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ACUTE EFFECTS OF LONG DISTANCE RUNNING ON PLANTAR FOOT PRESSURE DISTRIBUTION

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[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation

Abstract Twenty-six healthy men and women participated in this study in which 14 were long distance runners and remaining were control subjects. Following the initial assessment of foot pressure distribution, the runners were asked to complete the regular training program. Immediately after the run, foot pressure distribution was again assessed using the Zebris FDM-Treadmill. The parameters were analysed and compared with the pre-training data. The same parameters were also assessed for the control group at rest. Paired t-test was used to compare the foot pressure distribution before and after the run. Independent t-test was used to compare the same parameters between runners and control group. No significant changes were observed in runners post run whereas the control group showed significant changes in the foot pressure distribution of right forefoot and backfoot when compared to long distance runners at rest. The findings of the study suggest that the foot pressure distribution is not affected acutely after the long distance running. The future studies could analyse the plantar pressure measurement throughout the training programs to detect the time and nature of the deviations linked to long distance run, which would help in injury prevention.

Key words: runners, backfoot, forefoot, stance, plantar pressure

1. Introduction

In human locomotion, the foot serves as the last link in the kinematic chain. The foot aids in the management of the delicate muscle activity required to maintain balance while standing. Walking requires the foot to perform two roles, a passive role that cushions the impact forces that the human body is exposed to during walking and running, and an active function that transfers the internal forces created by the muscles to the ground in order to accelerate the body during push-off (Rosenbaum & Becker, 1997).

In recent years, health-focused activities as well as competitively oriented events, such as road races with distances ranging from 5 km to the traditional marathon distance of 42.2 km, have become popular. However, it is

unsurprising that, as a result of these changes, the number of running-related and overload injuries has increased (Nagel et al., 2008).

Running for an extended period of time puts a lot of pressure on the lower body, particularly the knees, ankles, and feet (Hong et al., 2012; García-Pérez et al., 2013). Long-distance runners' plantar pressure may be affected by accumulating loads on the foot. Plantar pressure is a biomechanical metric that coaches and players can use to manage or prevent foot injuries such as skin issues and stress fractures (Willems et al., 2012; Bisiaux & Moretto, 2008). As a result, understanding the impact of running on plantar pressure can aid in the prevention of foot ailments such as stress fractures.

Therefore, the aim of this study is to assess the acute effects of long distance running on plantar pressure weight distribution.

2. Material and Methods

26 healthy men and women (14 long distance runners and 12 control group) were involved in this study and were informed about the testing procedures and written informed consent was obtained. Runners were included if they had completed at least half/one full marathon and they were excluded based on any recent history of neurological diseases, surgery, trauma, any neuromuscular or cardiovascular pathology. The control group was selected under the same age group as runners and were excluded if they were involved in any sporting activity.

2.1. Ethics Approval

This study was conducted upon the prior consent of Ethical Committee of Guru Nanak Dev University, Amritsar (752/HG) and it was consistent with the provisions of the Declaration of Helsinki.

2.2. Experimental procedure

2.2.1. Pre run analysis

The runners filled a subjective data form including their name, age, height, weight etc. and they were asked to fill an injury history questionnaire which included questions related to their running history, injuries related to running, their weekly average duration and speed etc (Hespanhol Junior et al., 2012).

The plantar foot weight distribution was assessed using the Zebris-FDM treadmill. The participants stood in their relaxed stance position with double-limb support, their arms relaxed at their sides, and looking straight ahead; they were required to stand still in that position for approximately 30 sec, and they were instructed to take several steps, marching on the spot, prior to setting into a comfortable stance position. The system was calibrated each time with a new participant. Weight distribution of both left and right foot was taken (left forefoot %, backfoot %, and total %; right forefoot %, backfoot %, and total %). The control group under the same age were also recruited and were asked to follow the similar procedure. These results were compared with the pre run data of the runners.

2.2.2. Post run analysis

After the initial assessment of the pre run analysis for runners, the runners were asked to complete their regular training of running for different distances according to their experience. Immediately following the run, foot pressure distribution was again recorded and analysed and compared to the pre run data. The runners were given general cool down stretches by the trained physiotherapist

3. Statistical Analysis

The data was analysed using Statistical Package for Social Sciences (IBM SPSS Statistics version 28.0) software. Results were considered statistically significant if p value was less than 0.05. Independent t-test was used to compare the foot pressure distribution of runners and control group at rest followed by paired t-test used to compare the gait parameters pre and post the run.

4. Results

The anthropometric data of all the participants is shown in table 1 with mean age (39.62), mean height (165.31), mean weight (73.50) and mean BMI (24.281).

Table 1. Summary of anthropometric data of the participants

Characteristics	Mean (N = 26)	SD
Age	39.620	6.1390
Height	165.310	20.0470
Weight	73.500	23.0900
BMI	24.281	2.7287

Table 2 & figure 1 show the comparison of the foot pressure distribution in long distance runners pre and post run. There were no significant changes observed between the left and right foot of the runners before and after the run.

Table 2. Comparison of static foot pressure distribution in runners pre and post run

Parameter	Pre		Post		t value	p value	Cohen's d
	Mean (n = 9)	SD	Mean (n = 9)	SD			
Left forefoot pressure (%)	41.78	11.649	40.33	15.596	0.435	0.675	0.145
Left backfoot pressure (%)	58.22	11.649	61.89	11.591	–1.301	0.230	–0.434
Total (%)	53.78	12.696	50.56	3.167	0.789	0.453	0.263
Right forefoot pressure (%)	45.14	9.512	45.43	12.150	–0.073	0.944	–0.028
Right backfoot pressure (%)	54.86	9.512	54.57	12.150	0.073	0.944	0.028
Total (%)	49.57	3.994	49.14	3.288	0.817	0.817	0.091

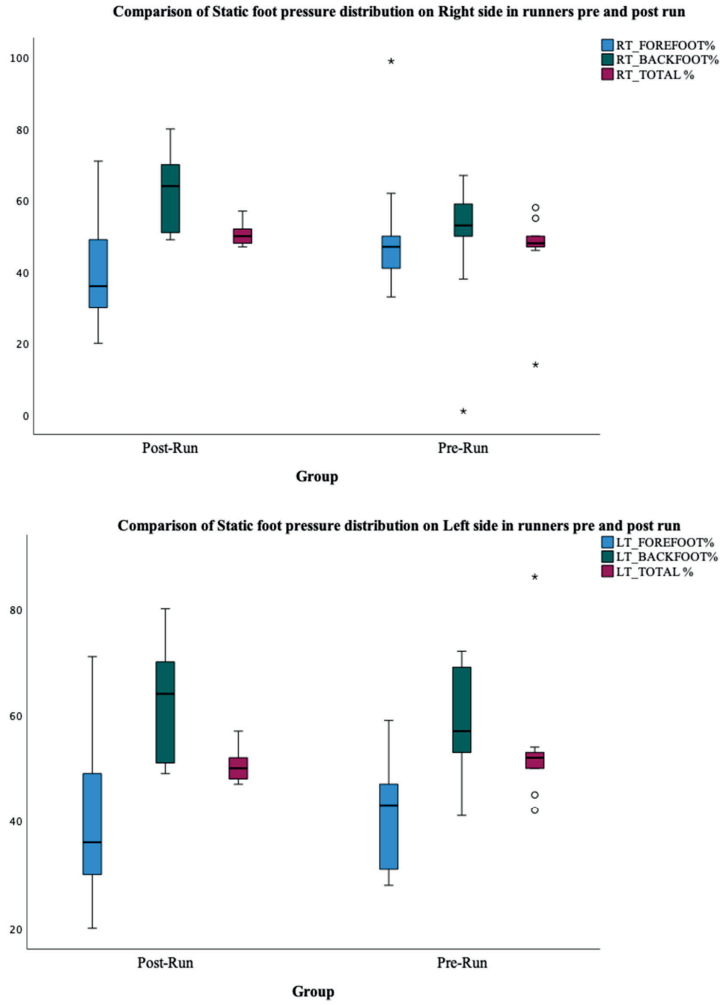

Figure 1. Comparison of Static foot Pressure Distribution in Runners Pre and Post Run

Table 3 & figure 2 show the foot pressure distribution during static stance between the left and right foot of the runners and control group at rest which shows significant difference in right forefoot and backfoot pressure.

Table 3. Comparison of static foot pressure distribution between runners and control group at rest

Parameter	Runners		Control		t value	p value	Cohen's d
	Mean (n = 14)	SD	Mean (n = 12)	SD			
Left forefoot pressure (%)	40.93	11.855	38.42	6.947	0.644	0.526	0.253
Left backfoot pressure (%)	59.07	11.855	61.58	6.947	–0.644	0.526	–0.253

Parameter	Runners		Control		t value	p value	Cohen's d
	Mean (n = 14)	SD	Mean (n = 12)	SD			
Total (%)	52.64	10.360	48.83	6.132	1.115	0.276	0.439
Right forefoot pressure (%)	53.07	16.936	40.45	11.827	2.097	**0.047***	0.845
Right backfoot pressure (%)	46.93	16.936	59.55	11.827	–2.097	**0.047***	–0.845
Total (%)	48.07	10.528	52.09	5.486	–1.146	0.263	–0.462

* statistically significant at $p < 0.05$

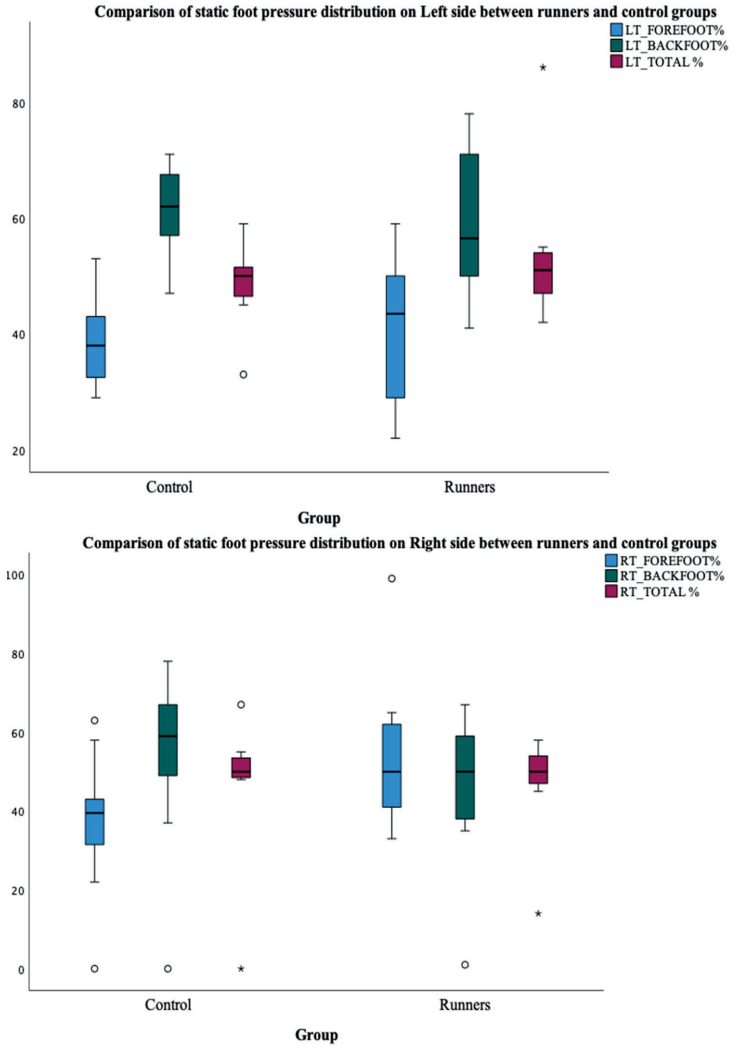

Figure 2. Comparison of Static foot Pressure Distribution between Runners and Control Groups Fig.1 Comparison of Static foot Pressure Distribution in Runners Pre and Post Run

5. Discussion

The purpose of the present study was to assess the acute effects of long distribution on plantar foot pressure weight distribution. In this study, there were no significant changes observed among runners pre and post run whereas on the other hand, comparing the runners with control group, there were significant differences observed in the right forefoot and backfoot pressure.

5.1. Static foot pressure distribution of the long distance runners pre and post training:

There were no significant changes found in the foot pressure distribution pre and post training which is similar to the results found by Rocha et al. (2014), where they concluded that static assessment of plantar pressure are less sensitive after 21 km and more sensitive after 10 km. Thus, as the runners in the current study ran more than 30 km, this could be the reason behind the non-significant change in foot pressure distribution after training.

5.2. Static foot pressure distribution between runners and control group:

In the current study, static foot pressure distribution among the control group was analysed and compared to the runners. According to our knowledge, this is the first study which compared the static foot pressure distribution between long distance runners and non-runners. There were significant changes found in the weight distribution of the right forefoot and backfoot ($p < 0.05$) when comparing the runners with the control group. The reason behind this significant variation can be due to habituation of the runners to strike their foot with the forefoot (forefoot strikers) or rearfoot (rearfoot strikers) and hence tends to bear more weight on that region of the foot. Also, as the BMI increases with age in adults, it leads to less stance stability and less motor response and hence, the variation can be seen in the runners and control group as runners tend to maintain their healthy BMI and therefore have better stability (Salsabili et al., 2011; Ku et al., 2012).

6. Conclusion

The present results show that the long distance running didn't influence the Plantar foot pressure distribution but the control group showed significant changes in foot pressure distribution when compared to runners. This explains that the runners adapt to these characteristics to enhance their running economy and hence, tend to adopt a pattern of striking their foot in a certain manner. The future studies could analyse the plantar pressure measurement throughout the training programs to detect the time and nature of the deviations linked to long distance run, which would help in injury prevention.

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References

Bisiaux, M., & Moretto, P. (2008). The effects of fatigue on plantar pressure distribution in walking. *Gait & Posture*, *28*(4), 693–698. https://doi.org/10.1016/j.gaitpost.2008.05.009

García-Pérez, J. A., Pérez-Soriano, P., Llana, S., Martínez-Nova, A., & Sánchez-Zuriaga, D. (2013). Effect of overground vs treadmill running on plantar pressure: Influence of fatigue. *Gait & Posture*, *38*(4), 929–933. https://doi.org/10.1016/j.gaitpost.2013.04.026

Hespanhol Junior, L. C., Costa, L. O. P., Carvalho, A. C. A., & Lopes, A. D. (2012). A description of training characteristics and its association with previous musculoskeletal injuries in recreational runners: A cross-sectional study. *Revista Brasileira De Fisioterapia (Sao Carlos (Sao Paulo, Brazil))*, *16*(1), 46–53.

Hong, Y., Wang, L., Li, J. X., & Zhou, J. H. (2012). Comparison of plantar loads during treadmill and overground running. *Journal of Science and Medicine in Sport*, *15*(6), 554–560. https://doi.org/10.1016/j.jsams.2012.01.004

Ku, P. X., Abu Osman, N. A., Yusof, A., & Wan Abas, W. A. B. (2012). Biomechanical evaluation of the relationship between postural control and body mass index. *Journal of Biomechanics*, *45*(9), 1638–1642. https://doi.org/10.1016/j.jbiomech.2012.03.029

Nagel, A., Fernholz, F., Kibele, C., & Rosenbaum, D. (2008). Long distance running increases plantar pressures beneath the metatarsal heads: A barefoot walking investigation of 200 marathon runners. *Gait & Posture*, *27*(1), 152–155. https://doi.org/10.1016/j.gaitpost.2006.12.012

Rocha, E. S. da, Machado, Á. S., Kunzler, M. R., & Carpes, F. P. (2014). Influence of running distance on plantar pressure. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *16*, 563–569. https://doi.org/10.5007/1980-0037.2014v16n5p563

Rosenbaum, D., & Becker, H.-P. (1997). Plantar pressure distribution measurements. Technical background and clinical applications. *Foot and Ankle Surgery*, *3*(1), 1–14. https://doi.org/10.1046/j.1460-9584.1997.00043.x

Salsabili, H., Bahrpeyma, F., Forogh, B., & Rajabali, S. (2011). Dynamic stability training improves standing balance control in neuropathic patients with type 2 diabetes. *Journal of Rehabilitation Research and Development*, *48*(7), 775–786. https://doi.org/10.1682/jrrd.2010.08.0160

Willems, T. M., De Ridder, R., & Roosen, P. (2012). The effect of a long-distance run on plantar pressure distribution during running. *Gait & Posture*, *35*(3), 405–409. https://doi.org/10.1016/j.gaitpost.2011.10.362

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