

Plasma concentrations of PAI-1, TNF- α , and interleukin-1

* $p < 0.05$.

physiology and chronic health evaluation (APACHE) III scores between the groups at baseline. Therefore the severity of trauma at baseline for the groups does not explain the different inflammatory response in 4G/4G, 4G/5G, and 5G/5G patients.

High interleukin 1 and TNF- α concentrations are an inflammatory over-response in 4G/4G patients due to impaired fibrinolysis, and represent an unfavourable course in 4G/4G patients.⁵ Therefore, an impaired fibrinolytic activity in 4G/4G patients after trauma, an enhanced activity of immunosuppressive cytokines, and downregulated proinflammatory cytokines in the later stages of disease, might be important causes of impaired microcirculation. These variables seem to determine the conversion of primarily functional and reversible systemic reactions into parenchymal lesions in organs, which might partly explain an increase in infections and high incidence of sepsis and multiorgan failure. We believe that 4G/4G patients have a genetic susceptibility to high PAI-1 responses after exposure to noxious factors. If individuals with 4G/4G are exposed to factors that result in an overwhelming inflammatory response, they should be thought of as at high risk of developing multiple organ dysfunction with poor outcome.

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Women's shoes and knee osteoarthritis

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We assessed whether wearing wide-heeled shoes has a similar effect on knee torque to narrow-heeled shoes by measuring the joint torques of 20 healthy women during walking. Wearing wide-heeled shoes had a 30% greater effect on peak external knee flexor torque than walking barefoot. Walking with wide-heeled and narrow-heeled shoes increased peak knee varus torque by 26% and 22%, respectively. Our findings imply that wide-heeled shoes cause abnormal forces across the patellofemoral and medial compartments of the knee, which are the typical anatomical sites for degenerative joint changes.

We have previously reported that traditional narrow-base (stiletto) high-heeled shoes exaggerate the knee varus and knee sagittal torques during walking—these torques are thought to be relevant to development of knee osteoarthritis.¹ Women and men have similar knee varus and knee sagittal torques during barefoot walking, which suggests that intrinsic biomechanical differences do not explain the fact that knee osteoarthritis is twice as common in women than men.² Although high-heeled shoes are traditionally thought of as stilettos with a narrow-base sole and heel, women's dress shoes with wide-base soles and moderately high heels are routinely worn by women of all ages, in work and other settings. These shoes, typically associated with a wide toe-box, are generally perceived to be more comfortable and stable than narrow-base heeled shoes.³ Although these shoes could reduce the risk for falls, ankle injuries, and foot deformities compared with narrow-base heeled shoes, we hypothesised that women's wide-base heeled shoes impose the same, if not greater, alterations in knee joint torques during walking as narrow-base heeled shoes.

We studied 20 healthy women, who were comfortable wearing wide-heeled and narrow-heeled dress shoes, with a mean age of 34.9 years (SD 7.1; range 23–44 years), mean height of 1.62 m (0.05), and mean weight of 59.1 kg (9.7). Our study protocol was approved by the Institutional Review Board and we obtained written informed consent from each participant. For each woman, one pair of her wide-base shoes and one pair of her narrow-base shoes of similar heel height (defined as the maximum height of the sole at the rear of the heel) were selected for comparison. We ensured that there were no substantial differences in average height between the

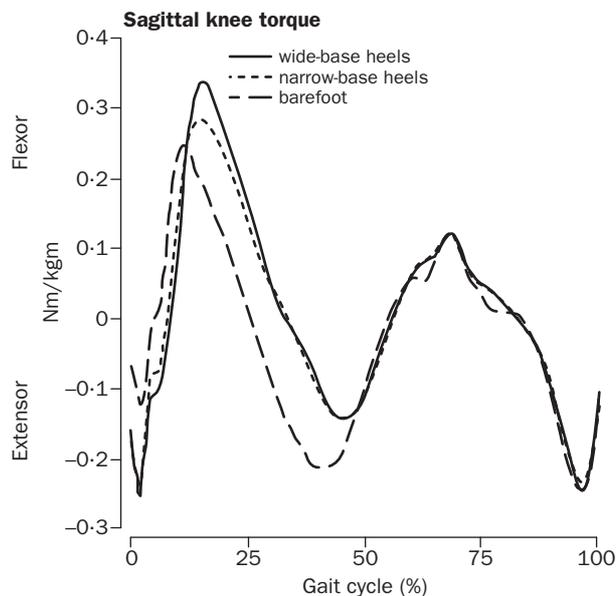


Figure 1:

Sagittal knee joint torque during walking plotted over an averaged walking cycle (0-100%) in heeled shoes and barefoot.

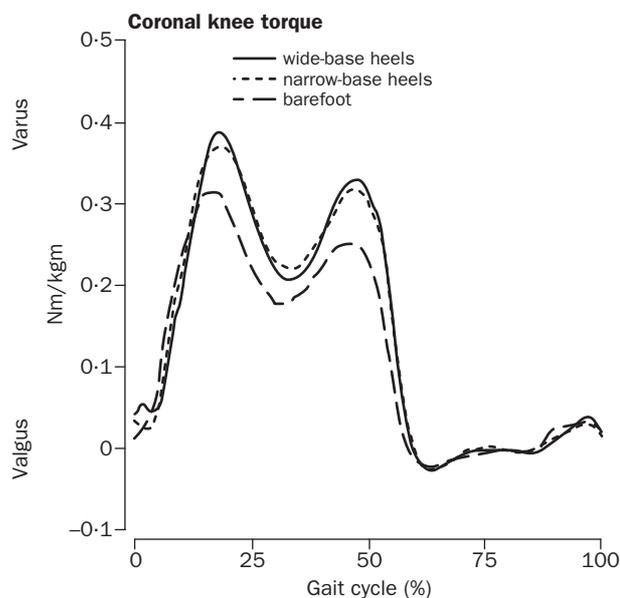


Figure 2:

Coronal knee joint torque during walking plotted over an averaged walking cycle (0-100%) in heeled shoes and barefoot.

wide-heeled and narrow-heeled shoes; mean heights were 7.0 cm (SD 1.0) for both the wide-heeled shoes and narrow-heeled shoes. Narrow-base shoes were an average 1.2 cm in width (0.4) whereas wide-base shoes were 4.5 cm in width (1.2). We measured bilateral joint torques, as the women walked barefoot, in each pair of shoes, at a comfortable speed across a 10 m gait laboratory walkway, with a six camera video-based motion analysis system (VICON 512 system; Oxford Metrics Ltd, Oxford, UK) and two staggered force platforms (Advanced Mechanical Technology, Newton, MA, USA) embedded in the walkway. We calculated joint torques with a commercialised full-inverse dynamic model (VICON Clinical Manager; Oxford Metrics Ltd, Oxford, UK) adjusted for healthy body weight and height, and reported in Newton metres per kg metres (Nm/kgm). We calculated the average peak joint-torque value for each woman over three walks (average of both lower extremities) for each type of shoe and walking barefoot. We compared peak torque-values with a repeated measures ANOVA with post-hoc *t* test assessment (Stata Version 6.0).

Figure 1 shows that the general pattern of sagittal knee torque was similar between wide-base and narrow-base heeled shoes, yet was different for barefoot walking. The knee flexor torque normally present during early stance, was sustained into the midstance phase and the peak knee extensor torque during late stance was significantly reduced compared with barefoot walking (mean 0.23 Nm/kgm [SD 0.08]) for both the wide-base and narrow-base shoes (0.16 Nm/kgm [0.08], $p < 0.0001$, and 0.16 Nm/kgm [0.09], $p < 0.0001$, respectively). In addition, the peak knee flexor torque for the wide-base heeled shoe (0.35 Nm/kgm [0.14]) was 30% greater ($p < 0.0001$) than for women walking barefoot (0.27 Nm/kgm [0.13]).

Figure 2 shows that the coronal varus torque at the knee was increased throughout the stance period for both the wide-base and narrow-base heeled shoes compared with barefoot. The first peak was significantly greater than the barefoot peak value (0.33 Nm/kgm [0.07]) for both the wide-base (0.40 Nm/kgm [0.06], $p < 0.0001$) and narrow-base shoe (0.39 Nm/kgm [0.06], $p < 0.0001$). The second peak was also significantly greater than the barefoot peak value (0.27 Nm/kgm [0.06]) for both the wide-base (0.35 Nm/kgm [0.05], $p < 0.0001$) and narrow-base shoe (0.34 Nm/kgm [0.05], $p < 0.0001$).

Although sagittal knee torque was sustained in women who wore both wide-base and narrow-base heeled shoes, there was a 30% greater reduction in peak sagittal knee torque in women who wore wide-base heeled shoes compared with those who were barefoot. This increased knee torque increases the work of the quadriceps muscles, increases the strain through the patella tendon, and increases the pressure across the patellofemoral joint.⁴ The increased patellofemoral pressures occurring with each repetitive step might be important with respect to the development of degenerative joint changes within the patellofemoral compartment. Both types of shoes exaggerated the normal varus torque at the knee by 26% and 22% for the wide-heeled and narrow-heeled shoes, respectively. Increased varus torque imposes greater compressive forces through the medial aspect of the knee, a site typically prone to degenerative joint changes.⁵

We have shown that wide-heeled, women's dress shoes cause the same, if not greater, alterations in knee torques, as narrow-heeled shoes. These findings may have particular importance with respect to the development of knee osteoarthritis, insofar as women tend to wear these wide-heeled dress shoes routinely and for longer periods of time.

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