time $W(3) = 0.712$, $p < .05$, so the sphericity assumption has not been met. Thus as an option to violation of sphericity, a univariate analysis was applied using an adjusted critical F-value.

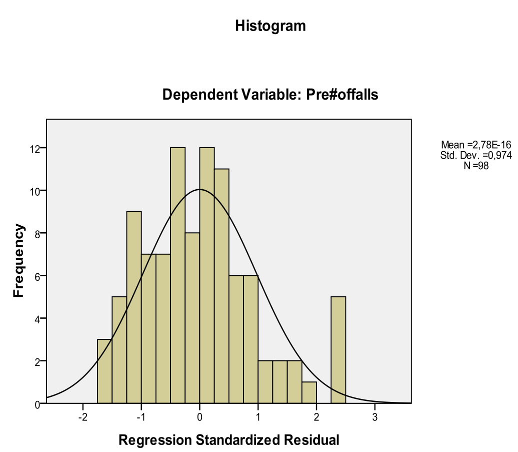
As the sphericity assumption was not met, the Greenhouse-Geisser correction was applied. The main effect of number of falls was significant, F (1.329, 77.09) = 28.40, $p < .005$, $\eta^2 = .33$ and dynamic balance F (1.699, 77.09) = 81.89, $\eta^2 = .58$ $p < .005$, SRT F (1.214, 70.40) = 63.84, $\eta^2 = .52$, $p < .005$, CRT F (1.552, 90.04) = 79.31, $\eta^2 = .57$,$p < .005$, The partial Eta squared value obtained in this study is .947. Using the commonly used guidelines proposed by Cohen (1988), this result suggests a very large effect size.

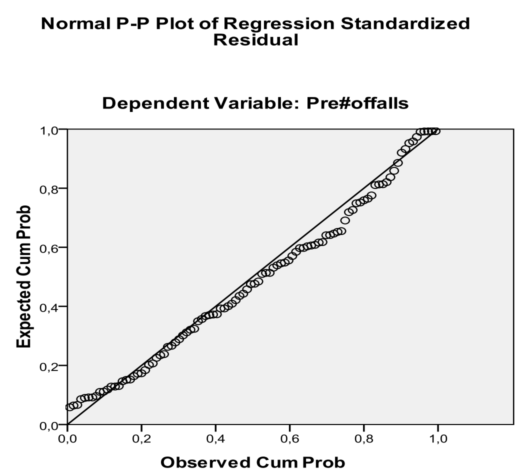
2. Testing Assumptions for Hierarchical Regression

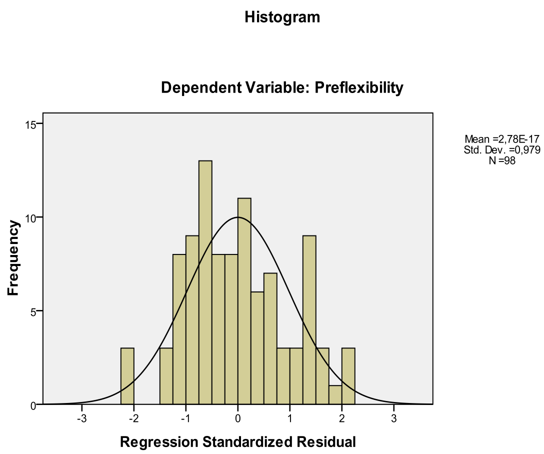
According to regression standardized histogram represents a roughly normal curve, so normality of errors assumption is not violated as it seen Figure 1. Moreover, the P-P plotted residuals nearly follow the 45-degree line. Linearity was also controlled by scatterplots.

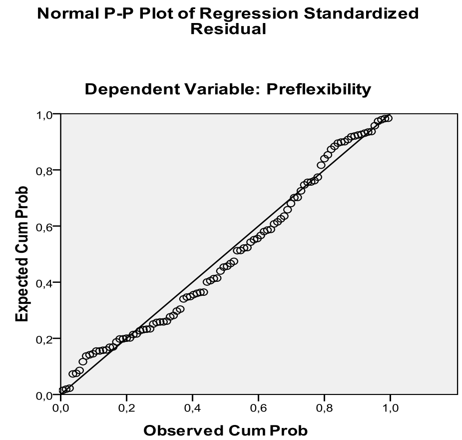


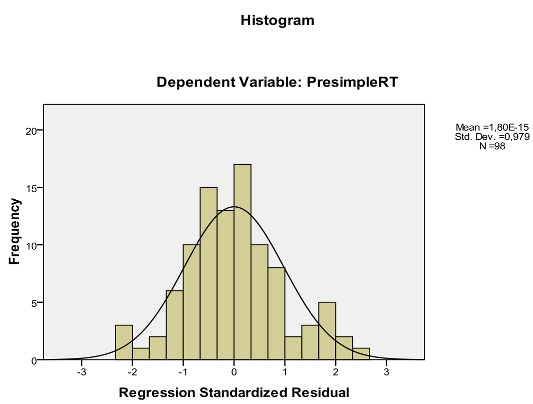


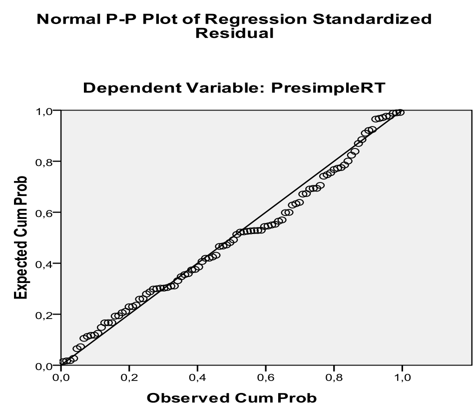


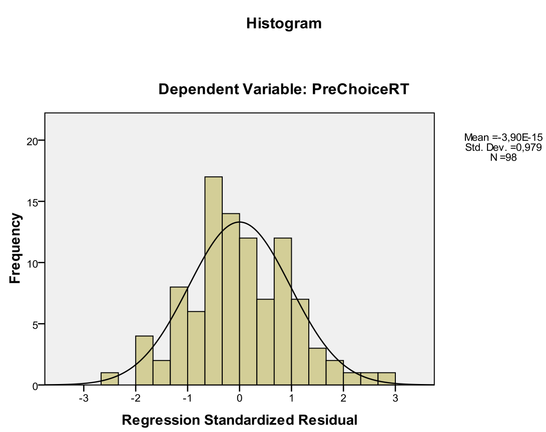


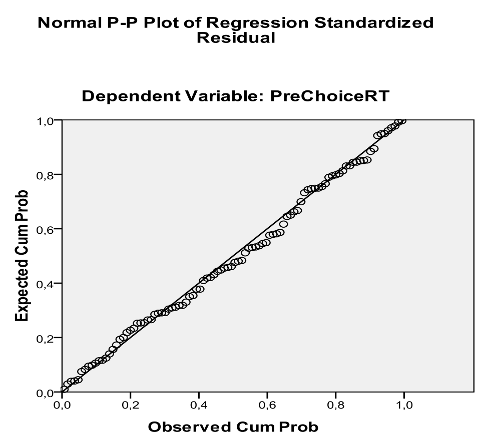

Histogram
Dependent Variable: Preflexibility
Mean =2,78E-17
Std. Dev. =0,979
N =98
Frequency
Regression Standardized Residual

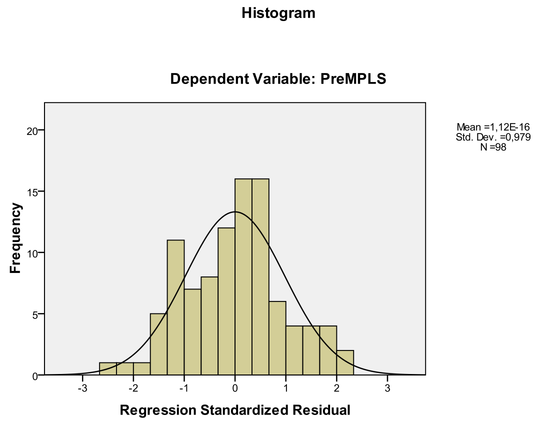

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Preflexibility
Expected Cum Prob
Observed Cum Prob


Histogram
Dependent Variable: PresimpleRT
Mean =1,80E-15
Std. Dev. =0,979
N =98
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: PresimpleRT
Expected Cum Prob
Observed Cum Prob


Histogram
Dependent Variable: PreChoiceRT
Mean =-3,90E-15
Std. Dev. =0,979
N =98
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: PreChoiceRT
Expected Cum Prob
Observed Cum Prob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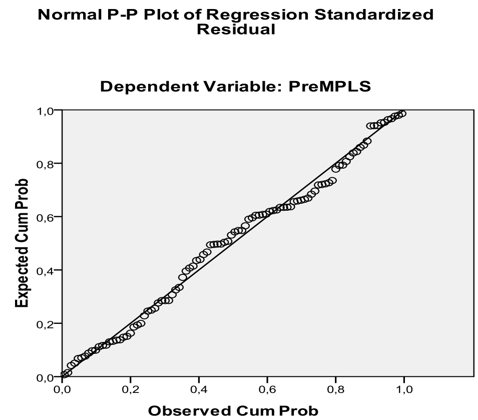
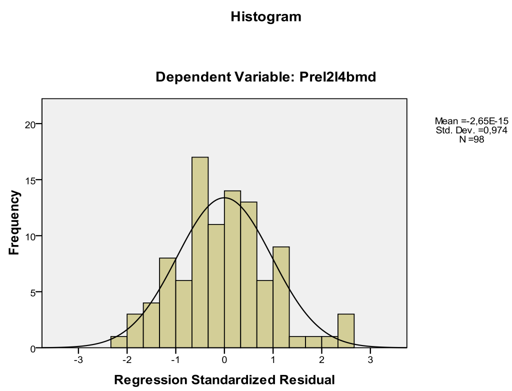
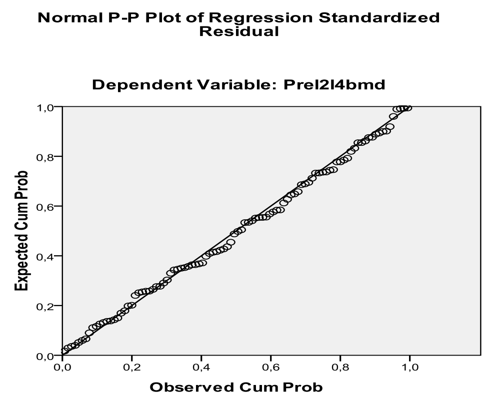
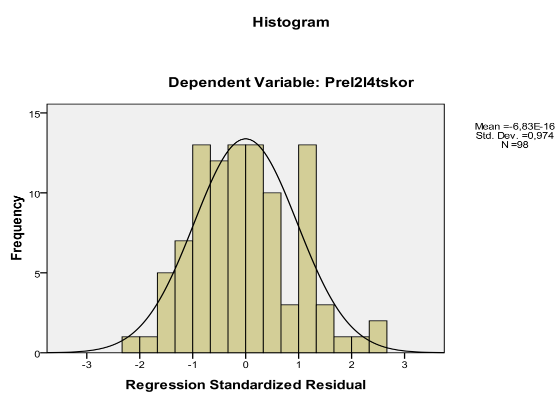
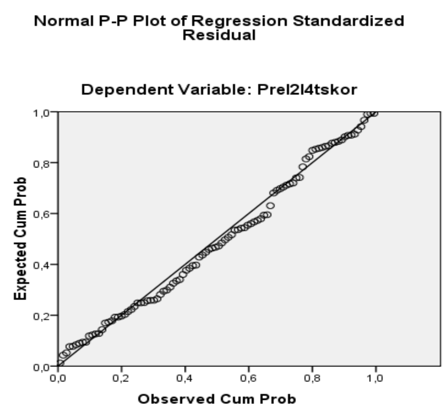
Dependent Variable: PreMPLS
Mean =1,12E-16
Std. Dev. =0,979
N =98
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: PreMPLS
Expected Cum Prob
Observed Cum Prob


Histogram
Dependent Variable: Prel2l4bmd
Mean =-2,65E-15
Std. Dev. =0,974
N =98
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Prel2l4bmd
Expected Cum Prob
Observed Cum Prob


Histogram
Dependent Variable: Prel2l4tskor
Mean =-6,83E-16
Std. Dev. =0,974
N =98
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Prel2l4tskor
Expected Cum Prob
Observed Cum Prob

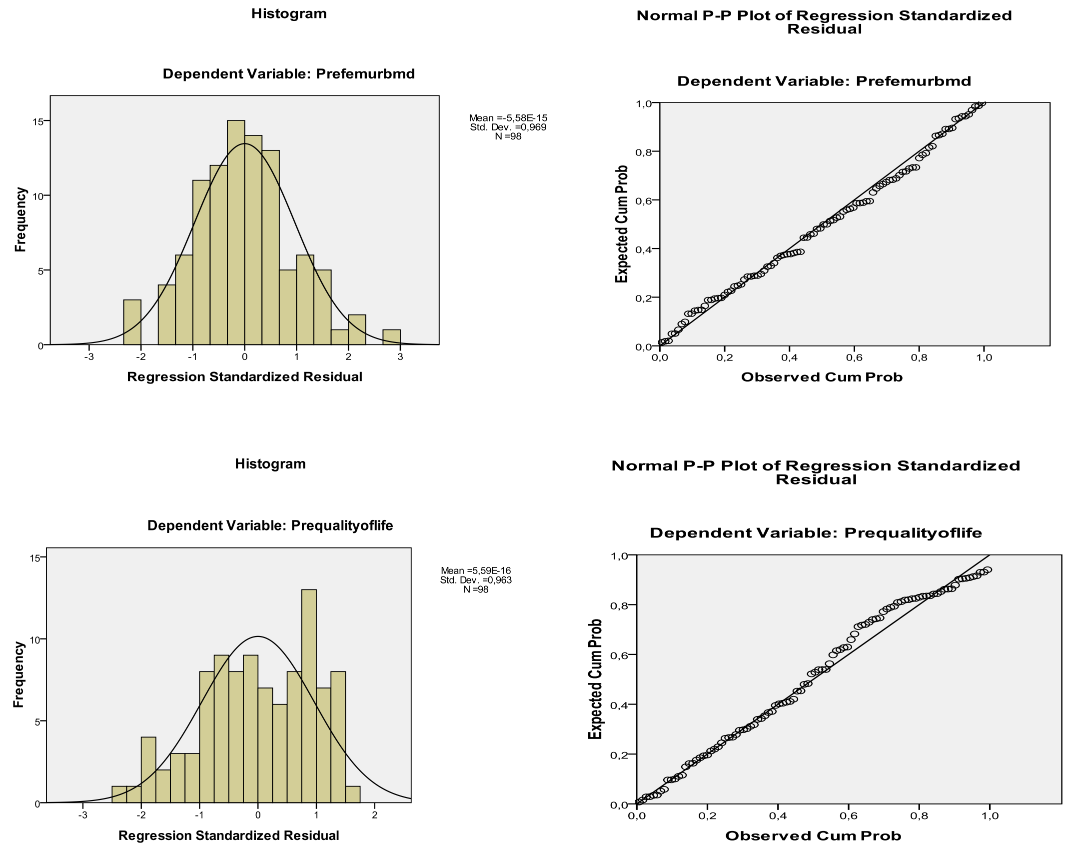
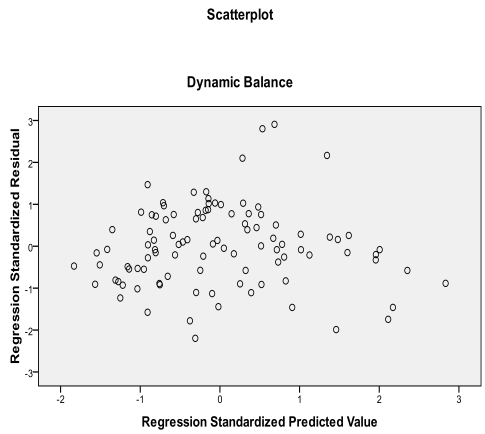
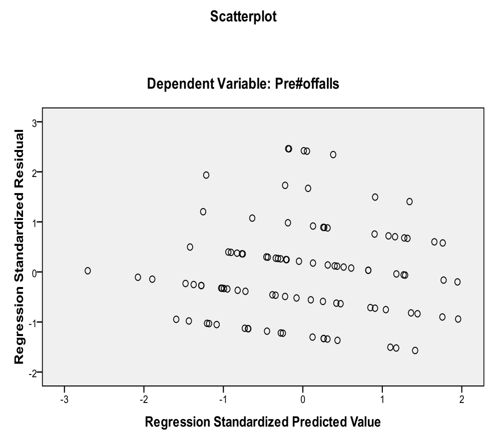
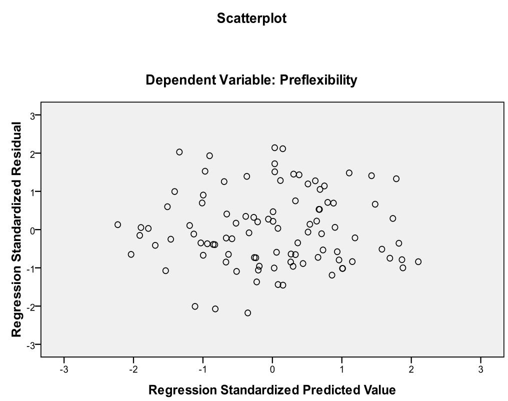


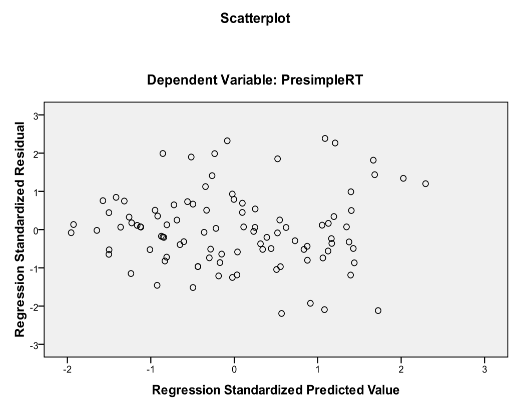
*Figure A. 1.*The histogram of the standardized residuals and the normal probability plot. Homoscedasticity assumption was checked by scatterplot of Regression Standardized Predicted Value.

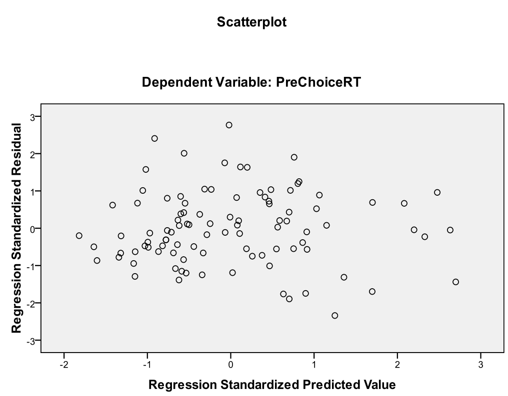
Figure A2, represent there is no apparent pattern in the scatterplot. The assumption means that the variance of the residuals is approximately equal for the predicted dependent variable was met.

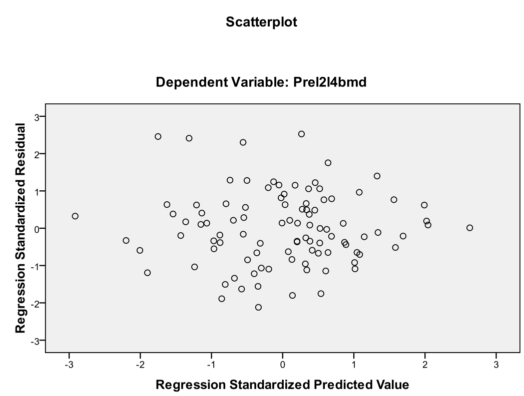

Scatterplot
Dynamic Balance
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: Pre#offalls
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: Preflexibility
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: PresimpleRT
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: PreChoiceRT
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: Prel2l4bmd
Regression Standardized Residual
Regression Standardized Predicted Value

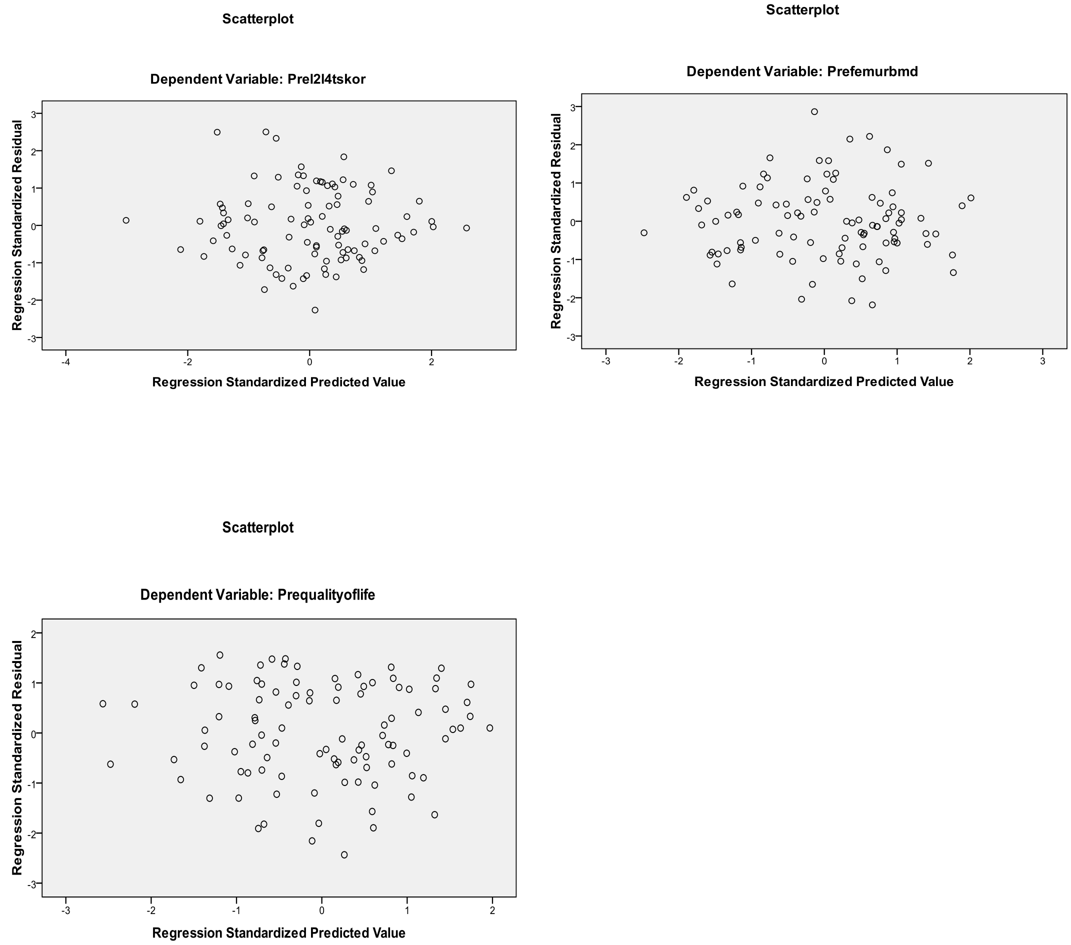


Figure A.2. Residuals scatterplot

Since control independence of errors of prediction, the Durbin-Watson coefficient (*d*) was used. As *d* should be between 1.5 and 2.5 (Field, 2005) to indicate independence of observations, obtained *d* value of 1.582 represents there is no violation of this assumption.

Multicollinearity assumption was controlled by means of the correlation matrix. There was not any tolerance value less than .20, and VIF value higher than 4 for the predictors. Multicollinearity exists when there is a strong correlations two or more predictors in a regression model. Consequently, there is no problem with the assumption of multicollinearity.

Influential observations include residuals and outliers. Outliers were examined on the dependent variable and on the set of predictors; and influential data points were measured by utilizing Cook's distance. Using the standardized residuals, outliers were screened on dependent variable. The leverage statistic varies from 0 to 1. A rule of thumb is to look for cases over .50. According to results there is no value greater than .50.

The means and standard deviations for predictors and criterion variable in hierarchical regression analysis and correlation coefficients were presented in Table 4.7

Appendix H: Türkçe Özet

PİLATES EGZERSİZİ, 65 ÜSTÜ YASLI KADINLARLARDA, DENGE, REAKSİYON ZAMANI, KAS KUVVETİ, DÜSME SAYISI VE PSİKOLOJİK PARAMETRELERİ OLUMLU OLARAK ETKİLER

Giriş

Sosyal ekonomik gelişmeler ve iyileşen sağlık hizmetleri sayesinde dünyada yaşlı nüfusun sayısı gün geçtikçe artmaktadır. Genç nüfusuyla bilinen ülkemizde de beklenen yaşam süresinin artmasıyla birlikte Avrupa ülkelerinde de olduğu gibi yaşlı sayısı artmaya başlamıştır. Türkiye`de 2000 yılında, 60 yas üzeri nüfusun toplam nüfusa oranı %7,8 olarak artış göstermiştir (NISBO, 2003).

Fiziksel aktivite her yaştaki birey icin oldukca faydalıdır. Egzersiz, kan basıncını düşürür; denge kaybedip düşme riskini ve yaralanma risklerini azaltır (kalça ya da bilek kırılmaları); vücudun kas ve kemik kütlesi kaybını yavaşlatır; esnekligi artırır. Bununla birlikte denge ve hareket kabiliyetini geliştirir, ideal kilonun korunmasıni sağlar, uyku düzenini sağlar, gerginlik ve stresi uzaklaştırır, sağlıkli uzun bir yaşam sunar (Chapek, 1994).

1926 yılında Alman asıllı Joseph H. Pilates tarafından geliştirilen Pilates, vücuda esneklik ve güç kazandıran bir egzersiz sistemidir. Tüm vücut kaslarını harekete geçiren bu sistem, esneklik ve denge kazandırarak, vücudun postürünü geliştirmekte ve şekillendirmektedir. Pilates egzersizlerinin ilk çıkışı tedavi amaçlı idi. Daha sonraları kasları kuvvetlendirmek için kullanıldı. Günümüzde ise özellikle konsantrasyon gerektiren bu egzersiz türü vücut postürünü, esnekliğini, dengesini geliştirmek ve genel olarak sağlıklı bir vücuda sahip olmak için kullanılmaktadır (Selby, 2002).

Pilates egzersizi diğer aerobik ve dans egzersizlerine göre daha az şiddette bir egzersiz olmasına rağmen sağlıklı bir vücut için oldukça önemli bir yere sahiptir. Kalp hastalıkları riskini azaltır, osteoporozu önler, vücudu güzel bir şekle sokar, denge ve esnekliği geliştirir (Robinson &Hunter, 2003; Solomon, 2003).

Joseph Pilates (1880–1967)'in temelini attığı Pilates egzersizinde önceleri dansçılar ve atletler faydalanıyordu. Fakat son zamanlarda, Pilates rehabilitasyon ve fiziksel uygunluk alanında da kendine yer edinmiştir (Trew & Everett, 1997). Pilates koordinasyon, denge, esneklik, kassal dayanıklılığı geliştirebilen ender egzersizlerden biridir. Pilates metodu, her yaştaki birey icin uygun bir egzersiz çeşididir (Cozen, 2000).

Yapılan araştırmalara baktığımızda, yaşlılarda düşme ve dengenin ve kas kuvvetinin oldukça fazla çalışıldığını görmekteyiz. Bir çok çalışmada, bu amaç için çeşitli egzersiz şekli araştırılmıştır. Bunlar genellikle, denge, esneklik ve kuvvet egzersizleri ayrıca, aerobik-step, tai chi, ağırlık çalışması, kalisteniks egzersizler olarak özetlenebilir. Pilates egzersizi yaşlılarda ve diğer yaş gruplarında daha çok rehabilitasyon amacıyla kullanılmıştır. Bu çalışmayı orjinal yapan nedenlerden biride Pilates egzersizinin reaksiyon zamanı, düşme sayısı, kemik yoğunluğu, anksiyete ve yaşam kalitesine etkileri üzerine oldukça az yada hiç çalışma olmamasıdır.

Daha önce Pilatesle ilgili yapılan çalışmalarda, çoğunlukla Pilates ve rehabilitasyon (Bryan&Hawson, 2003; Herrington&Davies, 2005) konusu işlenmiş, yada Pilates ve dansçılar (Fitt&et al.1993; McMillan et al, 1998) çalışılmıştır. Yaşlılarla ilgili yapılan çalışmalar oldukça azdır (Shedden&Kravitz, 2006). Yine "Pubmed database"de 1990-2009 yılları arası Pilates ile ilgili literatür taraması yapılmış ve yaklaşık 30 kadar çalışma bulunmuştur ve yine 'Science Direct' te yapılan taramada yaklaşık 244 araştırma saptanmıştır. Bu araştırmaların sonucuna göre yaşlılık ve Pilates ile ilgili yapılan çalışmaların çok az olduğu görülmüştür.

Bu çalışmanın amacı, ilk olarak, 65 yaş üstü yaslı kadınlarda 12 haftalık Pilates egzersizinin, dinamik denge, esneklik, reaksiyon zamanı, kas kuvveti ve düşme sayısı, kemik mineral yoğunluğu, anksiyete ve yaşam kalitesi üzerine etkisini arastirmaktir. İkinci olarak, bu parametrelerde bir yıl sonra görülen değişiklikleri belirlemek ve son olarak ta dinamik denge ve bağımlı değiskenler arasındaki ilişkiyi araştırmaktir. Çalışmada bağımlı değişkenler olarak, dinamik denge, esneklik, kas kuvveti, reaksiyon zamanı, düşme sayısı, kemik mineral yoğunluğu, yaşam kalitesi ve anksiyete alınmıştır.

Materyal ve Yöntem

Katılımcılar

Çalışmaya 65 ve üstü ve Huzurevinde yasayan toplam 100 katılımcı davet edildi ve bunların 30 kişisi rastgele olarak Pilates egzersiz (n=30, yaş=72.80±6.7, boy=156.1± 6.4 cm, kilo =67.20±9.5 kg) ve kontrol (n=30, yaş=78.03±5.7, boy=156.53±5.1cm, kilo=67.83±10.9kg) gruplarını oluşturdu. Geri kalan 40 kişi ise çalışmanın bir diğer amacı olan, dinamik denge ile kas kuvveti, esneklik, reaksiyon zamanı, düşme sayısı, kemik mineral yoğunluğu, anksiyete ve yaşam kalitesi arasındaki ilişkiyi açıklamak için teste dahil edilmiştir. Kontrol grubu Pilates egzersizi süresince herhangi egzersiz programına katılmadı.

Egzersiz grubundaki tüm bireyler son bir yılda düzenli egzersiz programına katılmayan kişiler arasından seçilmiş ve herhangi bir ciddi ortopedik rahatsızlık, görme bozukluğu, kalp dolaşım bozuklukları veya sinirsel ve zihinsel rahatsızlıklarının olmadığı huzur evinde çalışan uzman doktorlar tarafından teyit edilmiştir. Buna ek olarak katılımcılara sağlık bilgi formu doldurulmuştur. Tüm katılımcılar çalışmanın olası risklerinden haberdar edilmiş ve çalışmayla ilgili ayrıntılı bilgiler içeren bir onam formu imzalamışlardır. Çalışma öncesinde gerekli etik kurul raporu Atatürk Araştırma ve Eğitim Hastanesi tarafından onaylanmıştır. Çalışmaya başlamadan önce katılımcılara gönüllü olur formu verildi.

Çalışmaya katılanların demografik özellkilerine bakıldığında, katılanların çoğunluğunun üniversite mezunu (24%) ve yüksek okul mezunu (25%) olduğu, ve %57'sinin eşini kaybetmiş kişilerden oluştuğu görülmüştür. Ayrıca yine çoğu katılımcının (66%) algıladığı sosyo-ekonomik düzeyi ise orta seviyede olarak tespit edilmiştir.

Yöntem

Bu çalışma iki aşamadan oluşmuştur. Birinci aşamada 100 katılımcı arasından rastgele seçilen 30 kişi egzersiz ve 30 kişi kontrol grubuna ayrılmıştır.

Egzersizler haftada 3 gün (Pazartesi, Çarşamba, Cuma) ve günde 1 saat olmak üzere 12 hafta boyunca uygulanmıştır. Seanslar 10 dakikalık ısınma 40 dakikalık esas devre ve 10 dakikalık soğuma evrelerinden oluşmaktadır. Tüm pilates egzersizleri sertifikalı ve 5 yıllık uygulama deneyimine sahip uzman pilates eğitmeni tarafından fizik tedavi uzmanı eşliğinde gerçekleştirilmiştir. İlk 4 haftalık bölümde yer minderi kullanılarak kalça, sırt ekstansiyonu ve statik abdominal fleksiyon gibi temel pilates hareketleri uygulanmıştır. İkinci 4 haftalık bölümde thera-bantlarla egzersize devam edilmiş ve bu dönemde daha çok denge, kas kuvveti ve esnekliği geliştirici temel pilates hareketleri yaptırılmıştır. Son 4 haftalık bölümde ise tüm katılımcılara uygun ebatta ayrı ayrı seçilen pilates toplarıyla yine denge, kas kuvveti ve esneklik geliştirici hareketler uygulanmıştır. Her hareket ortalama 8–12 tekrardan oluşmuş ve tekrarlar arası 30-45 saniye arasında değişen dinlenme aralıkları uygulanmıştır.

Tüm ölçümler 12 haftalık egzersiz öncesi ve sonrasındaki bir haftalık süre içerisinde gerçekleştirilmiştir. Bununla birlikte bütün ölçümler, bir yıl sonrasında tekrar edilmiştir.

Pilates Malzemeleri

Thera-band, zorluk derecesine göre renklerle belirlenmiş bir elastik banttır. Mavi, yeşil, kırmızı ve gri gibi renk alternatifleri vardır. Biz bu çalışmada yaşlıların fiziksel ölçüm değerlerine göre mavi, yeşil ve kırmızı renk zorluk seviyesini kullandık ayrıca yine katılımcıların boy uzunluklarına göre çeşitli ebatlarda değişen Pilates toplarını kullandık. Böylece her birey için özel malzemeler tercih edilmiş oldu. Egzersiz tekrarları 8-12 arasında hareket çeşidine göre belirlendi.

Ölçümler 12 haftalık egzersiz programının basında, sonunda ve 1 yıl sonrasında yapıldı. Dinamik denge, MED-SP 300 Denge Platformu ile, esneklik, otur-eriş testi ile; reaksiyon zamanı, New Test-2000 reaksiyon ölçüm aleti ile; kas kuvveti, Nicholas manual tester ile hip abduksiyon, hip adduksiyon ve hip fleksiyon ölçümlerinin toplamının ortalaması alınarak belirlenmiştir (MPLS değeri); kemik mineral yoğunluğu için DEXA kemik densitometre ölçüm aleti kullanılarak Lumbar spine ve femur neck BMD ve t-skorlari ölçülmüş ve yasam kalitesi, SF-36 anketi ile ve son olarak anksiyete, “beck anksiyete” ölçeği ile saptanmıştır.

Dinamik denge için kullanılan, MED-SP 300 Denge platformunun daha önce geçerlilik ve güvenilirlik çalışması yapılmıştır. Geçerlilik değeri r=.87 ve test-retest güvenilirlik değeri r=.91 olarak belirlenmiştir. Denge aleti sağa-sola ve öne-arkaya hareket edebilen yuvarlak bir platform şeklindedir. Zorluk derecesi olarak üç tane aşama (kolay, orta, zor) vardır. Yaşlılar üzerine yapılan bu çalışmada "en kolay" derece kullanılmıştır.

Beck anksiyete ölçeği, 21 maddeden oluşup 0-3 arası puanlanan likert tipi bir ölçektir. Verilen cevaplara 0 ile 3 arasında değişen puanlar verilir.Puan ranjı 0-63 tür. Ölçekten alınan toplam puanların yüksekliği, bireyin yaşadığı anksiyetenin şiddetini gösterir. Yapılan güvenilirlik analizi sonucunda, Cronbach alpha, r=.88 ile yüksek güvenilirliğe sahip olduğu belirlenmiştir.

SF-36 Yaşam kalitesi ölçeği, Yaşam kalitesini değerlendirme de geçerli ve oldukça sık kullanılan bir ölçüttür. Fiziksel fonksiyon, fiziksel rol kısıtlanması, emosyonel rol kısıtlanması, vücut ağrısı, sosyal fonksiyon, mental sağlık, canlılık, genel sağlık olmak üzere sekiz alt skalada 36 soru içerir. SF-36'nın Türkçe geçerlilik çalışması Koçyiğitve ark.'ları tarafından yapılmıştır. Bu çalışmada da güvenilirlik analizi yapılmış ve fiziksel fonksiyon Cronbach alpha, r=.80, fiziksel rol kısıtlanması r =.90, emosyonel rol r=..83, vücut ağrısı vücut ağrısı r=.71, sosyal fonksiyon r=.73, mental sağlık r=.85, canlılık r=.75, genel sağlık r=.93 olarak sapatanmış ve sonuçta bu örneklem grubu için yüksek seviyede güvenilir bulunmuştur.

Katılımcıların düşme sayıları bir yıl boyunca aylık takvimlere kaydedildi. Toplam 100 kişinin ölçüm değerleri bağımlı değişkenler arasında ilişki olup olmadığına bakılmak için analiz edildi ve ayrıca bir yıl sonraki tüm değişim farklılığını anlamak için test edildi.

Bu egzersizin etkileri değerlendirilirken SPSS 17 programı kullanıldı. Her bir parametre ayrı 2x3 (grup ve zaman) "mixed designs repeated measures MANOVA" ile test edildi. Bağımlı değişkenler arasındaki ilişki ise Regresyon analizi ile ve tüm değişkenlerde 1 yıl önce ve sonraki değişimleri test etmek için eşleştirilmiş t-testi kullanılmıştır.

Sonuçlar

Yapılan pre-test ve post-test ölçümleri sonunda; Dinamik denge ($p<0.05$), esneklik (otur-eriş) ($p<0.05$), reaksiyon zamanı ($p<0.05$), düşme sayısı ($p<0.05$), kas kuvveti ($p<0.05$), yasam kalitesi ($p<0.05$) ve anksiyete ($p<0.05$) ölçümlerinde istatistiksel olarak egzersiz öncesi ve sonrasında anlamlı değişiklikler bulundu. Kontrol grubu değişkenlerinde önemli bir değişiklik kaydedilmedi ($p>0.05$)

Tablo Appendix 1

Denge, Kas Kuvveti, Reaksiyon zamanı, Esneklik, Düşme Sayısındaki Ortalama Değişimleri

	Gruplar					
	Egzersiz Grubu			Kontrol Grubu		
	Ön- test	Son- test	1 yıl sonra	Ön- test	Son- test	1yıl sonra
Değişkenler	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd
Dinamik Denge [c]	10.98±1.5*	8.99±1.5	10.59±1.2	11.40±1.8	11.23±2.1	13.20±1.5
Otur Eriş testi (Esneklik)[a]	12.75±4.4*	15.88±5.1	13.70±4.2	10.80±3.8	10.40 ±3.6	8.48±3.4
Kas Kuvveti [b]	23.34±5.7*	32.71±7.0	20.93±1.5	20.98±8.90	20.72±8.6	11.39±4.9
Reaksiyon Zamanı						
Basit RT[d]	0.34±.09*	0.26±.05	0.35±.08	0.38±.09	0.39±.08	0.61±.1
Seçmeli RT[d]	0.69±.20*	0.55±0.1	0.71±.15	0.72±.16	0.73±0.1	0.94±0.1
Düşme Sayısı	1.87±1.4*	0.37±0.5	0.63±0.8	1.63±1.2	1.30±0.4	1.67±0.6

a cm, b kg, c açı, d ms
*$p<0.05$

Genel olarak kemik mineral yoğunluğunda egzersiz grubunda pozitif anlamda değişimler görülmüştür. Bu değişiklik istatistiksel olarak anlamlı olmasada uzun vadede oldukça önemlidir. Bir yıl sonraki değişime bakıldığında (tablo 2) her iki gruptada kemik mineral yoğunluğunda düşüşler saptanmıştır. Ama bu azalma, egzersiz grubuna göre kontrol grubunda daha fazladır. Bunun nedenide egzersizin etkisi olabilir.

Bu çalışmada yaşam kalitesi alt ölçeklerine ayrı ayrı bakılmamıştır. Sadece toplam skor sonucu değerlendirilmiştir. Bu sonuca göre, yine 12 haftalık Pilates egzersizi sonrasında yaşam kalitesi toplam değerinde istatistiksel olarak anlamlı bir artış görülmesine rağmen, kontrol grubunda anlamlı bir değişiklik görülmemiştir. Bir yıl sonrasında ise egzersiz grubunda daha az bir düşüş belirlenmiştir. Beck anksiyete sonuçlarına göre yine egzersiz grubu ön test ve son test değerlerinde olumlu yönde anlamlı bir fark bulunmuştur. Her iki gruptada bir yıl sonra olumsuz yönde değişimler olmuştur (Tablo App. 2)

Tablo Appendix 2

Kemik Mineral Yoğunluğu, Yaşam Kalitesi ve Anksiyete Ortalama Değişimleri

	Gruplar					
	Egzersiz Grubu			Kontrol Grubu		
	Pre- test	Post- test	Follow up	Pre- test	Post- test	Follow up
Değişkenler	X± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd	X ± Sd
L2-L4 BMD(g/cm²)	1.05±0.2	1.07±0.2	0.99±0.2	1.02±0.2	1.01±0.2	0.92±0.1
L2-L4 T score (g/cm²)	-1.21±1.3	-1.04±1.4	-1.31±1.4	-1.27±1.3	-1.28 ±1.3	-1.65 ±1.0
Femur BMD(g/cm²)	0.88±0.1	0.90±0.1	0.86±0.1	0.82±0.1	0.80±0.1	0.77±0.1
Femur T score (g/cm²)	-0.95±0.9	-0.88±1.0	-0.97±1.0	-1.38±.9	-1.37±.8	-1.68±1.0
Beck anksiyete	9.90±4.6*	5.66±3.9	8.03±3.9	8.60±3.4	8.58±3.6	9.26±3.6
SF-36Yaşam kalit	67.1±17.5*	84.5±9.0	75.2±15.6	63.4±15.4	61.4±18.9	50.5±18.9

$^*p<.05$

Bir yıl sonra tekrarlanan ölçüm sonuçlarına göre ise; basit reaksiyon zamanında (%33), kas kuvvetinde (%31), seçimli reaksiyon zamanında (%20), düşme sayısında (%20), ve kemik mineral yoğunluğunda dikkat çeken değişiklikler görüldü.

Çalışmanın bir diğer araştırma sorusu olan denge ile ilişkili olabilecek çalışmanın bağımlı değişkenlerini belirlemek için hiyararjik regresyon analizi yapılmış ve sonucunda denge ile ilişkili olan parametreler bulunmuştur. Buna göre, kas kuvveti, seçmeli reaksiyon zamanı ve anksiyete parametrelerinin dinamik denge ile ilişkili olduğu sonucuna varılmıştır.

Bu çalışmanın sonuçlarına göre, Pilates egzersizinin yaşlı kadınlarda, düşme sayısını azalttığını, kas kuvvetini arttırdığını, reaksiyon zamanını pozitif yönde etkilediğini, dinamik denge ve esnekliği arttırdığını ve anksiyete düzeyini düşürürken, yaşam kalitesini artırdığı sonucuna varılabilir. Bununla birlikte, yaşlı kadınlarda denge ve kas kuvveti, ile reaksiyon zamanı arasında bir ilişki vardır.

Tartışma ve Öneriler

Yapılan araştırmaların da ışığı doğrultusunda, her geçen gün egzersizin önemi günden güne artmaktadır. Monoton yaşam şeklini seçen bireylerde çıkan bir takım sağlık ve psikolojik problemlerin çözümünde gerekli görülen spor aktivitelerin önemi, yaşamın her alanında kendini göstermektedir. İleriki yaşlarda esneklik, denge, reaksiyon zamanı ve kas kuvveti önemi gittikçe artan fiziksel uygunluk parametrelerinden biri olmuştur (Segal&et al.2004).

Bu çalışmada, 12 haftalık Pilates egzersinin 65 yaş üstü yaşlı kadınlar da dinamik denge, esneklik, kas kuvveti, reaksiyon zamanı, kemik mineral yoğunluğu, anksiyete ve yaşam kalitesi üzerine olumlu anlamda etkileri olduğu saptanmıştır. Ayrıca, bir yıl sonra tekrarlanan ölçüm sonuçlarına göre tüm bu değerlerde düşüş olmasına rağmen egzersiz grubunda bu azalma daha az olarak saptanmıştır. Bunun nedeni, Pilates egzersizinin katılımcılara egzersiz alışkanlığı kazandırmış olması ve bu nedenle Pilates grubu üyelerinin 12 haftalık egzersiz sonrasıda egzersize devam etmiş olma olasılığı olabilir. Çalışmanın bir diğer sonucuda, bir yıl sonrasında toplam 4 kırık vakası olmasıdır. Bunların ikisi kalça kırığı biri bilek ve diğeride diz kapağı kırığıdır. Egzersiz grubuna katılan kişilerde kırık rapor edilmemiştir fakat çeşitli düşmeler aktarılmıştır.

Literatürde Pilates egzersizi ile ilgili daha çok yaşlılarda denge, esneklik ve kas kuvveti ile ilgili çalışmalara rastlanmıştır. Hall, (1998) yaptığı bir çalışmada, 65-85 yaş arası 31 erkek ve kadında Pilates egzersizinin statik ve dinamik denge üzerine etkisini araştırmış ve 10 haftalık çalışma sonucunda deney ilk ve son test grubunda anlamlı fark bulmuştur. Bu çalışmada da dinamik dengede olumlu yönde artış gözlenmiştir. Yine bu çalışmada yeni geliştirilen bir denge aleti kullanılmıştır. Denge ölçümleri klinik ve laboratuar ölçümleri olarak ikiye ayrılmaktadır. Biz laboratuar ölçümünü kullandık. Hall`un (1998) yaptığı çalışmada klinik ölçümler kullanılmıştır.

Wolkodoff (2008) tarafından Pilates egzersizinin 23-64 yas arası bireylerde, fiziksel uygunluk parametreler üzerine etkisi araştırılmıştır. Katılımcılardan 13 kişi egzersiz grubunda yer alırken 6 kişi kontrol grubuna dahil edilmiştir. Vücut kompozisyonu, VO_2 max, kas dayanıklılığı, esneklik, denge ve postur ölçümleri 8 hafta öncesi ve sonrası ölçülmüştür.

Egzersiz sonrasında bütün değerlerde artış gözlenmiştir. Bizim çalışmamızda da bu çalışmaya paralel olarak kas kuvveti, esneklik ve dengede anlamlı artışlar olmuştur.

Pilates ile ilgili yapılan bir çok çalışma bizim bulgularımızı desteklemektedir (Kaesler et al., 2007; Kloubec 2005; Johnson et al., 2007; Petrofsky et al., 2005; Wolkodoff, 2008). Segal ve arkadaşları (2004) yaptıkları çalışmada ortalama yas grubu 41 olan örneklem grubunda 6 haftalık haftada 1 saat uyguladıkları pilates egzersiz grubunda erkek ve kadın katılımcılarda esneklik değerlerinde anlamlı değişikler bulmuşlardır oysa vücut kompozisyonu üzerine herhangi bir değişme görülmemiştir. Bu çalışmada ise egzersiz grubu 12 haftalık ve haftada 3 gün 1 saatlik bir egzersiz programına katılmış ve çalışma sonucunda esneklik değerleri ile birlikte diger değişkenlerde pozitif anlamda düzelmeler görülmüştür.

Rhodes ve ark.(1999) yaptıkları bir çalışmada, uzun süreli direnç egzersizinin yaşlı kadınlarda kas kuvveti ve kemik mineral yoğunlugu üzerine olan etkilerini arastırmışlardır. Bu direnç egzersizlerinde daha çok büyük kas gruplarını ele almışlardır. Onların çalışmaları sonucunda, direnç egzersizi sonrasında kas kuvveti ve kemik mineral yoğunluğunda istatistiksel olarak anlamlı değişmeler saptanmıştır. Bu bulguya ek olarak, kas kuvvetinin artmasıyla birlikte kemik mineral yoğunluğunda da olumlu gelişmeler olacağı sonucuna varmışlardır. Onların çalışmalarıyla benzer olarak, elastik bantların kullanılmasıyla bu çalışmada bir çeşit direnç egzersizi yapılmıştır. Kemik mineral yoğunluğunda bir artış gözlenmesine rağmen, istatistiksel olarak anlamlı bir artış görülmemiştir. Bunun nedeni de 12 haftalık Pilates egzersizin kemik mineral yoğunluğu artışı için kısa bir zaman olmasından kaynaklanıyor olabilir. Pilates egzersizinde kullanılan malzemeler hafif ağırlık egzersizi etkisi vermektedir. Bu da uzun vadede daha olumlu sonuçlar alınmasına neden olabilir. Literatürde bu tarz yapılan çalışmalarda uzun sureli egzersiz sonucunda kemik mineral yoğunluğu değerinde artış gözlenmiştir (Ling Qin et al.2002; Hourigan et al 2008).

Bu çalışmada sadece kadın katılımcılar yer aldı. Bundan sonraki çalışmalarda, erkek katılımcılar üzerine aynı çalışma tekrarlanabilir. Denek sayısı artırılabilir ve bu çalışmada sadece huzurevinde yasayan katılımcılar yer aldı. Diğer çalışmalarda huzurevi sakinleri ile evinde ailesi ile birlikte yasayan kadınlar yer alabilir.

Appendix I: Curriculum Vitae

PERSONAL DETAILS

Name:	Gönül Babayigit IREZ
Date of Birth:	1974/Yozgat
Current Occupation:	Research Asistant

CONTACT DETAILS

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EDUCATIONAL DETAILS

PhD	2009 METU Physical Education
MS	1998-2000 Mugla Universty Physical Education & Sports
BS	1991-1996 METU Physical Education
High School	1988-1991 Abidinpaşa High School

FOREIGN LANGUAGES

Advanced English, Basic German

EMPLOYEMENT AND EXPERIENCE

2007(September) - 2008	Colorado StateUniversity, Visiting Scholar
2005 (September) – 2009	METU Research Asistant
2003-2005	Muğla University Research Asistant
2002-2003	Muğla 75. Year Science High School
1998-2002	Mugla Kafaca Primary School
1996-1998	Kayseri Behice Yazgan High Schoo

RELEVANT SKILLS

- Track and Field trainer certificate
- Orienteering trainer certificate
- Scout and mountaineering certificate

RESEARCH INTERESTS

- Physiology of exercise
- Neuromuscular physiology

PUBLICATIONS

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