

INCREASING WOMEN'S ATTRACTIVENESS: HIGH HEELS, PAINS AND EVOLUTION – A GMM BASED STUDY

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*"Pride must suffer pain," replied the old lady... Everyone was enchanted, especially the prince, who called her his little founding; and she danced again quite readily, to please him, though each time her foot touched the floor it seemed as if she trod on sharp knives."
The Little Mermaid, Hans Christian Andersen (1836)*

Abstract: Since the early 19th century foot pathology caused by wearing high heels is covered by many publications. The most painful effect is the Morton's Neuroma, obviously described in Hans Ch. Andersen's fairy tale "The little Mermaid": "Every step she took was as the witch had said it would be, she felt as if treading upon the points of needles or sharp knives". GMM (Geometric Morphometrics) analyses of female feet gives evidence, that permanent wearing high heels can change the shape of the foot already in young age range of women. Latest publications in consumer behaviour and the evolution of female attractiveness are giving evidence how strongly significantly high heels can increase female attractiveness with a lot of benefits, which has been highlighted by Morris, 2013. In evolutionary psychology, this fact is described as "The High-Heel Hottie Effect" (Scientific American, 2014). In general, men tend to find women in high heels more attractive. Already in 1854 Mary Philadelphia Merrifield and Frederick William Fairholt wrote: "pride never feels pain", when they discussed the pathological consequences of wearing high heels permanently. We discuss the morphometric alterations of women's feet as well as theories dealing with the evolution of female attractiveness.

Keywords: high heeled shoes, Hallux valgus, GMM, female attractiveness.

1. Introduction

Since Catherine de Medici (1519-1589) set the cornerstone of "this absurd fashion", so called French shoes, women sacrifice health to create the extra feminine illusion of a socially constructed character for a desirable perception as a type of cultural oddity. For decades women overhear medical warnings, and continue indulging this danger fashion habit to satisfy the desire for power, status, sexuality, self-confidence and mate selection that is hidden behind the unnatural body shape transformation. Even though the controversial topic about well-known foot problems associated with wearing high heels has experienced scientific observations for 250 years, the sale of high heels is continuous growing. Women worldwide spend enormous amounts of money on high heels and stilettos ignoring the monologue with wearers of high heel [1, 2].

There is still a gap between aesthetics and science, thus the time is ripe to use the tremendously advances of technology to perform population-based studies about the use of high heels to pursue evidence and contribute to the perception of the health problems not only in young women. The scope of the investigation was to show how the frequent use of high heels changes foot morphology in a sample of young women.

Percentage of quotations out
of 5,2 million books

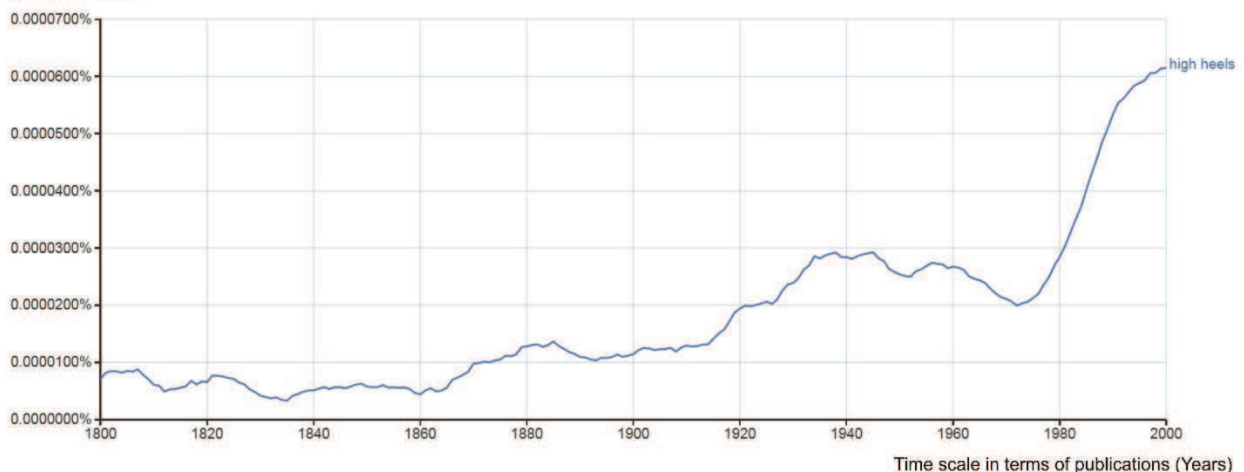


Figure 1: Google Books Ngram Viewer: search for high heels in 5,2 million books since 1800.

Figure 1 shows growing presence of books over decades dealing with high heels. A small, even significant number of books is dealing with a highly vibrant sociologically topic, which is social inequality. The reception of Jonathan Swift's critical novel *Gulliver's Travels* is an excellent piece of contemporary social history, Figure 2.



Figure 2: The political parties of the English government are represented by the conservative High Heels who depict the Tories, and the progressive Low Heels, or Whigs [3]

2. High heels - Hallux valgus, posture and GMM analyses of the feet of young women

2.1 Some consequences of long-term wearing high heels

Anatomically alterations caused by the use of high heels was examined already in the 19th century (Figure 3) [2]. A number of laboratory based studies [4-6] have exposed the negative effects of wearing high heels such as pathological alterations, postural changes, as well as unnatural restrictions that can lead to physical trauma. It's obvious that habitual use of high heels as part of the modern woman's wardrobe is a serious and at long last also a dangerous matter concerning women's health.

One of the most painful effects is Morton's Neuroma, obviously described by Andersen in his fairy tale "The Little Mermaid".

As early as in 1852 we can read one of the very first words of warnings in *The Journal of Health* concerning the injurious effects of wearing high heels, which matches perfectly with the study "Epidemiology of High-Heel Shoe Injuries in U.S. Women: 2002 to 2012" [7].



Figure 3: Ballin (1885) described anatomically correct the distortion of the foot as a consequence of wearing high heeled shoes: a. Normal position, b. Distorted position caused by high heel [8, 9].

Commonly Hallux valgus, the so called "bunion", is one of the most significant and frequent pathological foot conditions in women's foot. Hallux valgus turns the toe out of the mid-line of the body axis. Around the great toe there is red-swollen and much painful sensation on the inside of the foot, Figure 4. Even there are many causes for Hallux valgus including hereditary predispositions, the primary cause is wearing of high heeled shoes for a longer respectively a long period of time.

We would like to point out: Young Ladies, please be aware of the consequences of long-time wearing high heeled shoes especially stilettos, otherwise you could easily suffer pains and orthopedic treatments later on in your life!

Therefore: High heeled shoes, often combined with narrow toe boxes, that are consequently squeezing toes, are one of the most common causes to acquire Hallux valgus.



Figure 4: Foot alteration caused by the use of high heels: a. Hallux valgus, b. High heels can cause Hallux valgus, already in young age [10]

It is well known that there is a prevalence of Hallux valgus in women [11-14], especially when they are wearing high heels shoes almost daily.

The Dublin City Foot Clinic have noticed recently a dramatic increase in the number of young women (often under 16) attending with often complex foot problems such as corns, hammer toes, bunions (hallux valgus), Morton’s neuroma, plantar fasciitis some of which may be permanent and require surgery to alleviate the pain. “...The more feet are forced into this position, the more the calf muscle will shorten. The higher the heel, the bigger the body’s incline, greatly increasing the weight concentrated on the ball of the foot. That means wearing a 3in heel concentrates double the body’s weight on this area. Problems can show up after just six months wearing heels. A high heel also alters the body’s centre of gravity thereby increasing pressure on the lower back, compressing the lower back vertebrae and contracting the muscles of the lower back...” [11].

In this context we would like to stress the effect of wearing high heeled shoes on the weight distribution and the alterations of posture. One should take into consideration: the evolution of the human foot was an adaption on a flat underground [11].

The influence of high heels on the female posture is impressively illustrated by Caroline Jordan in Figure 5 [15].

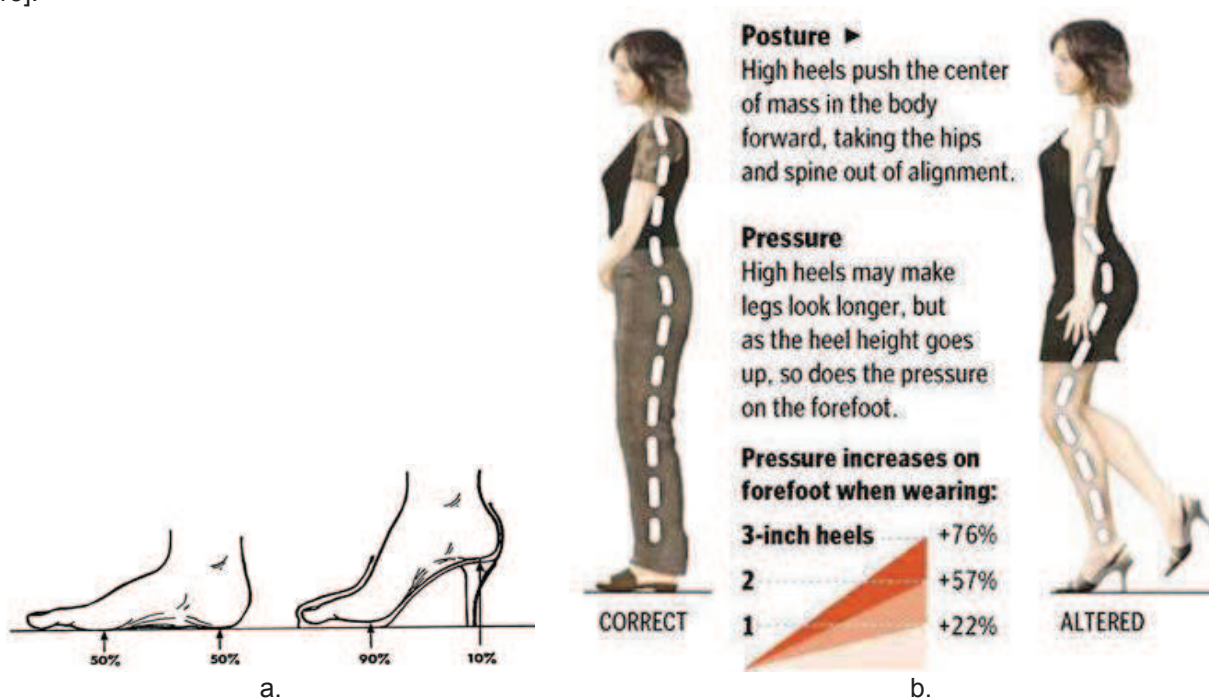


Figure 5: The influence of high heels: a. Weight distribution – flat foot, high heeled foot: Please pay attention on the impact of excessive forces caused by high heeled shoes and b. The impact of high heeled shoes on posture and gait [12].

Neil Cronin et al. (2012) described the consequences of long-term use of high heeled shoes on the quality of human walking. High heels wearers may suffer discomfort and muscle discomfort as well as high heels might increase the risk of strain injuries [16].

2.2 GMM analyses: feet alterations of young women caused by high heels

Research conducted on older women who frequently wore high heels has reported that women have increased prevalence of Hallux valgus [17], while a recent survey reveals a significant association between foot shape and shoe wearing habits even in very young women (median age 23 years) [18]. Figure 6 shows a threefold extrapolation of morphometric data of average right footprint shape of female individuals aged between 19 and 36 years derived from laser scan surfaces. The visualization of the relative warps reveal a displacement of landmarks and semilandmarks of the footprint outline especially in the forefoot and midfoot area. Each subject informed us about the frequency of wearing high heeled shoes, thus we could perform the standard tool of shape regression, to quantify foot deformations. The frequency of wearing high heels was characterized in a range from never till often wearing high heels. Adult females who regularly wear high heels have a broader medial forefoot area and the hallux are longer in relative length to the other toes [19].

This is associated with the increased pressure and shear stress on the forefoot, particularly on the medial forefoot (see the alterations of the foot skeleton in Figure 4).

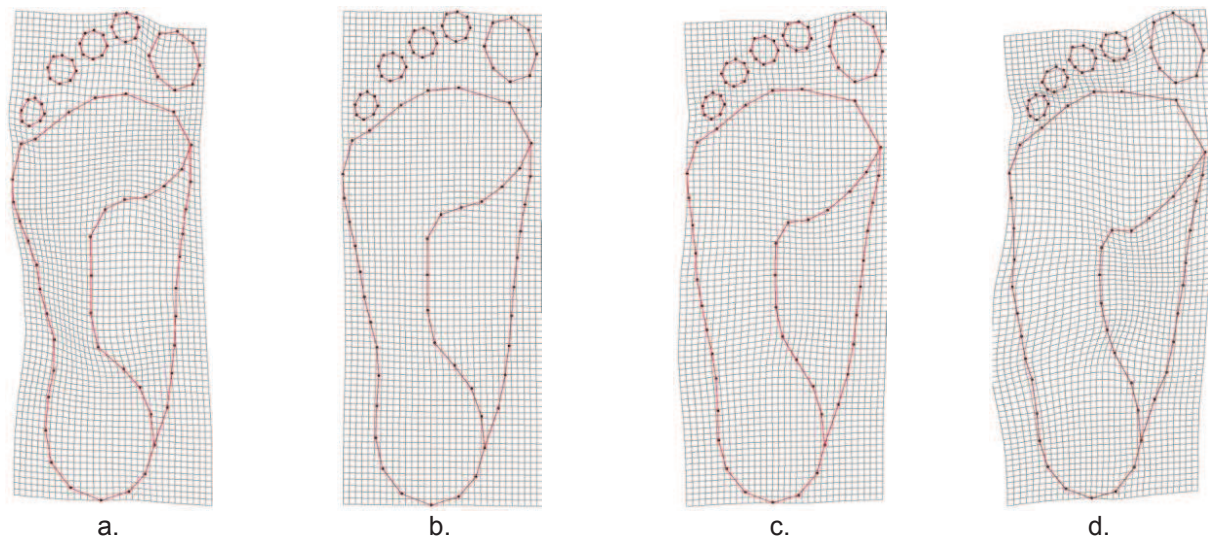


Figure 6: The consequence of wearing fashionable shoes on footprint shape for women that wear high heels: a. never; b. rarely; c. sometimes and d. often

GMM (Geometric Morphometrics Methods) provides us with a better understanding of Hallux valgus deformities at the base of the big toe, concerning the metatarsophalangeal (MTP) joint, in which the great toe, or hallux, is deviated or points toward the lesser toes. In severe types of the deformity, the great toe goes over or under the second toe. Hallux valgus involves medial deviation of the first metatarsal and lateral deviation and/or rotation of the hallux as well as prominence, with or without medial soft-tissue enlargement of the first metatarsal head [20].

Consequences are e.g. that the calf muscles will be shortened, while the weight is burdening the forefoot so that that the body weight doubles on the ball of the foot.

3. High heels in the light of evolutionary biology

Paul Morris et al [21] describe a highly significant aspect how high heels as a kind of supranormal stimulus enhance female attractiveness. (please see the “high heels altered posture” in Figure 5b and compare it with the posture on Figure 5a.

Even high heels, as we have pointed out, can cause chronic damage, women prefer high heels as being indispensable for attractiveness and getting attention, in terms of evolutionary biology an “instrument” for mate selection.

It has been convincingly analysed that wearing high heels increases the “feminity of gait” and women are becoming more attractive than females in flat shoes. Biomechanical analyses reveal a more sexy gait including an increased rotation and tilt of the hips – in fact a “supranormal stimulus” of female gait and walking. This has been confirmed also in sociological and psychological studies.

Additionally high heeled shoes allow women to be more selective over higher quality males competing for their attention, a convincing argument for evolutionary advantages via fashion.

True, high heeled shoes make women more attractive even they can cause pathological foot deformations and heavy pains. Is it true that “beauty must suffer”? Not necessarily! As Paracelsus [22] has said: Poison is a question of dose! High heeled shoes could be worn problem-free in special occasions as e.g. ball dancing or other kinds of social events – but definitely not permanently, especially not during daily professional activities.

4. Conclusion – or our point is:

GMM analyses of the feet, dependent how frequently high heels are worn, provides us with evidence that pathological alterations can be found already in young women frequently using high heeled shoes. Podiatry teaches us since the 19th century convincingly that those alterations will lead to severe problems including medical interventions later on. We definitely don't condemn high heeled shoes, but we believe that it is necessary that women should pay some attention on the periods of time they are wearing high heeled shoes.

Furthermore, we would like to suggest the importance of interdisciplinary research work. In our topic we have learned that aspects of clothing technology – here the problems of high heels and the width of toe box – would additionally deserve interdisciplinary collaborations and critical exchange of different hypotheses concerning evolutionary biology, evolutionary psychology and sociology in general. In principle apparel is made to impress, to attract and to get attention – in both sexes! We simply need to understand the balance between attractiveness and health, we need to understand also more deeply the interactions between dresses, pathology and sociological aspects in the light of biological evolution.

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