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INFLUENCE OF DIFFERENT RUNNING SHOES, TIME OF USE AND INDIVIDUAL ADAPTATION ON THE VARIABILITY OF GROUND REACTION FORCE IN RUNNING

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SUMMARY
The aim of this study was to examine whether the natural variability in running increases due to different running shoes and mileages of use of these shoes on Ground Reaction Force. Three male long distance runners imposed a total mileage of 300km to three different running shoes. Data collection consisted of 10 minutes of familiarization, followed by two data acquisitions of 12 seconds, at 14km.h^{-1} of running speed and using a sampling frequency of 1000 Hz. The coefficient of variation (CV) was calculated for the different types of shoes (A, B and C) and in each phase of usage (new, 100km, 200km and 300km). It was verified that the variability low in all conditions and suffered no increase between the different running shoes or the mileages of use.

INTRODUCTION
The control of variability is important in studies investigating the responses of human movement to the running shoes [1,2].

The coefficient of variation in the vertical component of the Ground Reaction Force (GRF) is approximately 10% [3]. This variability, although natural and inherent to human movement complicates the interpretation of results of biomechanical tests, since it is difficult to distinguish it from the real influence of the running shoe [4].

In a study analyzing the variability inherent to human movement with the possible variations that different running shoes can promote [5], the authors observed that the variability of human movement is similar to the variability resulting obtained by using different types of running shoes.

Another study looked at different running shoes and insoles, verifying considerable variation between subjects, to the point of significant differences were seen only among subjects and not among the conditions [6].

The aim of this study was to examine whether the natural variability in running increases due to different running shoes and mileages of use of these shoes on Ground Reaction Force.

METHODS
Three male long distance runners took part in this study (32 ± 7 years, mean body mass of 65.33 ± 2.88 kg and average height of 1.69 ± 0.09 m). Three different brands of running shoes were used (A, B and C). Each runner received three running shoes, one of each brand. The three models of shoes were composed predominantly of EVA midsole, with some technology inherent in each brand.

The GRF was measured by *Gaitway Instrumented Treadmill* (9810S1x), consisting of a treadmill with two force platforms in series. Data collection occurred with the running shoe in four distinct phases, when new (New) and after 100 (100km), 200 (200km) and 300 (300km) mileages of use.

In each data collection, the subjects performed a familiarization with the treadmill for 10 minutes. At the end of 10 minutes, there were two data acquisitions of 12s, at 14km.h-1, with sampling frequency of 1kHz. This procedure was repeated with each shoe and at each stage of use.

From the vertical components of GRF, the coefficient of variability (CV) was calculated by grouping the stance phases at each mileage and running shoe condition for each subject. A two-way repeated measures ANOVA for repeated measures and post hoc Tukey of ($p < 0.05$) was used for statistical analysis.

RESULTS AND DISCUSSION
Table 1 shows the CV between different mileages of use. GRF data from each tested footwear and subjects were grouped. Although CV was low, there was higher variability in the intermediate mileages of usage.

To compare the different shoes, GRF curves were grouped from all the subjects, and in all conditions of use (Table 2). The CV of the shoe C was significantly lower than that of the other shoes.

The CVs between the shoes and along the mileages of use conditions of use were very similar (Table 3). The greater variability observed was 6.4% for the shoe A, and occurred at after 200km of use.

In all analyzed cases, the variability is within the range considered as natural to human movement [3] and can be are considered low for running.

A study comparing the variability of GRF of running shoes in new condition and after 320km observed no significant difference [7].

Another study showed greater variability in GRF depending on different days of collection (21.1% on the first day, 21.9% at 24 hours after collection and 21.5% after a week in the collection) and used shoes (21.6 %) [1]. Although the variability was greater than the observed on this study, the authors argue that the variability between conditions was not affected by the conditions and the natural variability of movement was similar to the variability imposed by the use of different shoes. The same trend was observed in this study, showing that the variability of GRF suffered more significant influences by varying the mileages of usage than by type of running shoes.

Although some significant differences were observed, the variability was low and could not be shown that the type of running shoe or the mileage of use have increased the variability in GRF.

Table 1: Mean and standard deviation of the coefficient of variation (CV) at different mileages of use (p≤0,05). (n=360)

	New	100km	200km	300km
CV(%)	5,0±2,5	5,3±2,9◊	5,7±3,5*◊	5,0±2,4

* indicates significant difference with the new condition.
◊ indicates significant difference with the condition 300km.

Table 2: Mean and standard deviation of the coefficient of variation (CV) at different running shoes (p≤0,05). (n=480)

Shoes	A	B	C
CV(%)	5,42±2,77*	5,41±3,26*	4,98±2,54

* indicates significant difference with shoe C.

Table 3: Mean and standard deviation of the coefficient of variation (CV) on the interaction of shoes in different mileages of use (p≤0,05). (n=120)

Shoes	A	B	C
New	4,9±2,4	5,2±2,4	4,9±2,6
100km	5,1±2,2	5,8±3,6 ◊	5,2±2,8
200km	6,4±3,7*◊	5,7±4,1 ◊	4,9±2,3 [ab]
300km	5,2±2,2	4,9±2,5	4,8±2,5

* indicates significant difference with the new condition.
◊ indicates significant difference with the condition 300km.
[a] indicates significant difference with shoe A.
[b] indicates significant difference with shoe B.

CONCLUSIONS

We conclude that the natural variability of human movement was minimally affected by the mileage of use and by the running shoes. It should be noticed that the variability produced by the interference of these factors could have been masked by natural variability inherent to human movement.

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