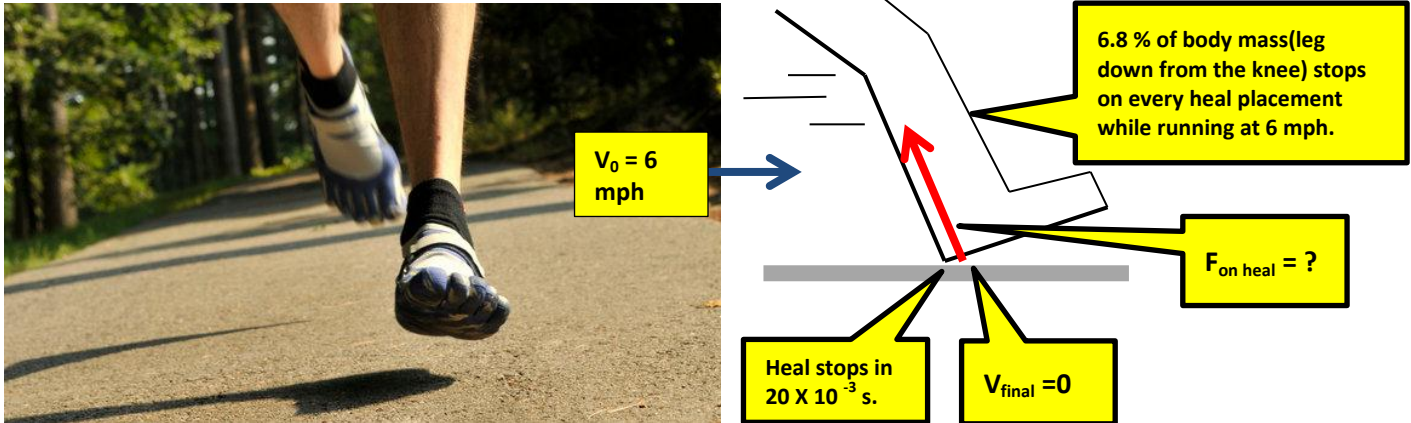


# NEWTON'S 2<sup>ND</sup> LAW

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## Barefoot Running Can Cause Injuries, Too



When Dr. Douglas Brown, a radiologist in Orem, Utah, noticed an uptick recently in the number of **barefoot runners he was seeing with heel and foot problems**, he wondered if there might be a connection between their unshod training and their sore feet. But he couldn't find any scientific studies that had examined the issue. So he approached Sarah Ridge, a professor of exercise science at Brigham Young University in Provo who studies impact injuries in sports, and suggested she undertake one. The resulting study, [published last month in Medicine & Science in Sports & Exercise](#), will probably add fuel to the continuing debate about the benefits of running barefoot or wearing minimalist "barefoot" shoes. They argue that being unshod is normal for humans and should reverse past injuries related to modern running shoes and prevent future ones. After 10 weeks, both groups of runners received a follow-up M.R.I. There was no evidence of injuries to or changes in the tissues of the lower leg, like the Achilles' tendon, in any of the runners. But **more than half of the runners wearing the minimalist shoes now showed early signs of bone injuries in their feet.** But a majority of the runners in the **minimalist-shoe group had developed at least a level 2 edema, "which indicates early bone injury,"** Dr. Ridge said, and three had signs of more-extensive level 3 bone edema, "which constitutes an actual injury."

**INTRODUCTION:** This 128 lb runner, running at 6 mph, has his/her heel stop in  $20 \times 10^{-3} \text{ s}$ . 6.8% of the body mass(knee to foot) stops on every heel placement. See the above graphic for more detail.

**QUESTIONS:** (a) Convert 6 mph to ft/s? (b) Find mass of runner in slugs? (c) Find 6.8% of body mass?(which is doing the stopping). (d) Find deceleration of leg foot(6.8% of body mass) on each heel placement? Find a in  $\text{ft/s}^2$ . (e) Find force(in lb.) on heel( $F_{\text{heel}} = ?$ ) during each heel placement running at 6 mph?

**HINTS:**  $F_{\text{net}} = ma$  ,  $60 \text{ mph} = 88 \text{ ft./s}$  ,  $\text{weight} = mg$  ,  $g = 32 \text{ ft/s}^2$  ,  $V_{\text{final}} = V_0 + at$

**ANSWERS:** (a) 8.8 ft./s , (b) 4 slugs , (c) 0.272 slugs , (d)  $-0.44 \times 10^3 \text{ ft/s}^2$  , (e)  $\sim 120 \text{ lb}$  on heel of just "one" foot.