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Body center of mass displacements during walking with low- and high-heeled shoes

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Walking is a natural activity that is very often performed wearing shoes. Among many other kinds of footwear, high-heeled shoes induce increased ankle plantar flexion, greater knee flexion, anterior pelvic tilt, and trunk extension [1]. The modifications in the arrangement of body segments cause an altered position of the body centre of mass (CoM). In the current study, we quantitatively compared the 3D displacement of CoM during flat-heeled and high-heeled gait.

Eleven volunteer women (mean age, 24 years) walked wearing either low-heeled and high-heeled shoes (minimum height, 70 mm). On each subject, the 3D coordinates of 14 body landmarks were recorded by an optoelectronic motion analyzer. The body was segmented in 10 independent masses: head, torso, two upper arms and two lower arms (upper body); two upper legs and two lower legs (lower body). Using mean anthropometric data, the whole body CoM was computed, as well as its superior (u_{CoM}) and inferior (i_{CoM}) components [2]. The body CoM was evaluated during normalized stride cycles.

High-heeled gait, compared to flat-heeled gait, had a significantly lower CoM at Right heel strike (p=0.024) and Left heel strike (p=0.030). The same findings were also observed for u_{CoM} and i_{CoM}. No significant differences were found at Right toe off. In addition, a significant forward displacement of the i_{CoM} in high-heeled gait was observed at each of the three stages (R heel strike, p=0.017; L heel strike, p=0.034; R toe off, p=0.003). Similar results were found for the whole CoM (p=0.024, p=0.038, p=0.004). The u_{CoM} in high-heeled gait, instead, was significantly more anterior than in flat-heeled gait only at R toe off (p=0.024).

Our findings confirmed that wearing high-heeled shoes significantly alters the normal displacement of both components of the human CoM.

References

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Key words

Gait analysis, footwear, center of mass, segmental centroid.