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Impact of anthropometric measures on medial arch height in half marathon runners

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ABSTRACT

The foot has been reported to be the site of injury in long distance runners in 5.7- 39.3% of all reported running injuries compared to the ankle (3.9% to 16.6%), knee (7.2% to 50.0%) and lower leg (9.0% to 32.2%). The integrity of foot arches plays a vital role in providing shock absorption in runners. Navicular height is a clinically approved reliable representation of medial arch height. Here navicular height was normalized to truncated foot length. This study is mainly intended to analyze whether anthropometric measures such as the height, weight and (BMI) to have an impact on medial arch height of the feet. Objective of this study is to find the correlation between anthropometric measurements and navicular height. 25 half marathon runners (13 females and 12 males) aged between 17 to 22 years were selected for this cross-sectional study, using convenient sampling method. The anthropometric measures like height, weight and BMI were taken. Medial arch height was measured by measuring navicular height in weight bearing position using the standardized protocol. Then navicular height was normalized to truncated foot length. All measurements were taken on both feet and analysed statistically. Normality test was established by Shapiro-Wilk test. As data has followed normal distribution, Pearson correlation coefficient (r) was used to report the association between the variables. BMI correlated negatively to normalized navicular height on both the feet (right r = -0.23 and left foot r = -0.52 respectively). Weight also correlated negatively to navicular height on both sides (right r = -0.28 and left r = - 0.52). Height correlated negatively to navicular height on both feet (right r = -0.18 and left r= -0.46). Two tailed independent t-test revealed no statistically significant gender difference on navicular height (right p= 0.41 and left p= 0.15). This present study revealed minimum to moderate degree of inverse correlation between anthropometric measurements and navicular height on the left side and little correlation on right side.

Key Words: Half Marathon Runners, BMI, Truncated Foot Length, Navicular Height

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INTRODUCTION

The foot has been reported to be the site of injury in long distance runners in 5.7 to 39.3% of all reported running injuries compared to the ankle (3.9% to 16.6%), knee (7.2% to 50.0%) and lower leg (9.0% to 32.2%)[1]. The morphology and functional development of the foot are influenced by internal factors such as sex, genetics and age and external factors such as footwear habits, loading, and physical activity [2]. The ground reaction force (GRF) upon impact, "is considered to be the most basic element which causes running related injuries". There was statistically significant increase in peak plantar pressure with midfoot area out of six plantar regions when obese subjects (BMI 30.0_34.99 kg/m2) were compared to non-obese controls [3]. These excessive impact forces reported to limit the ability of the medial longitudinal arch occurs in the form of increased plantar contact area within the region of the midfoot [4]. Further research is recommended to identify the appropriate method to normalize loading rates either to mass or to another covariate [5]. Lieberman et al studied the impact forces that the feet encounters while running barefoot and shod in different style namely forefoot running and heel strike running [6]. They also explained how these changes in different running pattern causes changes in effective mass and potential injuries in runners. But they have not given importance in correlating anthropometrics to load impact in runners. The integrity of foot arches plays a vital role in providing shock absorption in runners. But how far anthropometric measures have impact on medial arch of foot is not completely proven. Arzu Erden et al aimed to compare the level of medial longitudinal arch drop, ankle joint range of motion and extension of the hallux in males and females and to correlate these values with body mass index on one hundred sixty-three healthy students aged between 18 and 26 in which 74 female and 89 male included [7]. They reported that medial arch drop was greater in individuals with a higher than normal weight in males and in total subjects.

Very few studies [8] have evaluated anthropometric measures to medial arch height changes in healthy adults. But findings on half marathon runners were consistent with their centre of pressure pathways which remained more medial in low arched individuals and more lateral in high arched individuals during a short, non-fatiguing run. But the responses to prolonged cyclic mechanical stress along with different anthropometrics to have any impact on architecture of foot arch were not explored. BMI did not predict the change in arch height of half marathon runners [9]. Navicular height is a valuable predictor of medial arch height and characterization of foot arch. Yet their navicular height assessment has not been normalized to foot length to provide valid information for generalization.

Navicular height [10] (ICCs greater than 0.94), [11] measurement is a clinically approved reliable representation of medial arch height. Normalized truncated navicular height [12] was found to be a valid tool against radiological methods and also a reliable clinical method to measure medial arch height. This study is mainly intended to correlate whether anthopometrics have any impact on medial arch height of foot.

MATERIALS AND METHODS

Objective:
To find correlation between anthropometric measurements and medial arch height of foot in half marathon runners.

Methodology:
25 half marathon runners (13 females and 12 males) aged between 18 and 25 were selected for this cross-sectional study, authors adapted convenient sampling method to select subjects who fulfilled inclusion criteria. Alva's Institutional ethical review board approval was obtained. Patient consent form was used before including subjects for this study. Inclusion criteria were half marathon runners, runners who ran on both soil ground as well as on road equally selected, participation in endurance running for 3 years and above, age group between 18 to 25 years. Subjects were excluded if they had congenital lower limb deformities, trauma in the feet other than sports related, athlete with auto immune disorder, athlete with metabolic diseases and smokers.

Procedure
Once the subjects were included, their height and weight was assessed, through which BMI of the subjects were calculated. To measure medial arch height of foot normalized for participants with different foot length, truncated navicular height measure was used. Subject was made to assume relaxed standing position with feet positioned shoulder width apart. Navicular tuberosity was noted and marked with water soluble marker [Fig: 1]. Navicular height was measured using metal ruler placed perpendicular to navicular tuberosity [Fig: 3] and the distance measured from the most medial prominence of the navicular tuberosity to the supporting surface.

Fig: 1 Navicular tuberosity was noted and marked

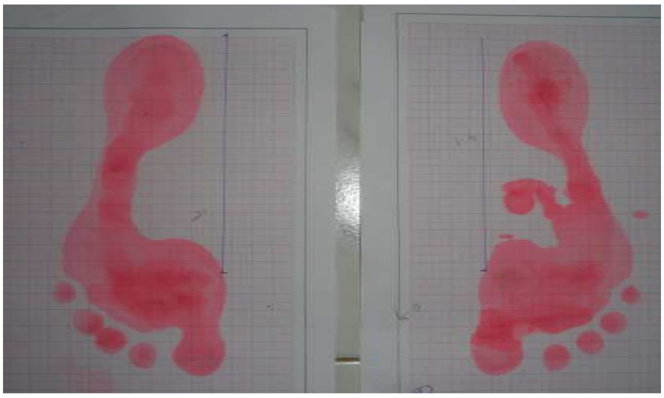

Fig: 2 Footprint on the graph sheet

Fig: 3 Navicular height is measured using metal ruler

Then subjects were made to stand on two graph sheets placed in front of them after dipping their feet in ink diluted tray for generating foot print [Fig:2]. Demarcation of first MTP joint in foot print is made maintaining that position on the graph. To calculate truncated foot length, distance between the two lines perpendicularly drawn from first MTP joint and from the most posterior aspect of the heel calculated [Fig4]

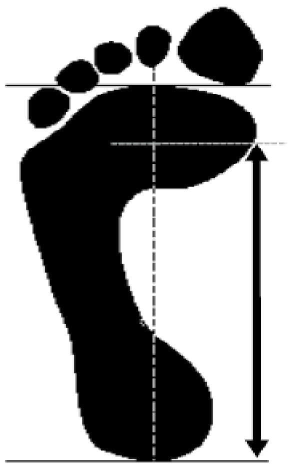

Fig: 4 Measurement of truncated foot length

Then navicular height was divided by truncated foot length to derive normalized foot arch height. Values are documented as normal arch foot if NNH value were 0.22 - 0.31. If NNH values were > 0.18, that was documented as Flat foot. The anthropometric measures like height, weight, and truncated foot length were taken. These measurements were taken on both feet of every subjects participated in the study and analyzed statistically.

RESULTS

For statistical analysis purpose, normality test was established by Shapiro-Wilk test. As data collected followed normal distribution, Pearson correlation coefficient (r) was used to report the association between the variables. Results revealed that BMI correlated negatively to normalized navicular height on both the feet (right r = -0.23 and left foot r = -0.52 respectively). Weight also correlated negatively to navicular height on both sides (right r = - 0.28 and left r = - 0.52). Height correlated negatively to navicular height on both feet (right r = -0.18 and left r= - 0.46). Two tailed independent t-test revealed no statistically significant gender difference on normalized navicular height (right p= 0.41 and left p= 0.15).

DISCUSSION

This study resulted in negative correlation of BMI to normalized navicular height on both the feet (right r = -0.23 and left foot r = -0.52 respectively). Weight also correlated negatively to navicular height on both sides (right r = - 0.28 and left r = - 0.52). Height correlated negatively to navicular height on both feet (right r = -0.18 and left r= - 0.46)) in which left foot showed more negative correlation in medial arch height in relation to BMI, body mass alone and height alone . Thus it goes well with the findings of Emma Cowley and colleague, in which a significant drop was recorded in navicular height in left foot alone in half marathon runners where navicular drop was assessed during pre-race and post-race conditions using Foot Posture Index (FPI). Though they have not explained the time taken for recovery of post-race navicular drop, (which was hypothesized to be the result of fatigue of soft tissues) on left foot of the participants to pre race values. One of the draw backs in their study was that they did not normalize navicular height to the length of the foot. They have further reported that BMI did not predict the change in arch height in half marathon runners. Their study subjects with larger foot sizes had higher FPI values, whereas taller and heavier participants had lower FPI values. One study has reported that FPI-6 should be used with extreme caution and may actually have limited value, especially from a research perspective [13]. Karagounis et al found significant variations in foot loading characteristics especially in the peak pressure and impulse values under the forefoot and toe regions immediately after spartathalon race [14]. When they tested it 24 hours later, measurements revealed insignificant changes from pre race state, which he reasoned probably of local restoration of muscular activity. H B Menz explained the influence of leg dominance resulting in differences in lower limb kinematics and kinetics between the two sides [15]. Gender variation reveals no significance of difference on navicular height to anthropometrics in this study despite size and length variation of feet among genders reported by previous studies [16,17]. Thus in one way truncated navicular height measurement is one of the clinically most valid tool to characterize foot arch regardless of gender difference. One of the major limitation of this study is that participants leg or hand dominancy were not taken into account in order to understand why anthropometric measures selected in these study exhibited negative impact more on participants left foot medial arch height.

CONCLUSION

This current study revealed minimum to moderate degree of inverse correlation between anthropometric measurements and navicular height on the left side and little correlation on right side. This might be of great importance in the view of researcher in exploring more number of samples to extrapolate the results for running population in terms devising strategies in preventing runners with BMI related injuries. More confirmation can also be obtained from dynamic force plate analysis in treadmill between left and right foot with anthropometrics. Hand dominancy of athletes also is of great concern in the result of this study. This study also sheds light for the shoe manufacturers to take into account the body anthropometrics and its moderate negative effect foot arch, while they think of prescribing morphology based right and left running shoe.

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