

DO IMPACTS CAUSE RUNNING INJURIES? A PROSPECTIVE INVESTIGATION

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INTRODUCTION

During running, the foot collides with the ground approximately 1000 times per mile. These collisions vary significantly by the strike pattern that the runner adopts. A rearfoot strike pattern results in a very distinct vertical impact peak that is missing in a midfoot or forefoot strike landing (Figure 1) [1]. The impact peak of a rearfoot strike is associated with higher rates of loading compared with a forefoot strike pattern. Impact peak magnitudes are also positively correlated to tibial shock. Interestingly, increased vertical impact peaks, loading rates and tibial shock have been associated with a history of tibial stress fractures [2], plantar fasciitis [3], and more recently, patellofemoral pain syndrome [4].

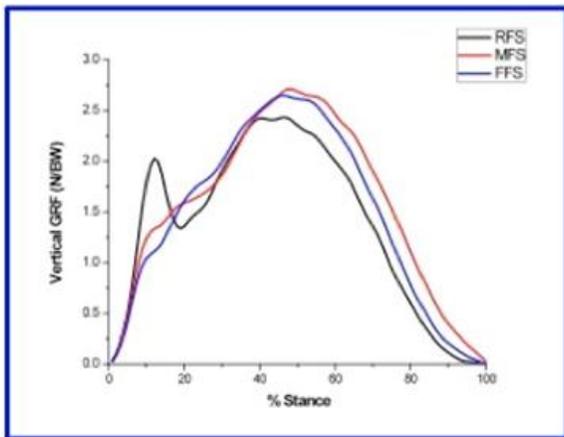


Figure 1. Vertical ground reaction force of a rearfoot, midfoot and forefoot strike landing.

Barefoot runners strike with a mid or forefoot strike pattern [5] as it hurts to land on their heels. Thus, it is possible that we were designed to run with a mid or forefoot strike pattern that is absent of this impact peak, thus lessening the impact loads to the body.

Up to 79% of runners sustain an injury in a given year [6]. Approximately 80% of shod runners are rearfoot strikers [7]. It is plausible that rearfoot strikers with increased impact loads, may be at greater risk for the development of an injury than those with lower loads.

In summary, previous studies have documented higher impact loading in runners with a history of injury. However, these studies were retrospective in nature and cannot establish causative relationships. Therefore, the purpose of this prospective study was to compare the impact loads of rearfoot strike runners who go on to develop a running injury to those who have never been injured. It was hypothesized that runners who went on to develop a running-related injury would have higher vertical impact peaks, vertical average loadrates, vertical instantaneous loadrates and peak tibial shock.

METHODS

240 female rearfoot strike runners, aged 18-40 years and running a minimum of 20 miles per week were recruited. Tibial accelerometry and ground reaction force data were collected at 1080 Hz as subjects ran overground at 3.5 m/s. The vertical impact peak (VIP), vertical average loadrate (VALR), vertical instantaneous loadrate (VILR) and peak tibial shock (TS) were extracted from 5 trials and averaged for each subject. In addition to the impact variables, peak vertical force (FZ) was assessed.

Running mileage and injuries were reported monthly for 2 years. Only injuries diagnosed by a medical professional were included. The impact loading variables were analyzed in the runners who went on to sustain an injury. These values were then compared to those of a group of runners who had never sustained a running related injury. Outliers were removed using a boxplot analysis. Independent t-tests were used to statistically assess the data. In addition, the four dependent variables (VIP, VILR, VALR, PPA) were entered separately into a forward binary logistic regression with the constant included. The odds to be injured were then calculated.

RESULTS AND DISCUSSION

A total of 242 female runners have been analyzed, to date (Figure 2). 139 (57%) sustained a prospective

injury. 70 (50%) of these sought medical attention and served as the injured (INJ) group. Of the 103 runners who did not sustain a prospective injury, only 22 had not been injured retrospectively either. This group served as the uninjured (UNINJ) group.

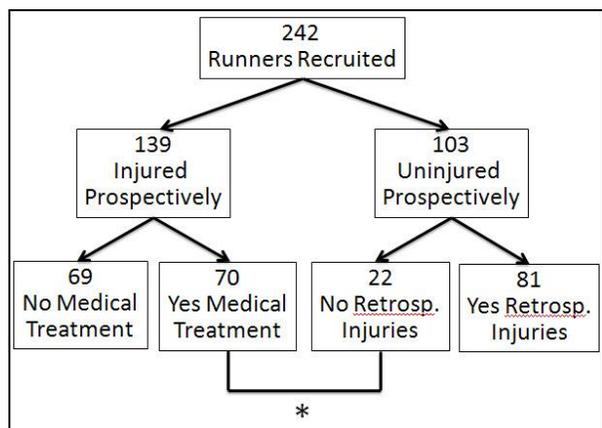


Figure 2. Breakdown of injured and uninjured groups. The ‘*’ indicates the two groups that were compared in this study.

The subjects were well-matched for age (INJ: 26.8±9.8 yrs; UNINJ: 25.5±10.3 yrs) and monthly mileage (INJ:107.6±43.1 miles; UNINJ: 97.0±30.9 miles). 125 injuries were medically diagnosed in the 70 INJ subjects. The top 5 prospective injuries are presented in Table 1.

Table 1. Top 5 injuries sustained prospectively

Injury	No.	% Total
Iliotibial Band Syndrome	14/125	11.2
Anterior Knee Pain	12/125	9.6
Tibial Stress Fracture	6/125	4.8
Tibial Stress Syndrome	6/125	4.8
Plantar Fasciitis	6/125	4.8
Total	44/125	35.2

Following the boxplot analysis, 1 subject was removed from the UNINJ group for TS, 1 for VALR. For the INJ group, 1 subject was removed for VILR, 2 for VIP and VALR, and 3 for TS. The resulting comparison of impact loading between the UNINJ and INJ groups is presented in Table 2

Table 2. Comparison of variables of interest between groups

Variable	UNINJ	INJ	P
TS (g)	4.8 (1.5)	5.9 (2.7)	0.018
VIP (bw)	1.5 (0.24)	1.7 (0.26)	0.041
VALR (bw/s)	62.4 (14.1)	72.1 (18.1)	0.028
VILR (bw/s)	77.0 (18.1)	84.5 (22.4)	0.157
FZ (bw)	2.5 (0.17)	2.5 (0.19)	0.961

Due to their significant contributions to distinguishing

between groups, VIP and AVLr were entered together into the logistic regression. Owing to shared variance, VIP was omitted and the final model was Odds = 1.035*AVLR*0.318 (1.035; 95%CI 1.003 to 1.069). Applying this to the AVLr group means resulted in odds to be injured of 3.2 times higher for the injured group than for non-injured group.

Our injury findings were consistent with previous literature. It has been reported that between 20-80% of runners get injured in a given year [6], and 57% of our runners sustained a prospective injury. In terms of injury distribution, iliotibial band syndrome, anterior knee pain, tibial stress syndrome and plantar fasciitis were also among the top five injuries in a much larger study of 2002 runners [8].

As hypothesized, all impact loading was greater in the injured runners compared with the never-injured group. All impact variables were significantly higher, except for VILR. Interestingly, FZ, the peak value of the vertical force, was identical between groups. This further underscores the importance of impact loads in the development of these injuries.

The fact that all running injuries were included increases the significance of these results. While it is recognized that the etiology of running injuries is multi-factorial, this suggests that impact loading may be a global indicator for the development of an injury. Based upon the odds ratio for VALR, reducing impacts is likely to result in an overall reduction of injury risk. Based on previous reports, adopting a midfoot or forefoot strike pattern will reduce these impacts. However future studies of injury patterns in midfoot and forefoot strike runners are needed.

CONCLUSIONS

Based upon the preliminary results of this study, it appears that an increase in impact loading amplifies the risk of developing a running-related injury.

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