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YEDITEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
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REHABILITATION

THE EFFECT OF BODY WEIGHT, FLEXIBILITY, BALANCE AND MUSCLE STRENGTH ON VERTICAL JUMP IN ATHLETES AND NON-ATHLETES

MASTER THESIS

TABARAK EDBAIS, PT

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SUPERVISOR
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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun 31/12/2019 tarih ve 2019/20-01 sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ

Sağlık Bilimleri Enstitüsü Müdürü

DECLARATION

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

Date

Signature

Name Surname

DEDICATION

I would like to dedicate this thesis to my Parents Khaled Edbais and Amira Kabaha, and to my brother and sisters and to my friends, whose support made this thesis possible.

ACKNOWLEDGMENT

I am sincerely grateful to Prof .Dr. Rasmi Muammer for guidance throughout this work and I am honored to be his student.

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LIST OF SYMBOLS AND ABBREVIATIONS

BMI	Body mass index
VJ	Vertical jump
EMG	Electromyography
SRT	Sit and reach test
ROM	Range of motion
SLRR	Straight leg raise right
SLRL	Straight leg raise left
HipExtR	Hip extension right
HipExtL	Hip extension
KneeFlexR	Knee flexion right
KneeFlexL	Knee flexion left
KneeExtR	Knee extension right
KneeExtL	Knee extension left
AnklePantR	Ankle planter flexion right
AnklePlantL	Ankle planter flexion left
AnkleDorsR	Ankle dorsiflexion right
AnkleDorsL	Ankle dorsiflexion left
SEBT	Star excursion balance test
AntR	Anterior right
AntLatR	Anterolateral right
AntMedR	Anteromedial right
MedR	Medial right
LatR	Lateral right
PostR	Posterior right
PostLatR	Posterolateral right
PostMedR	Posteromedial right
AntL	Anterior left
AntLatL	Anterolateral left
AntMedL	Anteromedial left
MedL	Medial left
LatL	Lateral left
PostL	Posterior left
PostLatL	Posterolateral left
PostMedL	Posteromedial left
VasLat	Vastus lateralis
RecFem	Rectus femoris
SemMem	Semi membranous
BicFem	Biceps femoris
Gastro	Gastrocnemius

ABSTRACT

Edbais T. (2019) the effect of body weight , flexibility , balance and muscle strength on vertical jump in athletes and non-athletes Yeditepe University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, MSc thesis. Istanbul.

vertical jump is important for a majority of sports and an indicator for the level of athletic performance and achievements, In this study we investigated the relationship of body weight, flexibility, balance and muscle strength with vertical jump, to gain a better understanding of the factors that may improve vertical jump . 44 participants joined this study in two groups (athletes group =22 (14males, 8 females), age 21.31±2.2) and (non-athletes = 22 (12 males, 10 females) age 22±2.3), measurements for BMI and flexibility (Sit and reach and ROM). Balance (flamingo test and Star excursion test). And muscle strength (surface EMG) was taken for all participants in both groups, the vertical jump was performed and measured for each participant. The findings showed that there is a significant relationship between vertical jump height and balance ($p<0.05$) for both groups. Muscle strength of lower limb muscles tested by EMG has a significant relationship with Vertical jump in both groups ($p<0.05$)**.** The relationship of balance was significantly stronger in the athletes group while relationship of muscle strength with vertical jump in non-athletes group was stronger. Body weight within the average ranges did not have a relationship with vertical jump, flexibility did not show a significance either. Balance and muscle strength in this reearch to have an effect on vertical jump height in ahletes and non nonathletes as well, while body weight in average ranges and flexibilty did not have a relation with vertical jump height .

Key words : balance, body weight, flexibility, muscle strength, vertical jump.

OZET

Edbais T. (2019) sporcularda ve atlet olmayanlarda vücut ağırlığının, esnekliğin, dengenin ve kas gücünün düşey sıçrama üzerine etkisi. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon Anabilim Dalı, Yüksek Lisans tezi. İstanbul.

Dikey sıçrama, çoğu spor için, atletik performans ve başarıların seviyesi için bir göstergedir. Bu çalışmada, düşey atlamayı faktörleri daha iyi anlamak için vücut ağırlığı, esneklik, denge ve kas kuvveti arasındaki ilişkiyi dikey sıçrama ile araştırdık,. Bu çalışmaya 44 katılımcı, iki grup olarak (atlet grubu = 22 (14 erkek, 8 kadın), yaş 21.31 ± 2.2) ve (atlet olmayan = 22 (12 erkek, 10 kadın) 22 ± 2.3)) katıldı. BMI ve esneklik için ölçümler (Otur ve ulaş test ve ROM), denge (flamingo testi ve Yıldız gezi testi) ve kas kuvveti (yüzey EMG) alındı, her iki gruptaki tüm katılımcılar için. Her katılımcı için dikey sıçrama yapıldı ve ölçüldü. Bulgular dikey sıçrama yüksekliği ile denge arasında anlamlı bir ilişki olduğunu gösterdi ($p < 0.05$) her iki grup için, EMG ile kas kuvveti test edilen alt ekstremite kaslarının kas kuvveti, her iki grupta da dikey sıçrama ile anlamlı bir ilişki içindedir ($p < 0.05$). Sporcu grubunda denge ilişkisi anlamlı derecede güçlüyken, sporcu olmayan grupta kas kuvvetinin düşey sıçrama ile ilişkisi daha güçlüydi. Ortalama aralıklar içinde vücut ağırlığının dikey sıçrama ile ilişkisi yoktu, esneklik de önemli bir şey göstermedi. Ahletlerde ve atlet olmayanlarda dikey sıçrama yüksekliği üzerinde bir etkiye sahip olması için bu araştırmadaki denge ve kas kuvveti, ortalama aralıktaki ve esneklikte vücut ağırlığının dikey sıçrama yüksekliği ile bir ilişkisi bulunamamıştır.

Anahtar Sözcükler: denge, vücut ağırlığı, esneklik, kas kuvveti, dikey sıçrama.

1. INTRODUCTION AND PURPOSE

The vertical jump is mostly used for the development of explosive strength, specifically in plyometric and highest power training program. It is an act of multi-joint function that it takes its muscular strength for ankle joint, knee joint and hip joint. (1)

Vertical jump heights assessment is done for both strength and conditioning. Furthermore, sports scientists have used vertical jump height to calculate lower limbs strength power and to differentiate between levels of sport skills as indicated by the player rankings and compare of starters and nonstarters athletes. More than that, vertical jump height is also assessed in sedentary populations and it appears to be an important to identify lower limb functionality in elderly, obese and non-obese children. (2)

In this study we will take interest in finding the correlation between vertical jump and factors that affect the vertical jump and their correlation between them for athletics and non-athletics. Factors included in this study are body weight, flexibility, balance and muscle strength.

Body weight calculated by body mass index, calculated as body mass in KG divided by height in CMs squared, is used to group the people into categories to differentiate body weight status. A BMI between 25–29.9 kgImj2 is considered overweight, and a BMI above 30 kgImj2 is considered obese. These classifications use BMI as an alternative measure for body percentage of fat. (3)

Flexibility is an important performance variable, and a part of conditioning training programs, for many sports. Flexibility assessment is done by measuring range of motion and also through other flexibility assessment tools, such as e sit-and-reach test, it’s worth mentioning that flexibility did receive enough research attention .so the effect of flexibility for performance remains not fully established. Although recognized as an important component in athletic performance as researchers have found athletes with lower flexibility performed poorer than flexible athletes. (7)

Balance is keeping the position of body’s center of gravity in a vertical position over the base of support and depends on feedback from the pathways visual, vestibular and somatosensory, and then executing organized neuromuscular actions (4).

Maintaining a balance ability is a connection for some sort of competition level as sufficient athletes display better balance performance. There are significant relationships between balance skills and various performance measures training component of active subjects or physical education students has showed improvements in vertical jump and agility. Balance training also can lead to task-specific neural adaptations. (5)

Greater muscular strength is related positively with enhanced force time characteristics which contribute to athletic performance. Many researchers suggest that that a greater muscular strength can lead to a better ability to perform sport skills like jumping, sprinting, and agility tasks, muscular strength enhance and change the characteristics of athletes. especially, increasing muscular strength by resistance training improve athletic performance. (6)

2. GENERAL INFORMATIONS AND LITERATURE REVIEW

2.1. Vertical Jump

Vertical jump height is an important factor determining performance in most of sports, Coaches are in continuous search for exercises that help in increasing athletes jumping performance (8). A vertical jump is an act of raising the center of gravity higher in a vertical plane with the activation of the muscles involved in the process. it determines how high an individual can elevate from the ground from the starting point (9). It as found that the score of a vertical jump height differ from males and females. (10), and athletes jump higher than non- athletic population (11). Figure 1, shows the norms of the vertical jump ranges and differences between males and females. (12)

Rating	Males(cm)	Females(cm)
Excellent	>70	>60
Very good	61-70	51-60
Above average	51-60	41-50
Average	41-50	31-40
Below Average	31-40	21-30
Poor	21-30	11-20
Very Poor	<21	<11

Figure 1 Norms of Vertical Jump Heights.

2.1.1 The Mechanism of Vertical Jump

Vertical jump involves extension of the hip, knee and ankle joints from start point, which involves flexion of the lower limb joints. The main muscle group extensors for knee is the quadriceps muscle group, vastus intermedius, vastus lateralis, vastus medialis and the rectus femoris. in this group, the rectus femoris work through the hip and knee joint and is responsible for hip flexion in standing starting point extension, the hamstrings (biceps femoris, semimembranosus and semitendinosus) and the gluteus maximus contract in a concentric role for hop extension from the lower limb to counter the hip-flexing of the rectus femoris and iliopsoas muscles. By this action the trunk will be brought into upright status while the hip extends by force by the same time with the knee and ankle joints. (13)

Figure 2: muscles during vertical jump

Activation of the muscles that control sagittal-plane action at the knee and hip joints are determined by the amount flexion of knee joint which happens during dynamic performances such as a jumping. Great concentric of the hamstring muscle group and gastrocnemius muscle can lead to large knee-flexion inside the joint and position the knee joint tends to be more flexion while landing. so, greater eccentric action of the quadriceps and gluteus maximus muscles can result in larger knee and hip extension movements within the joints, farther more facilitates the improve body posture to be more erect. (14)

Planar four and five segment model in vertical jump, when analyzing and investigating the vertical jump, a four-segment body computer simulation is used and it allows a better focus on lower extremity, but this model does not involve the effect of the arm swing action , which is how normally people tend to perform a jump. the arm swing helps the performer to jump higher by about 10 cm, this allows greater force to be produced by the lower extremity. (15)

It was confirmed that arm motion simulation in five segment model can improve jumping performance height and the increased initiation of the vertical velocity has a role in nearly 2/3 of vertical jumping height. The arms also have an effect for an early onset of hip torque as well as lengthen the ground contact duration. (16)

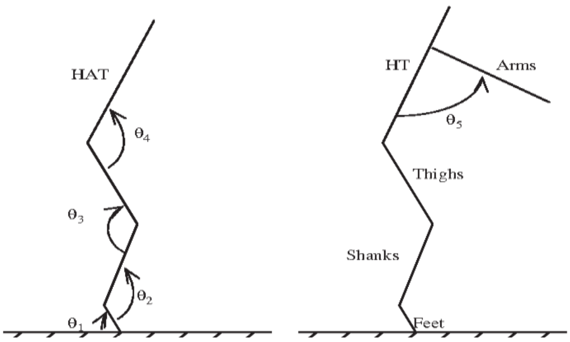

Figure 3 planner four and five segment model

2.2. Body Weight

Body weight has an effect on the human body, overweight and obese people are at risk of several medical conditions and difficulties in physical activities. In this research the effect of the body mass index will be discussed to see the effect of it on athletes and non-athletes adults in the vertical jump.

Body Mass Index is known as weight in kilos divided by the square of the individual height in meters, categories of body weight status is established through BMI , underweight (BMI of 18.5), while normal weight is (BMI of 18.5-25), overweight individuals have (BMI of 25-30), and obesity (BMI of 30). Obesity is subcategorized by Grade 1 obesity is between 30 to less than 35 BMI score; while grade 2 obesity is a BMI of 35 to less than 40 and final grade 3 obesity a BMI of 40 and above. (17)

Underweight and obese adults have higher rate dying earlier than normal weight adults. Obese adults have a much higher lifetime medication and medical attention than normal weight adults (18). Researchers also investigated the relation of BMI and fat composition on the athletic performance, some researchers found a significance relation between body size and body composition and movement performance but not clearly related with vertical jump in particular (19). In addition, elevated BMI is strongly and directly related to healthier physical fitness, excess of body mass has a bad effect on performance (countermovement jump, strength of the handgrip) in overweight athletes compared with healthy weight athletes. (20)

Some of the researchers found a negative effect of overweight and excess fat and decreased of physical fitness among athletes. (21, 22, 23)

The direct relation between BMI and vertical jump is not clear or widely investigated as most articles discussed fat percentage and obesity.

2.3. Flexibility

As the definition of flexibility remains under few explanations as it can be said that flexibility is the range of motion or ability of joints of being mobile.

- Range of motion

The full movement capability of a joint, but it is not only related to the joint as other anatomical factors are involved.

- Mobility

It is the ability of a joint to move throughout its range of motion. Range of motion is mostly used to represent flexibility testing. Flexibility tests are used to evaluate physical, occupational, sport fitness, diagnosis of injuries and observing progress of treatment. Testing is done by a goniometer, sit and reach test. Researchers used still photos and videos for static and dynamic flexibility (24).

2.3.1. The Effect of Flexibility State

Hypomobile joints are joints that are too tight and cause a decreased range of motion. The opposite of **hypermobility**. People who suffer from hypermobility show gait problems such as short step slower length and gait velocity, impairment in balance, kinesiophobia compared with healthy people (25). Researchers found that people with hypermobility has a poorer proprioceptive feedback than people with normal range of motion (26, 27)

Hypomobility and limitation of movement in the lower limb joints decrease the duration of walking, and cause muscle fatigue and decrease muscle strength. (28). Limited flexion range of knee may increase hip joint damage and loosening of hip endoprosthesis. (29)

2.3.2 Flexibility in Athletic Performance

Flexibility in relation with athletic performance was invested in researches especially when it comes to stretching. Improving flexibility by performing stretching is a very important preparation of the activity that has been suggested to increase and enhance physical performance. Keeping up good flexibility also helps in preventing injury to the musculoskeletal system. (30, 31)

Flexibility training on decreasing the stiffness enhances the athletic performance but no significant result when it comes to jumping performance. (32)

When investigating stretching, in research it was found that stretching of hamstring muscle can cause an increase short lived change on dynamic ROM but it did not affect the vertical jump height (33, 34). While other studies suggested that acute effect of stretching decrease the height of vertical jump. (35)

Passive stretching for number of sessions for the hip joint showed that it improves the range of motion and trunk stability. (36)

2.3.3. Range of Motion on Athletes

In previous research it was found that athletes have a greater range of hip on dominant leg than the non-dominant leg (37). As well it was found that a significant difference in the active range of motion in the static leg and the kick leg in baseball players for ankle plantarflexion as well as hip internal rotation and extension of hip in static leg (38).

Greater dorsiflexion range of motion is accompanied with greater flexion of knee joint dislocation and lesser ground reaction forces while performing a jump landing, restricted range of motion dorsiflexion is associated with knee-valgus displacement when performing landing and squat tasks, range of motion dorsiflexion restrictions may be associated with a higher risk of ACL injury. (39)

When preforming a vertical jump, it is suggested that a smaller range of motion in the start position for the knee joint and hip can result in a higher jump. (40)

Although flexibility in relation with athletic performance was discussed in research that suggested that stretching before match may negatively affect the vertical height, but it was limited to that so still it is not a clear answer if a greater or smaller range of motion or general flexibility state of athletes results in higher jump or not.

2.4 Balance

Balance is defined as the ability of maintaining the center of gravity (vertical line from center of the mass) of a body within the base of support with minimum number of postural sways. (41)

Balance includes coordination of input from multiple sensory systems involving three systems, (42):

- Vestibular, sense organs that regulate equilibrium.

- Somatosensory, proprioception sense and kinesthesia of joints of the body information are carried from skin and the joints.
- Visual systems: meaning the verticality of body posture and head motion; spatial location in relation to objects.

Balance can be affected due some neurological conditions such as stroke, spinal cord injuries and Parkinson's also it can affect in healthy people in cases of fatigue of joint muscles and musculoskeletal injuries. (43, 44, 45)

2.4.1. Balance Evaluation

Balance assessment for balance disorders

- The Valance Evaluations Systems Test (BESTest) consists of 36 items, grouped into 6 systems: “Biomechanical Constraints”, “Stability Limits/Verticality”, “Anticipatory Postural Adjustments”, “Postural Responses,” “Sensory Orientation”, and “Stability in Gait” (46).
- Functional gait assessment: The FGA is an ambulation-based balance test originally proposed to assess higher-level balance in individuals with vestibular impairments (47).
- Romberg's test is a commonly performed test during the neurological examination to evaluate the integrity of dorsal columns of the spinal cord (48, 49).

2.4.2 Balance Assessment for Athletes

- Flamingo test is performed to check balance status while standing on one leg to evaluate balance and to indicate balance problems. (50)
- Y balance test is an evaluation of dynamic balance done with stance leg maintain balance while the other leg reaches in anterior, posteromedial, and posterolateral directions. This test is helpful in the prediction of injury risk. (51, 52)
- Star excursion balance test (SEBT) is another test to evaluate dynamic balance it requires strength, flexibility, and proprioception its used to help physical performance and prognosis of ankle instability, and determine athletes at higher risk for lower extremity injury. (53, 54, 55)

2.4.3 Balance in Athletic Performance

Its known that balance training assist in increases of proprioception, muscular strength, movement awareness and core strength and stability, before, balance training was only preformed after injury for the purpose of reestablishing the neural awareness for specific proprioception and movement awareness. By balance training the athletes are conditioning the core when performing balance activities (56), therefore maybe making the athletic performance better in general.

The nature of sport as well, plays a role in the balance statues that is contributing by the training program as not all types of sports have the same balance ability. (57)

Balance ability is linked to competition level in specific sports, elite athletes have greater balance ability. There are significant relationships between balance ability and athletic performance.

Even though the relationship between balance statues and injury risk has been discussed in many researches, yet the relation between balance and athletic performance needs to be researched further. (58)

As for vertical jump relation with vertical jump not much research was found to conform if balance has influence on the jumping height although in one study it was found that balance training for core stability improve the vertical jump height (59). While in one article that investigated the relation of balance to vertical jump showed subjects who were able to maintain their balance for a longer time period has a negative effect on the vertical jump performance. (60)

Therefore, more research can give a better understanding of how balance can influence vertical jump.

2.5. Muscle Strength

Strength is a term that is employed to identify maximal force which can be developed by the muscles performing specific joint movement. moreover, maximum effort may be developed by muscles as either way of isometric contraction, concentric contraction or eccentric contraction and the velocities of two dynamic acts may be performed at a big range. (61)

Static strength: is defined as contraction of muscles without involving muscles shortening. While dynamic contraction is defined as a contraction that results in shorting of the contracted muscle. (62)

2.5.1. Muscle Strength Assessment

- Manual muscle testing

The method that is common the most of evaluating muscle strength known as Manual Muscle Testing scale. It involves testing key muscles from lower and upper limbs and testing it against the therapist's resistance patient's strength then will be graded on a 0 to 5 scale according to the performance as follows (63, 64):

0 grade: means that the muscle has no activation

1 grade: means the muscle has an activation, shown as a twitch, but there will not be no achieving of full range of motion.

2 grade: means that there is a muscle activation but with elimination of gravity. Achieving full range of motion

3 grade: means that the muscle activation without elimination of gravity, achieving full range of motion

4 grade: means that the muscle is active against resistance performing a full range of motion

5 grade: means that the muscle is activated against the therapist maximal resistance with achieving a full range of motion

- Instrument to test muscle strength:

Myometer: is a tool that measures the isometric muscle force of a function, a muscle group or a particular muscle (65, 66)

Electromyography: it is a recording of electrical activity of muscles, it also can be defined as a representation of audible signal in a visual, electrodes are used by attaching them to the surface of the skin or it can be inserted deeper through the skin into the muscle. EMG was found reliable to study and understand the muscle activity, strength and help better diagnosis (67, 68, 69)

2.5.2. Muscle Strength in Athletic Performance

A Great muscular strength is directly associated with improved force time characteristics which contribute to overall athletic performance, such as jumping, sprinting, agility, and direction changing tasks it also decreases risk of field injury.

Sport scientists and therapists uses different assessment methods and tolls to examine isometric and dynamic strength as well as reactive strength, this evaluation provides a better understanding of the relation between muscles strength and the athletic performance, the recognition of the relationship helps in developing the required motor learning strategies that leads to more skilled athletic performance. (70)

Although in one research it was found that female athletes have strong evidence of muscles weakness compared to male athletes even though it was found that even with the presence of muscle weakness female athletes have alternatives to compensate with while performing landing after jumping. (71)

It is also suggested that muscle strengthening improves the vertical jump performance but it also needs adaptation to vertical jump training to practice the change of the muscle strength (72).

Strength training that target muscles that contribute in the vertical can be effective to enhance the performance of the vertical jump such as isometric and dynamic strength. (73)

Muscular strength has a strong correlation to superior jumping, sprinting, and sport specific performance but more research will be helpful in further establishing the relation as information involving specific standards of what is the required muscular strength is lacking still. (74)

3. MATERIALS AND METHOD

3.1 Study Design

This research is a correlational non-experimental study conducted in the physiotherapy laboratory of Yeditepe University.

3.1.1 Sample Size

The sample size was calculated by using G*Power 3.1.7 for Windows (G*Power©, University of Dusseldorf, Germany), by using t family test ANOVA repeated measures and between factors, number of participants 44, 22 in each group.

3.2. Participants

Participants are 44 volunteers. The athletes were recruited from the sports team of Yeditepe University sport club from the following teams: (volleyball, handball, American football) while the non-athletes group participants are student from Yeditepe University collages who volunteered after directly asking them.

- Athletes group number 22 (8 females 14 males)
- Non-Athletes number 22 (10 females 12 males)

Procedure was explained to all participant and signed a consent form.

3.2.1 Inclusion Criteria

1. Healthy adults above the age of 18 years old.
2. Athletes should not be having a previous sport injury, if there is a history of injury it should be fully healed and he/she has returned to playing in the field.
3. No musculoskeletal or neurological conditions or injuries.

3.3. Assessment Method

Both groups went through the same assessment

- A 5 minutes warm-up method was conducted before the assessment:
- Jumping jacks: participant stand in the ground. feel near each other and arm at the side of the body obtaining an upright position then starts jumping with

creating a distance of the legs and raising arms up down. repeats 30 seconds for 2 minutes.

- High Knee Pulls: participants Pull one knee upwards toward the chest. Maintain the position for a count of five. Complete set of 10 repeats for each leg.

3.3.1. Body Weight

Body mass index was calculated after taking the measurements of height and weight.

3.3.2. Flexibility

- Sit and Reach Test :

Equipment: Sit and reach box; the box is cantilevered measurement scale of 20 cm in the level of the foot.

For this test the participants sit on the floor with stretched legs with shoes removed, soles of feet are placed with full contact against the box with locked knees, then they reach out with their hand side by side in the measuring tape as far as they can, the score then recorded. (75)

3.3.3 Range of Motion

Range of motion was measured for hip knee and ankle using a goniometer

- Straight leg raise for the flexibility of the the hip joint was measured in a supine position and subject performed a straight leg rise to the maximum while the other leg is in extension.
- Hip extension was measured in prone position subject extended his hip while keeping knee extended.
- Knee flexion is performed in supine position flexing the knee to the maximum.
- Knee extension is performed in prone position legs at the level of knees are out of the edge of the table, subject starts from 90 degree and extends the knee to the maximum.

- Ankle plantarflexion and dorsiflexion is measured while subject is sitting on the edge of the table and performs a plantarflexion and dorsiflexion from a marked 0 degree in the goniometer.

3.3.4. Balance

- Flamingo test

Stand on a stable surface with shoes removed on one leg while the other leg is flexed and held by the hand by the buttocks and other hand is raised and try to keep the balance for 60 seconds number of sways will be noted.

- Star excursion test

The SEBT was performed by participants stand in the middle of a star shaped line formed by eight lines in the ground extending out at 45° angle between each line. Then participant was asked to perform a reach as far as they can along each of the eight lines, touching on the marked line then return the leg to the star point, while maintaining balance by the other leg placed in the center Part. (76) Participants were asked to performs 3 rails for each leg and mean was taken, normalized % of leg length was calculated and recorded in the data form.

3.3.5. Muscle Strength

It was measured by electromyograph using two site electrodes with a ground electrode, site electrodes are placed on the proximal and distal sides of the surface of the belly of the muscle, ground electrode is placed between the two site electreds. The test is performed by doing a maximum voluntary contractions against resistance.

Muscles tested are :

- Knee extensors:

Rectus femoris and vastus lateralis: participant in supine position, electrodes are placed on the both muscles in the same time and performs knee extension from flexion position with maximal contractions against resistance for 10 seconds. mean is calculated by EMG. Both of the muscle results were combined a mean of them was calculated

- Knee flexors:

Biceps femoris and semimembranosus: participant in prone position, electrodes are placed on the both muscles in the same time and performs knee flexion position with maximum contractions against resistance for 10 seconds, mean is calculated by EMG., Both of the muscle results were combined a mean of them was calculated

Gastrocnemius: participant in prone position with ankles out of the edge of bed electrodes are placed on both of the muscle bellies, participant performed plantarflexion with maximum contractions against resistance for 10 seconds, mean is calculated by EMG.

After the assessment participant take a 5 min rest before performing the vertical jump.

3.3.6 Vertical Jump

A marked meter is taped on the wall, participant stands by the side of the wall with raised hand next to the meter to take the start point, then the participant performs a squat and jump as high as they can reaching with the hand. They are asked to wait 1 min between each jump wearing pair of shorts. They performed 3 trails and mean was taken.

Figure 4: balance assessment (left: SEBT, right: Flamingo test)

Figure 5 flexibility assessement, ROM, straight leg raise , sit and reach test

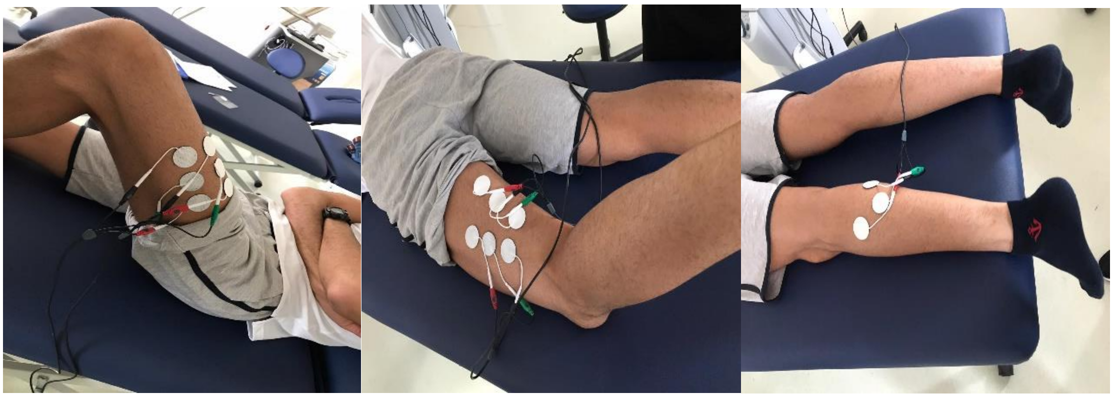

Figure 6 EMG testing, vastus lateralis and rectus femoris, bicipes femoris and semimembranosus, gastrocnemius

Figure 7 vertical jump

3.4 Statistical Methods

Statistical analyses were performed using SPSS software version 25. Descriptive analyses will be presented using means and standard deviations for continues data, frequencies and percentages for categorical data. The variables are investigated using Kolmogorov Smirnov test to determine whether or not they are normally distributed. Since the variables are normally distributed, two independent samples t test was used to compare the groups. Correlation tests was used to evaluate the relationship between the parameters. The person test and one-way anova test were appropriate, they were used to compare the proportions of the groups. A 5% type-I error level was used to infer a statistical significance.

4. RESULTS

4.1 Sociodemographic Results

Table 1: Athlete Socio-Demographic Variables

	N	%
Age		
Mean ±Sd	21.31±2.27	
Min-Max	18-26	
Gender		
Male	14	63.6
Female	8	36.4
Sport Type		
Volleyball	13	59.1
Handball	4	18.2
American Footbal	5	22.7
Years of Practice		
Mean ±Sd	7.18-4.32	
Min-Max	1-15	
Days of Practice(Week)		
Mean ±SD	2.72-0.76	
Min-Max	2-5	
Hours of Practice(Day)		
Mean ±Sd	2.59-0.50	
Min-Max	2-3	

M= Mean , SD = standerd deviation, Min= minimum, max= maximm.

Table 2 Athlete Socio-Demographic Variables

	N	%
Age		
Mean ±SD	22±2.39	
Min-Max	18-27	
Gender		
Male	12	54.5
Female	10	45.5

M= Mean , SD = standerd deviation, , Min= minimum, max= maximm.

Table (1) and table (2) are descriptive data of the sociodemographic of athletes group and non-athletes group.

4.2. Body Mass Index Results

Table 3: BMI score for athletes and non-athletes

Subject	Athletes	Non-Athletes	P
	Means(SD)	Mean(SD)	
BMI	23.50(2.78)	24.20(2.45)	0.38

***p<0.05,** BMI : body index, M= Mean , SD = standerd deviation

Table 4: BMI score for males and females within the athletes group

Subject	Male Athletes	Female Athletes	P
	Mean(SD)	Mean(SD)	
BMI	24.52(2.36)	21.75(2.69)	0.02

***p<0.05,** BMI : body index, M= Mean , SD = standerd deviation

Table 5: BMI for males and females with non-athletes group

Subject	Male Non-Athletes	Female Non-Athletes	P
	Mean(SD)	Mean(SD)	
BMI	23.77(2.59)	24.74(2.26)	0.36

***p<0.05,** BMI : body index, M= Mean , SD = standerd deviation

There was no significant difference between the athletes and non-athletes group in their body mass index (table 3) but within the athletes group female showed lower body mass index compared with males (table 4). No significant difference between males and females within the non-athletes group. (table 5).

4.3 Flexibility Score Results

Sit and reach test

Table 6: SRT result for athletes and non-athletes group

Subject	Athletes	Non-Athletes	p
	Mean (SD)	Mean (SD)	
SRT	9.77(9.72)	-1.09(7.48)	0.00

***p<0.05,** SRT : sit and reach test , M= Mean , SD = standerd deviation

Table 7: Comparing SRT between male and females athletes

	Male Athletes	Female Athletes	p
Subject	Mean (SD)	Mean (SD)	
SRT	7.07(7.10)	14.5(10.9)	0.05

***p<0.05,** SRT : sit and reach test

Table 8: Comparing SRT between male and females non athletes

	Male Non-Athletes	Female Non-Athletes	p
Subject	Mean (SD)	Mean (SD)	
SRT	0.50 (6.74)	-3.00 (8.23)	0.28

***p<0.05,** SRT : sit and reach test, M= Mean , SD = standerd deviation

Athletes group has a significant difference compared with non-athletic group in SRT result, table (6). and females over males within the athletes group table (7). While there was no significant between males and females within the non-athletes group table (8).

For the ROM result there was significant difference between the two groups in the hip flexion and hip extensions in both legs and no significance for rest of other joints ROM. table (9).

When comparing the result of ROM between female and male athletes there was no significant difference, significant was found only in the straight leg raise ROM in the left leg table (10).

But within non-athletes group there was significant difference in the straight leg raie ROM in both legs and no difference in rest of joint ROM, table (11).

Range of motion : Table 9: ROM results for athletes and non-athletes

Subject	Athletes	Non-Athletes	p
	%	%	
SLRR			0.004
normal	50	72.7	
hypomobility	0	27.3	
hypermobility	50	0	
SLRL			0.006
normal	50	72.7	
hypomobility	4.5	27.3	
hypermobility	45.5	0	
HipextR			0.001
normal	63.6	100	
hypomobility	0	0	
hypermobility	36.4	0	
HipextL			0.001
normal	63.6	100	
hypomobility	0	0	
hypermobility	36.4	0	
KneeflexR			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeflexL			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeextR			0.3
normal	86.4	95.5	
hypomobility	0	0	
hypermobility	13.6	4.5	
KneeextL			0.07
normal	86.4	100	
hypomobility	0	0	
hypermobility	13.6	0	
AnkleplantR			0.68
normal	86.4	81.8	
hypomobility	0	0	
hypermobility	13.6	18.2	
AnkleplantL			0.68
normal	86.4	81.8	
hypomobility	0	0	
hypermobility	13.6	18.2	
AnkledorsR			0.32
normal	95.5	100	
hypomobility	0	0	
hypermobility	4.5	0	
AnkledorsL			0.32
normal	95.5	100	
hypomobility	0	0	
hypermobility	4.5	0	

***p<0.05,** SLRR=straight leg raise right, SLRL= srtaight leg raise left ,hipextR=hip extesion right ,hipextR =hip eetension right,kneeflexR= knee flexion right, kneeflexl= kee flexion right, kneeExt l=knee extension right, kneeExtl= knee extension left, ankleplantR= ankle planter flexion right, ankleplantl= ankle planter flexion, ankledosrR=ankle dorsiflexion right, , ankledosrl=ankle dorsiflexion left.

Table 10: ROM for male and female for athletes group

Subject	Male Athletes	Female Athletes	p
	%	%	
SLRR			0.08
normal	64.3	25.0	
hypomobility	0	0	
hypermobility	35.7	75.0	
SLRL			0.013
normal	71.4	12.5	
hypomobility	0	12.5	
hypermobility	28.6	75.0	
HipextR			0.33
normal	71.4	50.0	
hypomobility	0	0	
hypermobility	28.6	50.0	
HipextL			0.33
normal	71.4	50.0	
hypomobility	0	0	
hypermobility	28.6	50.0	
KneeflexR			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeflexL			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeExtR			0.26
normal	92.9	75.0	
hypomobility	0	0	
hypermobility	7.1	25.0	
KneeExtL			0.26
normal	92.9	75.0	
hypomobility	0	0	
hypermobility	7.1	25.0	
AnkleplantR			0.17
normal	78.6	100	
hypomobility	0	0	
hypermobility	21.4	0	
AnkleplantL			0.17
normal	78.6	100	
hypomobility	0	0	
hypermobility	21.4	0	
AnkledorsR			0.46
normal	92.9	100	
hypomobility	0	0	
hypermobility	7.1	0	
AnkledorsL			0.46
normal	92.9	100	
hypomobility	0	0	
hypermobility	7.1	0	

***p<0.05, ,** SLRR=straight leg raise right, SLRL= srtaight leg raise left,hipextR=hip extesion right ,hipextL=hip eetension left,kneeflexR= knee flexion right, kneeflexl= kee flexion right, kneeExtl = knee extension right, kneeExtl= knee extension left, ankleplantR= ankle planter flexion right, ankleplantl= ankle planter flexion, ankledosrR=ankle dorsiflexion right, , ankledosrl=ankle dorsiflexion lef.

Table 11: ROM result for male and female in the non-athletes group.

Subject	Male Non-Athletes	Female Non-Athletes	
	%	%	P
SLRR			0.02
Normal	91.7	50.0	
hypomobility	8.3	50.0	
hypermobility	0	0	
SLRL			0.02
normal	91.7	50.0	
hypomobility	8.3	50.0	
hypermobility	0	0	
HipextR			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
HipextL			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeflexR			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeflexL			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
KneeextR			0.37
normal	91.7	100	
hypomobility	0	0	
hypermobility	8.3	0	
KneeextL			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
AnkleplantR			0.38
normal	75.0	90.0	
hypomobility	0	0	
hypermobility	25.0	10.0	
AnkleplantL			0.38
normal	75.0	90.0	
hypomobility	0	0	
hypermobility	25.0	10.0	
AnkledorsR			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	
AnkledorsL			-
normal	100	100	
hypomobility	0	0	
hypermobility	0	0	

***p<0.05,** SLRR=straight leg raise right, SLRL= srtaight leg raise left,hipextR=hip extesion right, hipextL =hip eetension left,kneeflexR= knee flexion right, kneeflexl= kee flexion right, kneeExtl=knee extension right, kneeExtl= knee extension left, ankleplantR= ankle planter flexion right, ankleplantl= ankle planter flexion, ankledosrR=ankle dorsiflexion right, , ankledosrl=ankle dorsiflexion left.

4.4. Balance Score Results

Flamingo test

Table 12: flamingo test result for athletes and non-athletes

Subject	Athletes	Non-Athletes	p
	%	%	
Flamingo			0.00
no sway	95.5	22.7	
one sway	4.5	36.4	
two sways	0	27.3	
three sways	0	4.5	
cannot complete	0	9.1	

***p<0.05**

Table 13: Flamingo test result for males and female athletes

Subject	Male Athletes	Female Athletes	p
	%	%	
Flamingo			0.93
no sway	92.9	87.5	
one sway	0	12.5	
two sways	7.1	0	
three sways	0	0	
cannot complete	0	0	

***p<0.05**

Table 14: Flamingo test result for male and female non athletes

Subject	Male Non-Athletes	Female Non-Athletes	p
	%	%	
Flamingo			0.97
no sway	33.3	10.0	
one sway	16.7	60.0	
two sways	33.3	20.0	
three sways	8.3	0	
cannot complete	8.3	10.0	

***p<0.05**

There is significant difference between athletes and non-athletes group in flamingo test results table (12). while there wasn’t within the athletes group comparing males and females table (13). but no significant difference was found with the non-athletic group comparing male and female non-athletes table (14)

Star excursion test

In SEBT result for athletes and non-athletes there was a significant difference in all 8 directions for both legs as athletes performed better in the test, table (15).

Table 15: result of SEBT for athletes and non-athletes

Subject	Athletes	Non-Athletes	P
	Mean (SD)	Mean(SD)	
AntR	93.6(9.33)	88.5(7.56)	0.05
AntLatR	96.2(7.7)	89.05(6.69)	0.007
AntMedR	90.77(9.3)	82.2(7.21)	0.002
MedR	84.05(11.86)	76.17(8.48)	0.015
LatR	100.59(6.7)	88.6(10.03)	0.00
PostR	99.05(9.85)	90.05(9.36)	0.003
PostLatR	100.69(7.48)	88.46(10.34)	0.00
PostMedR	91.67(11.22)	81.4(10.29)	0.003
AntL	94.72(9.52)	86.01(6.72)	0.001
AntLatL	97.76(7.81)	87.87(4.55)	0.00
AntMedL	90.75(11.31)	72.81(9.30)	0.00
MedL	87.73(11.78)	79.05(8.73)	0.00
LatL	100.89(7.82)	87.8(7.51)	0.00
PostL	98.92(10.17)	86.05(8.56)	0.00
PostLatL	98.83(9.50)	88.89(9.62)	0.001
PostMedL	93.20(9.55)	81.62(8.49)	0.00

***p<0.05 ,** AntR=anterrior right. AntlatR= anterior lateral right. AntMedR= anerior medial right, MedR=Medal right, LatR=Latral right, postR=postorior right,PostlatR=Posteriolateral right, postMedR= posteromadial right. **,** Antl=anterrior left. Antlatl= anterior lateral left. AntMedl= anerior medial left, Medl=Medal left, Latl=Latral left, postl=postorior left,Postlatl=Posteriolateral left, postMedL= posteromadial left. M= Mean , SD = standerd deviation

There was no significant difference between males and females in the athletic group except for anterior lateral right and anterior medial left in the star excursion test scores table (16)

Table 16: SEBT result for male and female athletes

Subject	Male Athletes	Female Athletes	P
	Mean (SD)	Mean(SD)	
AntR	94.55(9.21)	92.15(9.97)	0.57
AntLatR	98.53(5.58)	89.55(8.10)	0.00
AntMedR	92.89(7.65)	87.05(11.49)	0.16
MedR	86.46(13.06)	79.83(9.29)	0.21
LatR	102.15(5.59)	97.85(9.04)	0.15
PostR	98.5(10.36)	100(9.51)	0.74
PostLatR	101.30(6.43)	99.62(9.43)	0.62
PostMedR	92.99(10.95)	89.36(12.05)	0.47
AntL	96.98(9.89)	90.76(7.88)	0.14
AntLatL	99.07(7.14)	95.46(8.88)	0.30
AntMedL	94.48(7.23)	84.23(14.51)	0.03
MedL	89.62(12.35)	84.42(10.46)	0.33
LatL	103.24(7.51)	96.78(6.96)	0.06
PostL	97.77(11.40)	100.93(7.86)	0.49
PostLatL	98.95(10.90)	98.63(7.10)	0.94
PostMedL	94.65(8.69)	90.66(11.05)	0.31

***p<0.05,** AntR=anterrior right. AntlatR= anterior lateral right. AntMedR= anerior medial right, MedR=Medal right, LatR=Latral right, postR=postorior right,PostlatR=Posteriolateral right, postMedR= posteromadial right. **,** Antl=anterrior left. Antlatl= anterior lateral left. AntMedl= anerior medial left, Medl=Medal left, Latl=Latral left, postl=postorior left,Postlatl=Posteriolateral left, postMedL= posteromadial left. M= Mean , SD = standerd deviation.

There was no significant difference between males and females in the athletic group in the star excursion test scores table (17).

Table 17: SEBT result for female and male non athletes

Subject	Male Non-Athletes	Female Non-Athletes	P
	Mean (SD)	Mean (SD)	
AntR	89.24(7.12)	87.79(8.38)	0.66
AntLatR	90.34(4.84)	87.50(8.42)	0.33
AntMedR	83.44(6.94)	80.88(7.65)	0.41
MedR	75.82(8.65)	76.59(8.72)	0.83
LatR	89.48(10.79)	87.71(9.52)	0.69
PostR	89.47(10.28)	90.79(8.61)	0.75
PostLatR	87.05(12.90)	90.22(6.30)	0.48
PostMedR	80.13(11.31)	82.94(9.27)	0.53
AntL	86.65(3.48)	85.26(9.46)	0.64
AntLatL	88.90(4.28)	26.64(4.77)	0.25
AntMedL	77.15(6.37)	81.34(10.85)	0.27
MedL	71.80(7.98)	74.03(12.46)	0.59
LatL	89.05(6.47)	86.34(9.23)	0.41
PostL	84.37(7.34)	88.08(9.83)	0.32
PostLatL	87.84(10.04)	90.14(9.45)	0.58
PostMedL	80.06(8.49)	83.5(8.54)	0.35

***p<0.05** **,** AntR=anterrior right. AntlatR= anterior lateral right. AntMedR= anerior medial right, MedR=Medal right, LatR=Latral right, postR=postorior right,PostlatR=Posteriolateral right, postMedR= posteromadial right. **,** Antl=anterrior left. Antlatl= anterior lateral left. AntMedl= anerior medial left, Medl=Medal left, Latl=Latral left, postl=postorior left,Postlatl=Posteriolateral left, postMedL= posteromadial left. M= Mean , SD = standerd deviation

4.5 Muscle Strength

There was significant difference between athletes and non-athletes in EMG results in the semi membranous and biceps femoris muscles and in gastrocnemius muscle in both legs table (18)

Within the athletes group a significant difference between male and female was found in the gastrocnemius muscle in both legs table (19)

Table 18: EMG results for athletes and non-athletes

Subject	Athletes	Non-Athletes	P
	Mean(SD)	Mean(SD)	
VasLat+RecFemR	340.81(171.97)	269.95(147.84)	0.15
VasLat+RecFemL	276.35(121.46)	232.63(98.97)	0.19
SemMem+BicFemR	464.06(114.58)	301.27(105.00)	0.00
SemMem+BicFemL	387.32(103.98)	277.18(94.28)	0.001
GastroR	387.04(154.37)	263.09(140.21)	0.008
GastroL	335.68(123.25)	216.90(93.03)	0.001

***p<0.05,** vaslat=vastus lateralis, RecFem=rectus femoris, SemMem=semimembranous,bicfem= biceps femoris , Gastro= Gastrocnemius. M= Mean , SD = standerd deviation

Table 19:EMG results for male and female athletes

Subject	Male Athletes	Female Athletes	P
	Mean (SD)	Mean(SD)	
VasLat+RecFemR	360.39(166.02)	306.56(188.21)	0.49
VasLat+RecFemL	307.53(125)	221.75(99.03)	0.11
SemMem+BicFemR	472.89(135.2)	448.62(70.76)	0.64
SemMem+BicFemL	401.90(120.87)	361.81(64.30)	0.39
GastroR	435.35(166.78)	302.50(83.62)	0.04
GastroL	377.85(131.45)	261.87(60.82)	0.03

***p<0.05, ,** vaslat=vastus lateralis, RecFem=rectus femoris, SemMem= semimembranosus ,bicfem= biceps femoris , Gastro= Gastrocnemius, M= Mean , SD = standerd deviation

There was no Significant difference within the non-athlete group between males and females for both leg in the statistical analysis, table (20)

Table 20: EMG result for male and female non athletes

Subject	Male Non-Athletes	Female Non-Athletes	p
	Mean(SD)	Mean(SD)	
VasLat+RecFemR	310.25(185.66)	221.60(64.06)	0.16
VasLat+RecFemL	265.00(111.90)	193.80(66.57	0.09
SemMem+BicFemR	327.83(125.33)	269.40(66.75)	0.20
SemMem+BicFemL	305.25(108.69)	243.50(63.11)	0.12
GastroR	303.58(148.61)	214.50(118.63)	0.14
GastroL	237.08(98.47)	192.70(84.50)	0.27

***p<0.05, ,** vaslat=vastus lateralis, RecFem=rectus femoris, SemMem=semimembranous,bicfem= biceps femoris , Gastro= Gastrocnemius, M= Mean , SD = standerd deviation

3.6. Vertical Jump

As shown in table (21) athletes performed the vertical jump significantly higher than non-athletes . while males jumped higher than females in both groups table (22, 23)

Table 21: vertical jump height in athletes and non-athletes group

Subject	Athletes	Non-Athletes	P
	Mean(SD)	Mean(SD)	
VJ	46.63(6.45)	29.68(8.69)	0.00

***p<0.05,** VJ= vertical jump

Table 22:vertical jump height for male and female athletes

Subject	Males Athletes	Female Athletes	P
	Mean(SD)	Mean(SD)	
VJ	48.92(5.40)	42.62(6.36)	0.02

***p<0.05,** VJ=vertical jump

Table 23: vertical jump height for male and female non athletes

Subject	Males Non-Athletes	Female Non-Athletes	P
	Mean(SD)	Mean(SD)	
VJ	33.41(8.03)	25.20(7.28)	0.02

***p<0.05,** VJ= vertical jump

4.7 BMI Correlation with VJ

There was no relation found beween body mass index and vertical jump height in both groups table (24 ,25)

Table 24: Pearson Correlation: Athletes' BMI and Vertical Jump

	BMI	VJ
BMI	*	**,0,018**
VJ		*

**p<0,01 , *p<0,05, BMI = body mass index, VJ= vertical jump

Table 25: Pearson Correlation: Non-Athletes' BMI and Vertical Jump

	BMI	VJ
BMI	*	**,654**
VJ		*

**p<0,01 , *p<0,05, BMI = body mass index, VJ= vertical jump

4.8. Flexibility Correlation with VJ

Relation of body SRT and vertical jump: Sit and each test did not show a relation wih vertical jump height in both groups table (26, 27)

Table 26: Pearson Correlation: Athletes' SRT and Vertical Jump

	SRT	VJ
SRT	*	**,278**
VJ		*

**p<0,01 , *p<0,05, SRT= sit and reach test, VJ vertical jump

Table 27: Pearson Correlation: Non-Athletes' SRT and Vertical Jump

	SRT	VJ
SRT	*	**,751**
VJ		*

**p<0,01 , *p<0,05, SRT= sit and reach test, VJ vertical jump

Table 28: Means, standard deviations and Independent Sample t-test(t) results of Vertical Jump and Hip Range of Motion for athletes

	Vertical Jump	
	M (SD)	t
Straight leg raise Right		
Normal	47.81 (6,46)	0.853
Hypermobility	45.45 (6.53)	
Straight leg raise Left		
Normal	48.54(5.78)	1.175
Hypermobility	45.30(6.86)	
Hip Extension Right		
Normal	46.21 (7.15)	0.350
Hypermobility	47.37 (5.37)	
Hip Extension Left		
Normal	46.21 (7.15)	-0.397
Hypermobility	47.37 (5.37)	

***p<0.05,** M= Mean , SD = standerd deviation

Table 29: Means, standart deviations and Independent Sample t-test(t) results of Vertical Jump and Knee Range of Motion

	Vertical Jump	
	M (SD)	t
Knee Extension Right		
Normal	46.57 (6.81)	-0.102
Hypermobility	47.00 (4.35)	
Knee Extension Left		
Normal	46.57(6.81)	-0.102
Hypermobility	47.00(4.35)	

***p<0.05,** M= Mean , SD = standerd deviation

Table 30: Means, standard deviations and Independent Sample t-test(t) results of Vertical Jump and Ankle Range of Motion for athletes

	Vertical Jump	
	M (SD)	t
Ankle Plantar Flexion Right		
Normal	46.57 (6.54)	-0.102
Hypermobility	47.00 (7.21)	

***p<0.05** M= Mean , SD = standerd deviation

ROM did not show and relation of all of the leg joints tested with vertcal jump height in oth athlets and nn athletes groups (table 28, 29 . 30 . 31. 31)

Table 31: Means, standard deviations and Independent Sample t-test(t) results of Vertical Jump and Hip Range of Motion for non-athletes

	Vertical Jump	
	M (SD)	t
Straight leg raise Right		
Normal	31.37 (7.98)	1.556
Hypomobility	25.16 (9.30)	
Straight leg raise Left		
Normal	31.37(7.98)	1.556
Hypomobility	25.16(9.30)	

***p<0.05,** M= Mean , SD = standerd deviation

Table 32: Means, standard deviations and Independent Sample t-test(t) results of Vertical Jump and Knee Range of Motion

	Vertical Jump	
	M (SD)	t
Ankle Plantar Flexion Right		
Normal	28.27 (8.11)	-1,693
Hypermobility	36.00 (8.98)	
Ankle Plantar Flexion Left		
Normal	28.27 (8.11)	-1,693
Hypermobility	36.00 (8.98)	

***p<0.05** M= Mean , SD = standerd deviation

4.9. Balance Correlation with VJ

Flaminngo balance test:

As it is seen in Table (33), no sway non-athlete group has significantly higher vertical jump score(**p<0.05).** Athletes all performed full test without sways except one particepant in one sway that is a correlation test for non athletes was not performed.

Table 33: Means, standard deviation and One-Way Anova (ANOVA): Flamingo Balance and Vertical Jump Test for non-athletes

	Vertical Jump	
	***M* (SD)**	***F***
Flamingo Test		
No Sway	35.40 (6.87)	**4.559***
One Sway	27.37 (6.75)	
Two Sways	32.50 (6.89)	
Three Sways	35.00 (-)	
Could not complete	13.50 (2.12)	

***p<0.05**, M= Mean , SD = standerd deviation

Star excursion balance test:

In the athletes group muscle strength had a significant relation with vertical jump height in the directon (aneriolateral , anteriomedial and lateral) in the left leg table (34), as for the right leg the relaton was in the direction (anterior , aneriolateral , anteriomedial and lateral) shown in he able (35).

Table 34: Pearson Correlation: Star Excursion test for the Left Leg and Vertical Jump for athletes

	B1	B2	B3	B4	B5	B6	B7	B8	VJ1
AntL	*	,477*	,516*	,405	,524*	-,047	,211	,228	,336
AntLatL		*	,632**	,546**	,808**	,589**	,647*	,469*	,699**
AntMedL			*	,634**	,709**	,310	,304	,613**	,575**
MedL				*	,775**	,619**	,685**	,756**	,416
LatL					*	,590**	,631**	,711**	,633**
PostL						*	,866**	,716**	,376
PostLatL							*	,654**	,384
PostMedL								*	,342
VJ1									*

**p<0,01 , *p<0,05 Antl(B1)=anterrior left. Antlat(B2)l= anterior lateral left. AntMedl(B3)= anerior medial left, Medl(B4)=Medal left, Latl(B5)=Latral left, postl(B6)=postorior left,Postlatl(B7)=Posteriolateral left, postMedL(B8)= posteromadial left. , VJ= vertical jump

Table 35: Pearson Correlation: Star Excursion test for the Right Leg and Vertical Jump

	B1	B2	B3	B4	B5	B6	B7	B8	VJ
AntR	*	,613**	,670**	,542**	,544**	,292	,388	,440*	,510*
AntLatR		*	,644**	,632**	,720**	,333	,472*	,528*	,627**
AntMedR			*	,730**	,830**	,611**	,608**	,421	,587**
MedR				*	,745**	,676**	,690**	,747**	,398
LatR					*	,726**	,790**	,535*	,496*
PostR						*	,783**	,655**	,329
PostLatR							*	,550**	,212
PostMedR								*	,343
VJ									*

**p<0,01 , *p<0,05, , AntR(B1)=anterrior right. AntlatR(B2)= anterior lateral right. AntMedR(b3)= anerior medial right, MedR(b4)=Medal right, LatR(b5)=Latral right, postR(B6)=postorior right, PostlatR(B7)= Posteriolateral right, postMedR(B8)= posteromadial right, , VJ= vertical jump

In the non athletes group there was a signifiant relation only in the anterilateral direction in left leg , table (36). while there was a strong relation in the directions (anterior , lateral, posterior , posteriolateral and posteriomedial) in the right leg table (37).

Table 36: Pearson Correlation: Non-Athletes Star Excursion test for the Left Leg and Vertical Jump for non-athletes

	B1	B2	B3	B4	B5	B6	B7	B8	VJ
AntL	*	,718**	,752**	,636**	,725**	,589**	,659**	,414	,317
AntLatL		*	,606**	,478*	,842**	,575**	,698**	,376	,483*
AntMedL			*	,537**	,629**	,619**	,601**	,550**	,193
MedL				*	,522*	,676**	,566**	,577**	,271
LatL					*	,721**	,749**	,480*	,409
PostL						*	,810**	,737**	,247
PostLatL							*	,536*	,176
PostMedL								*	,291
VJ									*

**p<0,01 , *p<0,05, , , Antl(B1)=anterrior left. Antlat(B2)l= anterior lateral left. AntMedl(B3)= anerior medial left, Medl(B4)=Medal left, Latl(B5)=Latral left, postl(B6)=postorior left,Postlatl(B7)=Posteriolateral left, postMedL(B8)= posteromadial left, VJ= vertical jump.

Table 37: Pearson Correlation: Non-Athletes Star Excursion test for the Right Leg and Vertical Jump for non-athletes.

	B1	B2	B3	B4	B5	B6	B7	B8	VJ
AntR	*	,704**	,766**	,623**	,887**	,669**	,756**	,690**	,524*
AntLatR		*	,649**	,546**	,607**	,388	,398	,385	,273
AntMedR			*	,756**	,679**	,511*	,517*	,542**	,334
MedR				*	,535*	,594**	,538**	,746**	,239
LatR					*	,815**	,905**	,738**	,612**
PostR						*	,852**	,806**	,565**
PostLatR							*	,850**	,489*
PostMedR								*	,495*
VJ									*

**p<0,01 , *p<0,05, AntR(B1)=anterrior right. AntlatR(B2)= anterior lateral right. AntMedR(b3)= anerior medial right, MedR(b4)=Medal right, LatR(b5)=Latral right, postR(B6)=postorior right, PostlatR(B7)= Posteriolateral right, postMedR(B8)= posteromadial right. , VJ= vertical jump

4.10. Muscle Strength Correlation with VJ

As seen in table (38) there is a significant relationship between stronger muscle strength results and vertical jump in the vastus lateralis and rectus femoris muscles for he left leg and the gastrocnemius muscle in both legs in the athletes group

While the relation between muscle strength and vertical jump showed a significant in all muses tested for both legs in the non-athletes group table (39).

Table 38: Pearson Correlation: Muscles Strength and Vertical Jump for athletes

	M1	M2	M3	M4	M5	M6	VJ
VasLat+RecFemR	*	,775**	,378	,232	,449*	0,525*	,390
VasLat+RecFemL		*	,384	,623**	,414	,617**	,426*
SemMem+BicFemR			*	,586**	,247	,078	,374
SemMem+BicFemL				*	,152	,391	,260
GastroR					*	,759**	,682**
GastroL						*	,566**
VJ							*

**p<0,01 , *p<0,05, VasLat+RecFemR(M1)=vastus lateralis+rectus femoris right, VasLat+RecFemL(m2) = vastus lateralis+rectus femoris left, SemMem+BicFemR(m3)= semimembranosus +bicips femoris,right, SemMem+BicFemL (M4)= semimembranosus +biceps femoris,left, GastroR(M5)=gastrocnemius right ,GastroL(M5)=gastrocnemius left , VJ= vertical jump

Table 39: Pearson Correlation: Non-Athletes's Muscles Strength and Vertical Jump for non-athletes

	M1	M2	M3	M4	M5	M6	VJ
VasLat+RecFemR	*	,867**	,684**	,626**	,772**	,494*	,492*
VasLat+RecFemL		*	,678**	,684**	,743**	,538**	,491*
SemMem+BicFemR			*	,835**	,674**	,453*	,484*
SemMem+BicFemL				*	,715**	,592**	,497*
GastroR					*	,719**	,597**
GastroL						*	,524*
VJ							*

**p<0,01 *p<0,05, VasLat+RecFemR(M1)=vastus lateralis+rectus femoris right, VasLat+RecFemL(m2) = vastus lateralis+rectus femoris left, SemMem+BicFemR(m3)= semimembranous+bicips femoris,right, SemMem+BicFemL (M4)= semimembranous+bibips femoris,left, GastroR(M5)=gastrocnemius right ,GastroL(M5)=gastrocnemius left , VJ= vertical jump

5. DISCUSSION

The aim of the study was to investigate the effect of body weight, flexibility, balance and muscle strength on vertical jump for two groups (Athletes and Non-athletes) using tests to measure each variable.

While finding the measurements for vertical jump the mean of the vertical jump height for the athletes was 46.6 cm while in non-athletes group it was 29.6 cm. In the athletes group, all participants were average and above average jumpers, while in the non-athletes group all participants were below average. The main aim of the study was to find what is the main effects of this differences that determine a higher vertical jump height.

In this study the result suggested that there is no relationship of BMI and vertical jump height, this result was found in both groups although it is worth mentioning that BMI in athletes group was 23.5 and 24.2 in non-athlete group which means all participants were the average rang of BMI. So, to be more specific, the variation of BMI within the average range has no relationship with higher vertical jump.

These results were in a previous study investigating BMI relation to vertical jump in handball player found that there is no significant relation between BMI and vertical jump in adult athletes compared to adolescent player, (76).

In another study performed on young basketball players it was suggested that athletes in their normal weight range did not had a significant difference to vertical jump while overweight athletes performed worse, so the study connected the relation between BMI and vertical jump on age and overweight in young players (77). But one study suggested a significant relationship between weight and vertical jump in libros volleyball players (78)

As for flexibility, two measurement method were used (sit and reach test and ROM), although athlete group performed significantly better than non-athletes group in sit and reach test and conducted better result in hip flexibility, the relation in both tests result did not have a significant relationship with vertical jump height for both groups. So, our result suggests that the rage of motion flexibility has no influence to a high vertical jump. A previous study investigating the relation of long-term stretching to increase range of motion and the relation of that to vertical jump found that increase range of motion has no effect to jump performance (79).

Another article discussed the relation of acute effect of increasing range of motion on vertical jump found that the acute effect results in decrease vertical jump scores (80), while in another study done in the same matter did not find any significant difference before and after the acute increase of ROM on vertical jump height (81). Despite of that we found an article that advises a warmup stretch method to increase range of motion showed a better vertical jump performance after (82).

In current study, balance was tested by two tests. For static balance done by flamingo test and dynamic balance by star excursion test. In both tests there was a significant difference between the groups, as athletes performed significantly better in both tests compared to non-athletes group. And in investigating the relation of balance to vertical jump height, both test results of balance showed a significant relation to vertical jump height in both, athletes and non-athletes group, in one article that studied the relation of balance to functional performance in football player found a significant relation between single leg BESS and vertical jump performance (83).

Another study investigated a balance training program for 12 weeks to improve balance and to see the relation of that to vertical jump performance, found that the program improved the balance and thus there was a significant improvement to vertical jump height (84).

In one more study that did a measurement of balance capacity using an electric platform, suggested a correlation significant to jumping performance in soccer player and advised that balance training should be used to improve jumping height (85).

Also, in another study made to predict the characteristics that has a relation with vertical jump in male athletes found that balance is one factor to predict a good jumping performance (86).

Even with the lack of articles that only focused in the relation of balance static and dynamic with vertical jump but all article found, did support the findings in the current study there was none that suggested non or negative relation of balance to vertical jump although more direct and detailed studies are needed.

In this study it was found in that muscle strength in athlete group was significantly better than non-athletes group, especially in semi membranous and semi tendinous muscle and gastrocnemius muscle, when investigating the relation of muscle strength with vertical jump it was found that gastrocnemius muscle has a strong relation to vertical jump height as well a significant relation of vastus lateralis muscle of the left leg in athlete group, that was different in the non-athletes group that showed a significant relation of the muscle strength of all of the selected muscles in this study to a higher vertical jump.

The current study suggests according to findings that gastrocnemius muscle is the muscle that mostly affected the vertical jump height in addition to vastus lateralis and biceps femoris, while non athletes lower limb strength showed more connection.

In previous articles that discussed the effect of muscle strength on vertical jump, In one of the articles where in one group did strength exercise with maximal vertical jumps and the other group only did strength exercise it was found that the first group showed a significant increase in the vertical jumps prior and after the exercise(87). This result can explain the higher vertical jump and the stronger muscle strength in athletes compared to non-athletes, yet non-athletes has correlation between vertical jump and all muscle tested in this study.

More articles suggested that increasing the strength of lower extremity effect the increase of vertical jump height positively (88, 89, 90)

Its worthy to discuss the measurements test results for both groups to have a better view of how well each group performed, and compare the difference between the two groups and within each group between male and female participants.

In testing BMI it was found that there was no significant difference between athletes and non-athletes. As both groups BMI fell in the healthy category, but there was a significance between male and females within the athletes group , females showed a lower BMI compared to males , while in the non-athletes group females had a slightly higher BMI than males. Many research suggested that athletes, especially female athletes show higher level of weight satisfaction and eating disorders compared to non-athletes, (91, 92)

Testing flexibility two tests were used (sit and reach test and measurements of ROM). Athletes showed a much higher reaching point compared to non-athletes, females showed a higher flexibility compared to males within athletes group, in the non-athletes group the difference was not much but males had better results than the females.

ROM of hip flexion that was performed by a straight leg raise was a determination that athletes have a better hip flexibility than non-athletes. There was no noticeable difference in the other joints between the two group. Although percentage of females who had a hypermobility in hip flexion was higher than male athletes. In the non-athletes group participants had normal and hypo mobile ROM in the straight leg raise, males had percentage in particular while they showed normal ROM in most of the rest joints ROM. These finding were also suggested in an article that studied the flexibility in athletes and non-athletes undergraduates it as found that athletes have higher sit and reach results and better ROM than non-athletes (93). even though in another study that discussed the ROM of elite and non-athletes players, found that there was no significant in the ROM between the two groups in ROM measurements but non elite had a higher sit and reach results compared to elite players (94).

As for balance testing two tests were used 1. flamingo balance test for static 2. Star excursion balance test for dynamic balance. In the static balance athletes performed highly better than non-athletes, but there not much difference between genders with both groups, the same case was obvious in the star excursion test as athletes had a noticeably better performance in all directions of the star and only significant difference in two direction, (anterior lateral for right leg and anterior medial left leg) was seen between the genders within the athletes group. While within the non-athletes no significant was showing between genders.

This result was supported by a study done to investigate the traits of athletes and non-athletes and found that in the balance testing measured by flamingo test that endurance athletes have significant better results than non-athletes (95), similar results were found when comparing athletes gymnastics comparing to non-athletes using flamingo test (96)

Also in star excursion test in a an article that studied the difference between athletes basketball plyers and non-athletes had the same results as the our current study the athletes had a significant difference in all directions (97). Same results also were found in another article that did a comparison between physical education students and non-athletes students for SEBT results (98).

As for the effect of gender on balance research suggests that females have poorer balance abilities (99,100), even though there were no such significant results in the current study but we can still say that males had slightly performed better in both flamingo and SEBT.

Surface EMG was used to calculate the strength of the muscle, results if muscles which belongs to same muscle group doing the same action were combined. Each muscle was tested separately and then a mean as taken, combining muscle was used in other research in similar methods (101,102)

Results for EMG for muscle strength we found that that athletes group have a greater strength in Semimembranosus + Biceps Femoris and gastrocnemius muscle compared to the non-athlete group while no significant difference in Vastus Lateralis + Rectus Femoris . On the other hand, we found that male athletes had a stronger gastrocnemius muscle compared to female athletes, while male non athletes seemed to have no significant difference between them.

Further more studies should be done in regard of vertical jump, recommendation of investigating relation of more characteristics in one study also for example core muscle strength and proprioception .also investigating the role of vertical jump training and its effect on these variables and the role of vertical jump training on vertical jump itself.

CONCLUSION

The outcome of this study suggests that body weight has no relation to vertical jump height within the average ranges. as for flexibility we found that flexibility status did not show a relationship with vertical jump performance for both athletes and non-athletes group. while both balance and muscle strength in our research resulted in showing a strong relationship to vertical jump in both athletes and non-athletes group. other finding of this research are suggested a significantly higher vertical jump for athletes group over non-athletes, and that males jump higher than females in both groups, while female athletes have better flexibility over male athletes, on the other hand, males in both group have better performance in balance as well as greater muscle strength.

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Appendixes

Appendix 1: ethical approval

T.C. YEDİTEPE ÜNİVERSİTESİ

Sayı : 37068608-6100-15- 1676 **30/05/2019**
Konu: Klinik Araştırmalar
Etik kurul Başvurusu hk.

İlgili Makama (Tabarak Edbais)

Yeditepe Üniversitesi Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü Doç. Dr. Rasmi Muammar'in sorumlu araştırmacı olduğu **"Sporcu ve sporcu olmayanlar için vücut ağırlığı esneklik dengesinin ve kas kuvvetinin onvertik sıçramaya etkisi"** isimli araştırma projesine ait Klinik Araştırmalar Etik Kurulu (KAEK) Başvuru Dosyası **(1654)** kayıt Numaralı KAEK Başvuru Dosyası), Yeditepe Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından **29.05.2019** tarihli toplantıda incelenmiştir.

Kurul tarafından yapılan inceleme sonucu, yukarıdaki isimi belirtilen çalışmanın yapılmasının etik ve bilimsel açıdan uygun olduğuna karar verilmiştir (**KAEK Karar No: 1026**).

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

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755 Ataşehir / İstanbul
T. 0216 578 00 00 www.yeditepe.edu.tr F. 0216 578 02 99

Appendex 2: participant consent form (English)

Consent to Participate in a Research

Title of Study: effect of body weight, flexibility, balance and muscle strength on vertical jump for athletes and non-athletes

Investigator: Name: Tabarak Edbais____ **Dept:** Physiotherapy____**phone** 05313172844

Introduction

• You are being asked to be in a research study of assessment of group of physical variables and the effect of them on vertical jump .

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

Purpose of Study

- the purpose of this investigation is to examine the relationship between vertical jump performance and several physical characteristics including balance, body weight , flexibility and muscle strength by EMG
- Ultimately, this research will be used for Master degree thesis and may be used in external publications

Description of the Study Procedures

- You will take a part of one of the two groups in this study (athlete or not athlete) according to your criteria.
- You will be asked to do a 5 minutes warm up routine
- After the warm to will go through assessment to examine your body weight, the level of your flexibility, the level of your balance and your muscle strength which will be measured by EMG (electrical device that monitor the strength of the muscle associated with vertical jump)
- After assessment you will be asked to do an instructed vertical jump, 3 repetitions.

- The procedure will be conducted by a physical therapist in the physiotherapy laboratory.
- The procedure time will be approximately 20 / 25 minutes.

Risks/Discomforts of Being in this Study

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

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

Confidentiality

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

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

Right to Refuse or Withdraw

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

Right to Ask Questions and Report Concerns

• You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have any further questions about the study, at any time feel free to contact me (Tbarak edbaisss) at tbrkedb@gmail.com .or by telephone at 05313172844 If you like, a summary of the results of the study will be sent to you. If you have any problems or concerns that occur as a result of your participation, you can report them to the investigator at the number above.

Consent

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

Subjects name ________________ Investigators name _______________

Signature ___________ Signature ___________

Appendix 3 : participant consent form (TURKISH)

YEDİTEPE

Araştırmaya Katılma İzni

Çalışmanın başlığı: Sporcular ve atlet olmayanlar için vücut ağırlığının, esnekliğin, dengenin ve kas gücünün düşey sıçrama üzerine etkisi

Araştırmacının adı: Tabarak Edbais **Bölüm:** Spor Fizyoterapi ve Rehabilitasyon
İletişim: 05313172844

Giriş

• Sizden fiziksel değişkenler grubunun değerlendirilmesi ve bunların dikey sıçrama üzerindeki etkisinin araştırıldığı bir araştırmada bulunmanız isteniyor.

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

Çalışmanın amacı

- Bu araştırmanın amacı, dikey sıçrama performansı ile denge, vücut ağırlığı, esneklik ve kas kuvveti gibi çeşitli fiziksel özellikler arasındaki ilişkiyi EMG ile incelemektir.

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

Çalışma Prosedürlerinin Açıklaması

- Bu çalışmadaki iki gruptan birinin bir kısmını (atlet veya atlet değil) kriterinize göre alacaksınız.
- Sizden 5 dakikalık bir ısınma rutini yapmanız istenecektir.
- ısınma rutini sonra, vücut ağırlığınızı, esnekliğinizin seviyesini, dengenizin seviyesini ve kas olan gücünüzü incelemek için EMG tarafından ölçülecek ve değerlendirmeler yapılacak. (dikey sıçrama ile ilişkili kasın gücünü izleyen elektrikli cihaz)

- Değerlendirmeden sonra, tekrarlanan bir dikey sıçrama, 3 tekrarlama yapmanız istenecektir.
- İşlem fizyoterapi laboratuarında bir fizyoterapist tarafından gerçekleştirilecektir.
- İşlem süresi yaklaşık 25/30 dakika olacaktır

Bu Çalışmadaki Olmanın Riskleri/Rahatsızlıkları

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

• Kaslarda çalışan yaklaşımın doğası gereği hafif bir rahatsızlık meydana gelebilir.

Gizlilik

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

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

Reddetme veya Çekme Hakkı

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

Soru Sorma ve Endişelerini Bildirme Hakkı

• Bu araştırma çalışması hakkında soru sorma hakkınız var ve bu soruları çalışma öncesi, sırası ve sonrasında tarafımdan cevaplandırmaktadır. Çalışma hakkında başka sorunuz varsa, herhangi bir zamanda benimle temas kurmaktan çekinmeyin (Tbarak edbaisss) tbrkedb@gmail.com tarafından veya telefon numarama 05313172844 .İsterseniz, çalışmanın sonuçlarının bir özeti size gönderilecektir. Katılımınızın sonucu olarak ortaya çıkan herhangi bir sorun veya endişeniz varsa, bunları yukarıdaki numaradan araştırmacıya bildirebilirsiniz.

İzin

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

Katılımcının adı: ________________________

İmza: ______________________________

Araştırmacının adı: ____________________

İmza: ______________________________

Appendix 4: data collection form

Data collection sheet

(the effect of body weight flexibility balance and muscle strength)

Investigator name: Tabarak Edbais

Participant name ___________

Age __________

Gender (male – female)

Groupe (athlete – non-athlete)

If athletes

Type of sport	
Years of practice	
Days of practice	
Hours of practice	

1. Body mass index

Weight	Height	BMI

2. Flexibility

- Sit and reach test

Sit and reach test	

- Range of motion of lower limb

Joint	Flexion	Extension	Result
Hip			
Knee			

Joint	Dorsiflexion	Plantarflexion	Result
Ankle			

3. Balance

- Flamingo test

Time	Score

Star excursion test: leg length ____________________

Direction	Mean (right leg)	Mean (left leg)	Normalized distance (left leg)	Normalized Distance (right leg)
Anterior				
Anterolateral				
Anteromedial				
Medial				
Lateral				
Posterior				
Posterolateral				
Posteromedial				

4. Muscle strength

Muscle	Result (left / right)
Quadriceps	
Hamstring	
Gastrocnemius	

Vertical jump

Start point	First trial	Second trial	Third trial	Mean

Appendix 5: curriculum vitae

Personal Informations

Name	Tabark	**Surname**	Edbis
Place of Birth	Zarqa / Jordan	**Date of Birth**	11/01/1989
Nationality	Jordanian	**TR ID Number**	
E-mail	tbrkedb@gmail.com	**Phone number**	05313172844

Education

Degree	**Department**	**The name of the Institution Graduated From**	**Graduation year**
Doctorate			
Master			
University	Physiotherapy	Arab American university / Jenin / Palestine	2017
High school	Science -	Rabea alAdaweya high school / Doha / Qatar	2008

Languages	**Grades (*)**
Arabic	Native
English	EELTS score 6.5

* All the grades must be listed if there is more than one (KPDS, ÜDS, TOEFL; EELTS vs),

Work Experience (Sort from present to past)

Position	**Institute**	**Duration (Year - Year)**
Physiotherapist	Alreayeh physical clinic	6 months (2017) -

Computer Skills

Program	**Level**
Microsoft world	Excellent

***Excellent, good, average or basic**

Scientific works

The articles published in the journals indexed by SCI, SSCI, AHCI

Articles published in other journals

Proceedings presented in international scientific meetings and published in proceedings book.

Journals in the proceedings book of the refereed conference / symposium

Others (Projects / Certificates / Rewards)
