Ground reaction forces during downhill and uphill running.

Journal of Biomechanics. 2005; 38(3):445-52 (ISSN: 0021-9290)

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We investigated the normal and parallel ground reaction forces during downhill and uphill running. Our rationale was that these force data would aid in the understanding of hill running injuries and energetics. Based on a simple spring-mass model, we hypothesized that the normal force peaks, both impact and active, would increase during downhill running and decrease during uphill running. We anticipated that the parallel braking force peaks would increase during downhill running and the parallel propulsive force peaks would increase during uphill running. But, we could not predict the magnitude of these changes. Five male and five female subjects ran at 3m/s on a force treadmill mounted on the level and on 3 degrees, 6 degrees, and 9 degrees wedges. During downhill running, normal impact force peaks and parallel braking force peaks were larger compared to the level. At -9 degrees, the normal impact force peaks increased by 54%, and the parallel braking force peaks increased by 73%. During uphill running, normal impact force peaks were smaller and parallel propulsive force peaks were larger compared to the level. At +9 degrees, normal impact force peaks were absent, and parallel propulsive peaks increased by 75%. Neither downhill nor uphill running affected normal active force peaks. Combined with previous biomechanics studies, our normal impact force data suggest that downhill running substantially increases the probability of overuse running injury. Our parallel force data provide insight into past energetic studies, which show that the metabolic cost increases during downhill running at steep angles.