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High Heeled Shoes and their Effects on Musculoskeletal System

Yüksek Topuklu Ayakkabılar ve Kas İskelet Sistemi Üzerine Etkileri

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ABSTRACT

In recent years, usage of high heeled shoes have been searched by scientists. Because these shoes have been prefered by most of females not knowing its effects. But, high heeled shoes are dressed as visual intentional and they are used especially by some professional groups like model, business females etc. The aim of this study is to research of the effects of continuously using high heeled shoes and to research on reasons of wearing high heeled shoe. Moreover, this review study summarises recent studies about effects of high heeled shoes on musculoskeletal system in healthy females.

Key words: High heeled shoes, fashion and health, musculoskeletal system.

ÖZET

Son yıllarda, yüksek topuklu ayakkabı kullanımı bilim insanları tarafından araştırılmaktadır. Çünkü, bu ayakkabılar yarattığı etkiler bilinmeksizin çoğu kadın tarafından tercih edilmektedir. Fakat, yüksek topuklu ayakkabılar görsel amaçlı olarak giyilmekte ve özellikle model, iş kadını gibi bazı meslek grupları tarafından kullanılmaktadır. Bu çalışmanın amacı yüksek topuklu ayakkabının sürekli kullanımının etkilerini değerlendirmek ve bu tip ayakkabıların kullanım nedenleri üzerine araştırma yapmaktır. Ayrıca, bu derlemede sağlıklı kadınlarda kas iskelet sistemi üzerine yüksek topuklu ayakkabı kullanımının etkileri ile ilgili yapılan güncel çalışmaları özetlenmiştir.

Anahtar kelimeler: Yüksek topuklu ayakkabı, moda ve sağlık, kas iskelet sistemi.

Introduction

The main function of lower extremity is asscociated with posture and walking[1]. Foot contacts with tuber calcanei at back side and head of first and fifth metacarpal bones (caput ossis metatarsi I and V) at front side[2]. Foot arch structure and function are significant for maintain the body optimum functions[3]. Because, medial longitudinal arch (arcus pedis longitudinalis pars medialis-MLA) which is important for sustain foot function, is a primer shock absorption region[3-5]. MLA structure is supported with various anatomic structures and it has the most important structural features[5,6]. The arches of foot transmit body weight to floor as flexible and allow adaptation to foot againts some changes[1,7]. The foot arch structure and function which are linked with some factors such as foot shape, bone structure, the stability of ligament, footwear, age, gender and race effect the medial longitudinal arch structure[4,6,8]. Moreover, the height of MLA is an important reference point to determine the degree and presence of high arch (pes cavus) and flat foot (pes planus)[6].

Shoe especially protects the feet from trauma[9] and is the most important factor which causes to forefoot deformities such as hallux valgus, hammer toe or callosities[10]. Moreover, the footwear features or quality (softness or rigidity), heel witdth and heel height can change the gait mechanism[11]. High heeled shoes (HHS) are described as the footwear having a heel which is more elevated than the toe[12]. It has been declared that high heeled shoes are considered as a symbol of sexuality, class or degree and gender[12]. Many problems are associated with wearing HHS that includes blisters, bunions (hallux valgus), heel spur, callosities and postural changes[13]. Hallux valgus deformity which is the most frequent type of foot in adults, means an angular disorder of the first metatarsophalangeal joint and lateral deviation of the pollex[14]. Moreover, wearing high heeled shoes can cause various hazardous effects, such as expose to much more force on the feet, ankles, knees, and lumbar region. The feet are in plantarflexed position, which in turn significantly increases pressure on the plantar of the forefoot[15].

Whereas, todays' fashion encourages the styling and vogue of high heeled footwears[16]. Wearing HHS seems to be an ordinary and an essential requirement for some occupational groups: Models, actresses, high ranking officials[17]. The most of musculoskeletal foot problems in females are related to biomechanical alterations originated from ill fitting shoes like high heeled shoes and narrow toe box[14,18] and it has been declared the using of HHS has negative and irreversible effects[13,19].

This paper presents some information about the females' accessory called as high heels. Moreover, the use of wearing HHS are increased day by day. Wearing high heeled shoes has more advantages and disadvantages for females and is in fashion. So, this study was performed to evaluate the reasons of using HHS and its impact on the health of females.

Reasons for Using by Females

HHS are preferred due to many reasons by females. For example, they are dressed because of having more attractive appearance[20]. Moreover, most of females like HHS because they have thought that these shoes provide a sense of self esteem, attractiveness and psychological well being[19,21] and give to female sense of longer and slim legs[17,22]. Wearing of HHS is more common in between young females[22]. Furthermore, especially tight-fitting high heeled shoe has been prefered[23]. High heels are not only foot accessories but also an significant part of fashion that reflects her personality[24]. Studies have shown that while females are wearing these type shoes they feel themselves more confident, authority source, psychologically empowering or well being. Additionally, this type shoes provide taller height possibility[16,19,25,26]. It is thougth that HHS are used by females psychological feelings of beauty, feminity, class, elegance and attractiveness[15,17,20,26-29]. In addition, HHS cause increasing in foot arch height so, it leads to appearance of a shorter foot[16]. The most important is that wearing HHS can strengthen women at work[15].

History of High Heeled Shoes

It was reported that in the ancient Greece and Rome, platform sandals called "kothorni" had high wood or cork stoper. They were popular especially among actors. Actors dress these shoes with different heights. These shoes were thougth to be indicated varying social status or importance of characters[21]. There are a source about the wearing of high heeled shoes began in the 14th century too[13]. Approximately, in this period high heeled shoes were dressed to sit stable on the back of horse[30]. On the other hand, it has been declared that high heels like chopines (i.e:high heeled shoes) or platform heels were worn in Turkey in the 1400s[21,31].

Platform heels and chopines were popular in Europe until the mid- 1600s. Chopines have seven or eight or thirty inches high. When females worn these type shoes they had to use canes or servants for helping them walk[21]. In between 1519 and 1589 years, the official creation of high heeled shoes as vogue is based on the Catherine de Medici who was rather

short-statured. In 1580, high heels were popular for both genders and these shoes namely well-heeled were dressed by subjects who had authority or wealth[21]. After, it has been reported females began to wear HHS to satisfy her desire and be more beatiful during the age of Louis XIV in France[21]. It was known that red high heels called Louis heels which was nobility symbol that are approximately 12.7 cm (5 inch), were worn in 1700s in period of France King XIVth Louis and high heels have accepted as both fashion and social status symbol[31-33]. Afterwards, Napoleon abolished high heeled shoe using in 1793 because of not to equalizing to people. High heels called Louis heels got behind on that occasion. Moreover, Marie Anotoinette was executed because of showing resistance to Napoleon rules[31].

Now, the footwear has evolved from its main origination to gigantic heights whereas footwear is used because of basically protecting foot from various trauma[9,10,25]. Furthermore, today in the western world, these are slowly changing into women's daily shoes and the heel height is continuously getting higher with effect of fashion trends[30]. There are many heels models like cone, kitten, prism, puppy, spool or Louis, wedge and stiletto[21]. There are many heel height such as 0-1.5 inches, kitten heels (1.5-2 inches), high heels (2.5-4 inches) or extreme (above 4 inches)[21].

Frequency of High Heeled Shoes Usage by Females

In the world 37 to 69% of females approve to wear HHS[35]. Aproximately, one third of females suffer permanent problems due to wearing HHS regulary[32]. More than two thirds of American females frequently wear HHS. Forty percent females wear high heels daily. Ten percent of females use these more than eight hours a day[34]. In other hand, in the world, HHS are worn by thirty seven and sixty nine percent females[35]. Additionally, a study have shown that 59% of American females and 78% of British females wear HHS daily[16]. In short, females wear high heeled shoes of all ages regularly or not[30]. Because most of females like HHS because of some effects of HHS such as attractive appareance[19,20].

Functional Anatomy of Foot

The foot which occurs twenty six (26) bones, thirty three (33) joint, various ligaments and muscles is complex and original structure[36-38]. While the stability function occurs with stable arc structure of the foot (the straight or proportional weight distribution along the foot, right to left rotation of the foot on a rigid surface, dynamic postural control, balance, etc.) mobility

task takes place with foot flexible structures (shock absorption, adaptation to changes in the support surface, to avoid from extreme rotation movements etc.)[38,39].

Since there is no articulation mechanism to prevent from dorsiflexion movement in the ankle, ankle dorsiflexion movement which body weight forces in the standing position is inhibited by the contraction of the plantar flexor muscles (especially soleus muscle).When soleus muscle is constracted, the body is pulled towards back slightly. When it relaxes, the body slightly moves forward. Thus, there are sustained and slow swingings toward front and back side in symmetric posture for a long time[1,2,7,36]. In symmetric posture, while body weight wants to do extension movement to hip and knee joint and dorsiflexion movement to ankle joint, foot arch tends to collapse. In the case of walking on the tip toe or wearing high heeled shoes, the force that forces the foot arch to correct is increased by four times[1,2,7,36].

It is declared that foot deformities such as high arch (pes cavus) and flat foot (pes planus) can cause difficulty in maintaining daily life activities[40]. Moreover, it is stated that foot structure is connected with different physical injury patterns and while bony injuries, ankle problems and lateral injuries are seen in runners who suffer from pes cavus, soft tissue injuries, knee problems and medial injuries are occurred in runners who suffer from pes planus[41,42]. It is specified that the differences in this injury pattern originate from some factors; increase in the eversion deviation seen in the pes planus and overload seen in pes cavus deformity[42].

Negative Effects of High Heeled Shoes

It has known that HHS effect lower extremity from studies performed. On the other hand, it is well-known that HHS have been used because of both positive and negative effects. Studies have shown that HHS which are one of the most chronic pain of the lower extremity, are implicated in nearly 60% or 83% of foot problems in females[34,43,44]. Speksnijder et al declared that wearing HHS results in load shifting from the heel region towards the central and medial forefoot. Increases of pressures as far as 40 % are common in the forefoot[44].

Normally, standing on barefoot, the perpendicular line of column forms a ninety degree angle with the floor. As the heel height (i.e. three inch heel) increases, column will be forced forward and this angle will comedown to fifty five degrees. If such an extend risk continues during wearing HHS, the strain becomes chronic and causes many problems to subject and chronic use of high heeled might induce structural and functional changes[37,45].

High heel shoes have smaller and unstable supporting surface. This condition alters the structure of the lower extremities and decreases shock absorbing ability and so weight bearing functions of the foot collapse[43,45]. So, the musculoskeletal system may need to work much more to resist all the biomechanical changes to overcome the stress on it[45]. Some females complain that the wearing of HHS causes to low back pain. It is thought that the source of the this pain is the increased lumbar lordosis. Because, HHS cause an increase of the lordotic curve of the lumbar spine and this condition is the main pain reason[46]. As heel height increases, the center of gravity moves more and more forward due to the increased plantar flexion of the ankle joint[47]. Eversion (pronation) motion is decreased. The peroneus longus muscle (mPL) is a foot everter, and when dressed HHS, it is possibly to control the increase in supination of the foot with increased activity of mPL. Moreover, knee flexion continually increases[47]. Furthermore, this increase in knee flexion is a result of compensating for the loss of ankle dorsi flexion[48]. Rectus femoris muscle becomes more active to control the increased knee flexion too[47]. In addition, it has been indicated that high-heels shift forward the center of the body mass and the ankle position may also cause a shorthening of the achilles tendon and restrict the ankle joint motion and power[34,37]. Whereas, gastrocnemius and soleus muscles knowing as calf muscles play major roles in maintaining balance when wearing HHS[9,13,24,30] and HHS lead to spinal flexion increase and postural changes[9,13].

Shorthened calf muscles and increased achilles tendon stiffness in females wearing high heeled shoes reduce the ankle range of motion and this condition can explain why females wearing high heels suffer pain when walking with flat shoes after taking off high heels[34,37]. So, ankle gets position in plantar flexion-inversion and an there are overload on the forefoot and the pressure transfers from the 3rd, 4th, and 5th metatarsal heads to the 1st and 2nd metatarsal heads. In this position, the triceps surae or calf muscles become shortened and contractile strength decreases because of the constant wearing of these type shoes. Therefore, ankle sprains and foot fractures can outbreak and this situation reduces balance. This condition can be compensated for via by displacement of the gravity line and postural changes. Emergent these changes were observed especially on trunk, knees, and ankles and can take place differently[16,34,37,49]. On the other hand, muscle loading and fatique can accelerate[43].

In the great scheme of things, the iliopsoas muscle is active in maintaning normal lumbar lordosis position during standing and resisting hiperextension of the hip joints. The sartorius

and quadriceps femoris muscles are forced to work much more. Because of overuse hip flexor muscles, these muscles can be shorten and contracture can develop. Hip muscles tightness could be an adjusment mechanism of knees and low back. The pain appears due to high heeled shoes originates from improperly positioned lumbar spine[37].

Shortly, continuous using of HHS can cause the pain of knee, foot, ankle and foot deformity, normal gait pattern alterations, changing of lower extremity mechanics and energy consumption[19,20,35]. High heels induce the different movements of the body to rotate and fluctate much more. These eventually increase the moment of the ankle, the knee and the spine joints. Therefore, the muscles prefer to be more strength and to work more harder for more stable walking[20]. In normal gait, the muscles work in a spesific functional synergy and co-activation. Moreover, it plays an important role in walking speed control, by regulating. So these protect lower limb againts overuse injuries. Whereas, the use of the HHS alters the normal gait and forces to non-physiological situation to the muscles and joints[19].

To conclude, females wearing HHS are subjected to trauma, fractures and injuries due to this situation change[13]. Moreover, the using of both high heeled shoes and narrowed toe box are related to blister, callosities, heel spur, bunions-hallux valgus, metatarsalgia in the foot[13,14]. Additionally, walking with high heeled shoe have required both more efforts and many impact like on the balance, posture, gait kinematics and foot stability of the wearer[9]. On the other hand, this type shoes cause muscle fatique, repetitive strain injuries, low back disorder and muscle imbalance[22]. Subject's stride length is reduced and in order to keep a normal speed, the subject has to increase the frequency of her pace to meet demanding both in cardiovascular stres and oxygen consumption[30]. The center of mass is shifted forward. This change in position translates into a higher vertical ground reaction force on the forefoot and shock absorber mechanisms like knee, ankle or inverters can not work[30]. As a result, all these effects blood circulation and lymph fluid by restricting[23].

Positive Effects of High Heeled Shoes

There are less studies have been found in the literature on the positive effects of HHS. The use of HHS have both negative and positive effects and they can be used therapeutically, for instance, in the treatment of tendinitis and partial ruptures of the Achilles tendon[50]. How many days in a week and how many hours a day these shoes will be worn? And what time suggested by scientific articles can be?

In literature, it has been reported that females wearing HHS should not exceed 3 cm or 4.13 cm height at risk of having a locomotor pattern disturbed and to be subject to musculoskeletal disorder[9,35]. The other study was declared the ideal heel height should be between 3 and 5 cm for providing balance. Heel height having greater than 5 cm can cause fatigue quickly[51]. Ko and Lee indicated that 4 cm heel height is more favorable for females[51]. Moreover, chiropodist suggested that footwear should not exceed 4 cm heel height and medium heel height are the best choice[52]. It was recommended that high heeled shoes should wear wear for short periods of time[52]. Females wearing HHS should do specific exercises to decrease its long term negative effects[19]. The importance of the footbed shape in the design of a comfortable high heeled shoe has demonstrated[17].

Conclusions

This review study summarises recent studies about effects of high heeled shoes on musculoskeletal system in healthy females and directions of high heeled shoe wearing time (how many days in a week do females dress and how many hours a day do females wear?) that is suggested or evaluated by scientific studies. HHS have both negative effects and positive effects. Negatives features are much more than positive features. But, the only thing that matter is that:

What should heel height to be? or How many days in a week or how many hours a day are the high heeled shoes dressed? The answers of these questions are very important in developing of negative and irreversible results. As noted above, HHS can cause changes on musculoskeletal system such as foot, knee, back pain etc. According to literature review heel height can be in between 3 cm and 5 cm height. On the other hand, we believe that females wearing HHS should do some private exercises to decrease its negative effects. For example, exercise should include in abdominal muscles and lower extremity muscles like quadriceps, hamstring, calf and foot muscles in terms of subjects'health. Besides, a suitable footbed or sole can be used to be obtained of design of a comfortable HHS. Furhermore, when comparing the literature findings, we observe that there are both differences and similiarities about high heel shoes's effects. We consider that these discrepancies could be a result of such factors like heel height differences, frequency of wearing HHS, etc.

In conclusion, we think that the precise knowledge of the high heels'effects may be essential for avoiding from many problems such as foot deformities, knee problem or back pain for

wearers or clinicians. Therefore, the observations presented in this study have defined parameters like positive and negative effects of HHS, favorable or suitable heel height (suggested heel height), frequently of HHS using that need to be taken into consideration for evaluate musculoskeletal problems and guidelines for prevent the negative effects.

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