ENERGETIC ADVANTAGES AND DISADVANTAGES OF RUNNING SHOES

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INTRODUCTION
Adding mass to the feet or shoes increases energetic demand: ~1% for each 100 grams added per foot [1,2]. However, several studies indicate that running with lightweight shoes has an equivalent energetic cost as running barefoot (Figure 1). Frederick et al. [3] hypothesized that this could be explained if running barefoot involves a greater “cost of cushioning” which counteracts the energy savings due to eliminating shoe mass. Here, we directly tested Frederick et al.’s hypothesis.

Figure 1: Summary of previous studies. Solid squares = p<0.05 vs. barefoot; open squares = p>0.05.

METHODS
11 experienced barefoot runners ran at 3.35 m/s with a mid-foot strike pattern on a Quinton 18-60 motorized treadmill which has a rigid steel deck. Subjects ran unshod on the normal belt and with 10 mm and 20 mm thick slabs of ethylene-vinyl acetate (EVA) foam affixed to the treadmill belt (Figure 2). We calculated metabolic power (W/kg) from rates of oxygen consumption and carbon dioxide production.

Figure 2: Treadmill equipped with EVA foam slats.

RESULTS
Despite considerable individual variability, metabolic cost for unshod running was on average 1.83% (SE +/- 0.67%) cheaper on the 10 mm foam compared to the rigid surface (p=0.027). The reduction in metabolic cost on the 20 mm thick surface was not statistically significant (0.92% +/- 0.90% p=0.322).

DISCUSSION & CONCLUSIONS
Our results support the cost of cushioning hypothesis. When total foot + shoe mass is equalized, using shoes generally requires 3-4% less energy than unshod running [2]. Cushioning cannot explain all of that difference (Figure 3). Unshod running elicits a faster stride frequency which could explain ~0.4% difference if the relationship between stride frequency and energetic cost is independent of footwear. Other aspects of shoe construction (heel lift, arch support and sole flex/return) may be advantageous and explain the remaining difference in energetic cost.

Figure 3: Graph combines results of the present study and those of Franz et al. [2].

To date, running barefoot and in lightweight, cushioned shoes are energetically similar; the advantages and disadvantages counterbalance each other. Perhaps even lighter shoes will tip the balance in the future.

REFERENCES

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