

INTER AND INTRA-SUBJECT CLASSIFICATION OF OUTSOLE WEAR IN RUNNING SHOES

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INTRODUCTION

Rubber outsole wear in running shoes is a result of abrasion between the shoe and the running surface. Outsole wear is affected by factors such as individual technique, impact surface, rubber compound, outsole tread pattern, impact force and body weight. Using ultrasonic measurements, the progression of outsole wear over the course of 300 miles of running has been quantified (Ocif et al., 2004). It is known that asymmetries between right and left feet exist in ground reaction force and underfoot pressure profiles (Nigg, 1986). The purpose of this study was to quantify intra-subject bilateral variability in the rate of outsole wear in the rearfoot and to classify runners from low to high outsole abraders.

METHODS

Fifty-six (56) runners who were subjects in various studies were evaluated (mean age: 41.5 yrs, weight: 147.8 lbs, height: 67.4 in). In each study, subjects were asked to run 150-200 miles (mean miles: 188, range: 100-307) in full pairs of running shoes. The shoe model varied, but the outsole rubber compound was the same for all shoes, and the outsole tread pattern and initial outsole rubber thickness was similar (mean: 5.5, range: 4.3-6.9 mm).

Outsole rubber thickness was measured at 4 sites on the lateral heel before and after each wear test using a Panametrics 25DL ultrasonic thickness gauge with an M1016 ultrasonic pulse transducer (Panametrics, 1996). To ensure consistent placement of the ultrasonic transducer for pre- and post- wear measurements, a pair of templates was constructed by vacuum-forming a clear stiff piece of polyethylene plastic over the shoe sole, and drilling four (4) 1.59 mm (1/16 inch) diameter holes over the chosen measurement sites for each model of shoes that was tested (Figure 2).

The 4 thickness measurements were averaged pre and post wear, and the outsole wear rate was calculated as rubber thickness lost divided by the accumulated running miles for each runner.

The inter-measurer and intra-measurer repeatability for this method has been shown to be high (inter-measurer correlation coefficient $R = 0.999$, intra-measurer correlation coefficient $R = 0.999$; Ocif et al., 2004).

RESULTS

There was no significant difference in average wear rate between right and left shoes (left shoe wear rate = $0.688 \times 10^{-2} \pm 0.730 \times 10^{-2}$ mm/mile, right shoe wear rate = $0.584 \times 10^{-2} \pm 0.685 \times 10^{-2}$ mm/mile). The data were then grouped by higher and lower wear rate within each subject regardless of shoe. The results showed that the runners had an asymmetrical trend between shoes. The average wear rate of the higher wear rate shoe was $0.763 \times 10^{-2} \pm 0.828 \times 10^{-2}$ mm/mile, and the wear rate of the lower shoe was $0.509 \times 10^{-2} \pm 0.538 \times 10^{-2}$ mm/mile ($P = 0.056$; Figure 3).

Based on wear rates, the right and left shoe of each runner was classified into 1 of 3 groups: low, ($0.0 - 1.5 \times 10^{-2}$ mm/mile) medium ($1.6 \times 10^{-2} - 3.0 \times 10^{-2}$ mm/mile) and high (above 3.0×10^{-2} mm/mile) outsole abraders (Figure 4). Forty-nine (49) runners had both shoes in the low abraders category (average of all low abraders shoes = $0.451 \times 10^{-2} \pm 0.354 \times 10^{-2}$ mm/mile), 2 runners had both



Figure 1. Panametrics 25DL ultrasonic thickness gauge with running shoe and clear plastic template.



Figure 2. Location of the outsole thickness measurement sites (white marks) in the lateral heel.

shoes in the medium abrader category (average of all medium abrader shoes = $2.34 \times 10^{-2} \pm 3.60 \times 10^{-2}$ mm/mile) and none of the runners had both shoes in the high abrader category (average of all high abrader shoes = $3.34 \times 10^{-2} \pm 3.79 \times 10^{-2}$ mm/mile). Five (5) runners had a different classification for their right and left shoe.

Figure 3. Outsole wear rates of runners (n=56).

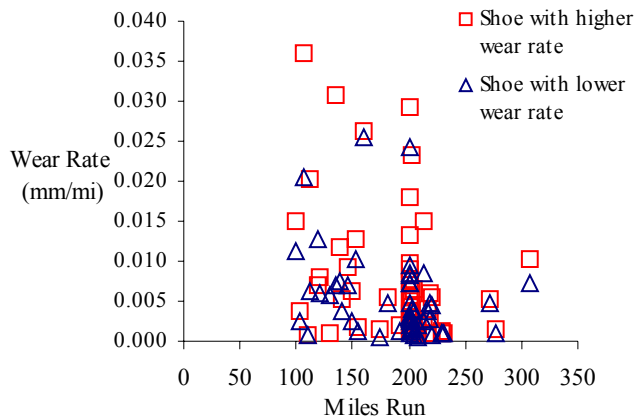
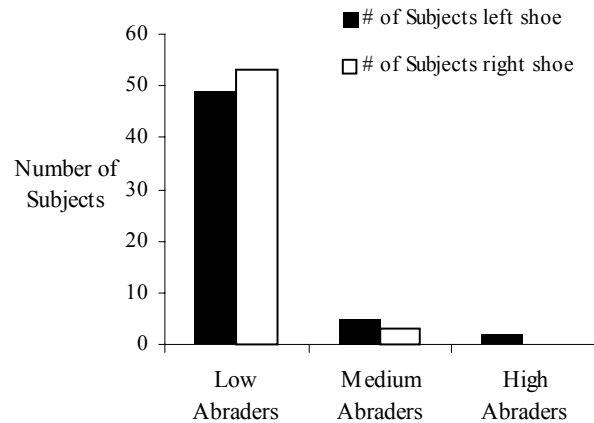


Figure 4. Number of runners by abrader category (n=56).



DISCUSSION

Although not statistically significant, the results of this study support previous findings of bilateral asymmetries within runners. The functional differences in the loading of the foot and tissues between right and left legs should not be ignored.

Outsole durability is an important topic in the footwear industry and it is common to measure the wear rate of different outsole rubber compounds. One method of testing different rubber compounds is to have runners wear a mixed pair of shoes in which the shoes are identical except for the outsole rubber (i.e., the right shoe and left shoe are made with 2 different rubber compounds). However, the results of this study suggest that shoes with different rubber compounds should be tested: 1) by runners with equal right and left wear rates, or 2) in consecutive wear tests with full pairs of shoes. In this second test design, the runners would wear a full pair of shoes with one rubber compound for a certain number of miles, followed by shoes with the second rubber compound for the same number of miles and under the same conditions. This design ensures that any difference in outsole wear rate between the shoes would be due to the intervention and not any asymmetry in outsole wear rate.

The majority of runners in this study fell into the low abrader category. Assuming an average outsole wear rate for low abraders of 0.451×10^{-2} mm/mile, a low abrading runner could conceivably run approximately 1100 miles before wearing through a 5 mm thick rubber outsole to the midsole underneath. However, low abrading runners will usually buy new running shoes after 400-500 miles due to other reasons such as decreased underfoot cushioning (Reebok International Ltd., unpublished). Medium and high outsole abraders may be able to run 220 and 150 miles, respectively, before wearing through the outsole.

REFERENCES

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