A Big Data Approach to Understanding How Marathon Shoes Affect Fatigue over the Boston Marathon**John Kuzmeski**1, Josh Cohen1, Wouter Hoogkamer1

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#### Summary

This study investigated the impact of advanced footwear technology (AFT) on marathon performance using data from the 2024 Boston Marathon. Race results and shoe types, identified via Marathonfoto.com images, were analyzed for sub-3-hour finishers. A custom web tool categorized shoes, grouping similar models (e.g., Nike Alphafly/Vaporfly). Statistical analysis (ANCOVA, Tukey's HSD) revealed significant decreases in pace between shoe types. Notably, the Adidas Adios was significantly slower than all others, while the Saucony Endorphin Pro 2 was slower than the Vaporfly and Asics Metaspeed Edge Paris. The Alphafly and Vaporfly were faster than the Asics model, with a significant difference also found between the Alphafly and Vaporfly. The results demonstrate that AFT significantly influences marathon pace, extending beyond short-distance metabolic benefits.

#### Introduction

#### The introduction of advanced footwear technology (AFT) in distance running has coincided with a period of improved performance, notably marked by a series of world record breakthroughs (Victor, 20XX). AFT is designed to reduce the metabolic cost of running at a given speed (Hoogkamer et al., 2018), however the testing for this takes part over short distances. While these metabolic improvements are significant it is not known if this carries over to events like the marathon. This study leverages a unique dataset from the Boston Marathon, combining publicly available race results with visual shoe identification from Marathonfoto.com. By analyzing a large cohort of runners completing the same course, we investigated the effect of various AFT models on marathon performance.

#### Methods

Race results and participant information were scraped from the official Boston Marathon website (<https://results.baa.org/2024/>). Data for any 3:00.00 finishers were collected. Data for each 5K split was used and speed was defined as average MPH over the split. A custom web-based image classification tool was developed to identify the type of shoe worn by each runner. The tool displayed public images of each runner's shoes from Marathonfoto.com and allowed for manual classification into predefined categories. For ease of classification, certain shoes were grouped as family, such as any Nike AlphaFly and Vaporfly variants, the same was done for Adidas Adios variant. As an initial analysis Repeated measures ANCOVA were used to compare the average pace of runners wearing different shoe types. Post-hoc analyses were conducted using Tukey's HSD to identify significant differences between specific shoe types.

Results and Discussion

Significant differences in marathon running speed were observed across shoe types (ANCOVA, p < 0.05). Post-hoc analysis (Tukey HSD) revealed that runners in the Adios family decreased speed the over the race more than all other shoes tested (all p < 0.05; mean differences ranging from 0.198 to 1.050 MPH). The Saucony Endorphin Pro 2 was also signifcantly slower than the the Vaporfly (p<0.001), and Asics Metaspeed Edge Paris (p<0.001). Both the Alphafly and Vaporfly were helfd pace better than the Asics Metaspeed Edge Paris (both p<0.001). There was a significant difference between the Alphafly and Vaporfly (p=0.0159). See Table 1. These findings suggest that shoe choice significantly impacts marathon running pace. A graph of different colored lines

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**Figure 1**: Expected abstracts for ISB2025 in January 2025.

#### Conclusions

Using large scale, in race data can provide insights into the impacts of AFT beyond just changes in metabolic power for a 5 minute trial.

#### References

**Table 1:** Adjusted mean difference between shoes

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Comparison | Adios vs. Vaporfly | Adios vs. Alphafly | Adios vs. Saucony EP2 | Adios vs. Asics MEP | Vaporfly vs. Alphafly | Vaporfly vs. Saucony EP2 | Vaporfly vs. Asics MEP | Alphafly vs. Saucony EP2 | Alphafly vs. Asics MEP | Saucony EP2 vs. Asics MEP |
| Adj. Mean Diff (MPH) | 0.761 | 0.9 | 1.05 | 0.198 | 0.139 | 0.289 | -0.563 | 0.15 | -0.702 | -0.852 |
| P-value | <0.001 | <0.001 | <0.001 | 0.048 | 0.016 | <0.001 | <0.001 | 0.029 | <0.001 | <0.001 |