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Does foot wear influence the occurrence of foot defects, deformities and diseases in long and middle distance runners?- An analytic cross sectional study

Watson Arulsingh[1] and Ganesh S Pai[2]

Alva's college of Physiotherapy and Research Centre, Moodbidri. Mangalore Taluk. D.K.
Professor &Medical Director, Derma Care, Mangalore., D.K

ABSTRACT

As controversy persists in the claims of barefoot running versus modernized running shoe in gaining advantage over injury prevention in running. Though literature goes on saying ill fitted shoes can cause foot problems like onychocryptosis, hyperidrosis, bromidrosis, hallux Valgus, hallux varus, arch collapse and the like. No studies have exclusively tested the correlation of shoe components to the occurrence of foot defects, deformities and diseases in endurance runners. 77 middle and long distance shod runners were chosen for this study to be screened for their various foot defects, deformities and diseases with validated tools. Bivariate non parametric test used to correlate shoe components to foot disorders. In the result shoe upper material made up of mesh correlated negatively with foot deformities. Shoe outer material made up of plastic correlated positively with foot defects r=0.35 and heel-forefoot height difference above 3cm correlated positively r=0.23 with foot defects. When shoe fixation components correlated, board lasting type had shown positive correlation of r=0.36 to occurrence of foot defects and positive correlation with foot deformities. Combination type had shown negative correlation with foot defects and also with foot deformities. Forefoot flexion point at proximal to first MTP joint correlated negatively with the occurrence of foot deformities (r=-.24) and forefoot flexion point at distal to first MTP joint correlated positively with foot defects (r=0.19). Shoes with fair motion control exhibited negative correlation to foot defects and medially tilted upper exhibited positive correlation (r=0.26). Shoes with no midsole wear pattern (MSWP) exhibited negative correlation to foot deformity and medially tilted wear pattern positive correlated. Shoes with normal way of outer sole wear pattern (OSWP) exhibited positive correlation to foot diseases and laterally worn OSWP exhibited positive correlation to foot deformities. All these variables discussed here have shown statistical significance.

Key words: Hallux valgus, corn, Tinea pedis, Callosities, Foot wear, Ingrown toe nail.

INTRODUCTION

Experts believe that most athletic shoes, with their inflexible soles, structured sides and super-cushioned inserts keep feet so restricted that they may actually be making your feet lazy, weak and more prone to injury. Few researchers [1,25]reported that athlete's foot does not occur among people who traditionally go barefoot. They reported that wearing shoes could facilitate this problem.

Footwear that fails to respect natural foot shape and function will ultimately alter the morphology and the biomechanical behaviour of the foot.[26] Another study found that Onychocryptosis, Hyperidrosis, Bromidrosis, Hallux Valgus, Hallux Varus, Bursitis at the first or fifth metatarso phalangeal articulations more evident in people who wore shoes. This survey conformed that hallux valgus will not develop if footgear are not worn. [9]

Another survey [13] reported the occurrence of hallux valgus with barefoot walker compared to shod people. Proper nail care with nonrestrictive footgear is necessary to prevent onychocryptosis. People who have never worn shoes were reported to acquire very few foot defects, most of which are painless and non-debilitating. Barefoot walkers were found with wider feet and more equally distributed peak pressures more uniformly than in habitually shod subjects[7]. But runner's feet in shod condition and the responses to prolonged cyclic mechanical stress on architecture of foot arch were not explored[9].

Samuel B et al stated the range of foot motions are remarkably great in barefooted people, allowing for full foot activity. It's moisture, sweating and lack of proper ventilation of the feet that present the perfect setting for the fungus of athlete's foot to grow[1]. Ill-fit shoes can contribute to abnormal foot mechanics and areas of excessive pressure will cause foot pain, bunions, corns or plantar warts [14].

Though various foot defects and diseases were claimed to have been produced by ill-fitted shoes used, none of the studies have neither explored various components of sports shoes and their relationship with the foot disorders.

This present study was intended to thoroughly screen the foot defects, deformities and diseases of shod runners and also explore the relationship of shoe components to the occurrence of foot defects, deformities and diseases.

MATERIALS AND METHODS

It is a cross-sectional study which was carried out on south Karnataka district from 2009 to 2014 as it is a part of major research programme.

:

Material used

Stadiometer, vernier caliper, weighing scale, goniometer ruler,life size photographs of defects, deformities and diseases of feet, colour ink, graph sheets, colour, metal scale, magnifier, pencil and knee hammer, 16 megafixel sony camera (10 optical zoom). **Figure 1**

Figure 1 Materials Used in this study.

PROCEDURE:

This current study was focused on 77 shod endurance runners participated in shod runner's group. Alva's institutional ethical review board committee approval was obtained. Adult long, middle distance shod and barefoot runners participating in event minimum of three years duration with the age group between 18 to 55 years and controls of same age group were included in study. Both genders were included. Individual with congenital deformities of foot, trauma in the feet other than running related, systemic disease affecting lower limb, having a history of or suspicious of diabetic, gout and any other neurologically affected foot were excluded for this study. Hypothesis was that whether runner's various components shoe correlate with the occurrence of foot defects, foot deformities and foot diseases in them.

Screened foot defects:
Black toenail, thick toenail, Bunions, neuromas, march fracture, jones fracture. tarsal tunnel syndrome, blisters, corns, callosities, fissures, Ingrown toe nail, calcaneal prominence.

Screened foot deformities:
overriding toe, hallux valgus, curly toe, hammer toe, hallux flexus, hallux rigidus, pes planes, claw toe, mallet toe, foot splaying, calcaneo varus, calcaneo valgus, forefoot valgus, forefoot varus.

Screened foot diseases:
Plantar warts, tinea pidea and toe nail Fungus**.**

To Identify Hallux valgus deformity :
The Manchester Scale was used [2,24]. Life-size versions of the photographs(Figure2) of grading of validated hallux valgus deformities were used and laminated. Subjects were asked to stand on an elevated platform and were instructed to walk for a few steps and then stand in a relaxed position. Life size photographs were kept alongside subjects' weight-bearing feet, and matching photo's with which participants degree of hallux valgus deformity determined.

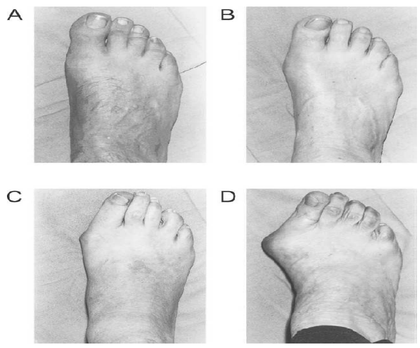

Figure 2 Illustrate the image of Life size photographs used to screen hallux valgus

To Screening hallux rigidus of great toe :
Coughlin MJ's and colleagues method of Screening hallux rigidus of great toe was carried out[20]. To screen hallux rigidus, extension of first MTP joint is measured with goniometer foot in plantigrade position. Subject is made to stand on the wooden box, goniometer's immovable arm was placed parallel to edges of box along subjects first metacarpal bone and movable arm placed to the bisection of the proximal and distal phalanx of the great toe[9]. Subjects were asked to do great toe dorsiflexion in closed kinetic position . 45^0 to 55^o of dorsiflexion considered normal Figure 3 .If subject experiences pain with limited great toe extension, was sent for radiograph analysis for osteophyte formation and changes in joint and to be diagnosed and conformed by orthopaedic surgeon. Then Hallux rigidus were graded as per following grading validated by Coughlin and Shurnas**.**

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Figure 3 . Illustrate evaluation of first MTP ROM

Figure 4 . Illustrate evaluation of first MTP ROM

Figure 4,5,6,7 . Illustrate evaluation forefoot and rear foot angle.

To screen forefoot:

Kirsten & Irene grading was used to identify fore foot & rear foot deformities[19,27,28,20]. The subject was asked to assume prone lying position with measuring foot and ankle to be extended approximately 6 inches off the plinth. The opposite extremity will be placed in slight knee flexion and with abduction, flexion and external rotation of the hip. Evaluator's thumb and index finger were used to palpate the medial and lateral talar head, become prominent repectively with pronation and supination of subtalar joint where subtalar joint neutral position was obtained.Then examiner applied a dorsiflexion loading force to the forefoot, with the thumb and index finger holding the foot in the toe sulcus across the lesser toes until a firm resistance was felt. Forefoot position will be determined by placing the stationary arm of the goniometer perpendicular to the calcaneal bisection and the movable arm parallel to the second to fifth metatarsal heads. If positive degrees obtained that is Forefoot varus, neutral if it (0º), or if negative degrees obtained that is forefoot valgus **Figure 4**. Angle was determined as the angle between the perpendicular to the bisection of the calcaneus and an imaginary line drawn through the metatarsal heads.

To determine rear foot alignment:
Subjects were made to assume original position adapted for forefoot angle measurement. The vernier caliper was positioned at the medial and lateral borders of the lower leg at 8 and 6 inches above the calcaneum, and both the midpoints were marked with a water soluble marker. **Figure 5,6**. A vertical line was drawn between the two midpoints to create the bisection line in calf. To draw a calcaneal bisection line, midpoints at both the superior and inferior aspects of the calcaneum by palpating the medial and lateral borders of the calcaneum and midpoint was located by using a flexible ruler marking a dot at midpoints **Figure 7**. Then vertically connect these two midpoints to make posterior calcaneal bisection line. Then subject was asked to stand on the wooden box. Evaluator used palpation technique to feel for talar dome congruency, placed the subject's foot in subtalar joint if necessary and goniometer ruler was aligned parallel to bisection of lower leg against calcaneal bisection lines, the angle was recorded **Figure 8**. More than 6 degree of calcaneal tilt from neutral was considered as rear foot varus and valgus.

To screen type of foot arch: [11]
To screen flat foot normalized navicular height (NNH) was calculated. Subjects were made to assume relaxed standing position with feet positioned shoulder width apart. Navicular tuberosity was marked with water soluble marker Figure 8. Navicular height was measured using metal ruler placed perpendicular to navicular tuberosity to the supporting surface. 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 (Figure 9). 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. 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 was documented as Flat foot. illustrate foot print taken for truncated foot length.

Figure 8&9 . Illustrate evaluation normalized navicular height truncated.

Standard photographs of various diseases for this study approved by dermatologist used to grade various foot diseases and defects are employed[15,3]. Criteria for identifying corns, calluses and verrucas are followed as per guidelines given by Snider RK and others[20,21,22]. Callosities, corns, warts are differentiated by its location, appearance, type of onset, direct pressure, side to side pressure and confirmed by dermatologist who is the second author of this study Figure10,11. To screen tarsal tunnel syndrome (TTS), tinel's sign was tested by tapping behind medial malleolus with knee hammer to see the provocation of symptoms pertaining to TTS.

Figure 10 image of ingrown toe nail. **Figure 11 image of tinea pedia.**

Procedure of shoe evaluation:
Shoe properties were evaluated by tools developed by Christian J Barton[4]and colleagues and numerical values are additionally included for statistical calculations.

Fit of the shoe:
An objective measurement using a custom built Brannock-style device utilised to find the difference between shoe length **Figure 13** and foot length (SL-FL) **Figure 12**. Then the value was compared to the footwear owner's thumb width. If the SL-FL difference was less than half the breadth of owner's thumb's width ,Fit of the shoe was categorised as short (score2) and if more than half the breadth of owner's thumb's width foot wear was considered too long for the wearer (score 3). Other is good (score1)

Figure 12&13 illustrate how foot and shoe length evaluated

Width – grasp test
To measure the adequacy of footwear width, the upper over the metatarsal heads were grasped and then categorized footwear as too wide-score 3 (excessive bunching of the upper), good –score 1(slight bunching of the upper), or too narrow-score2 (tight, taught upper unable to be grasped).

Depth
Examining shoes upper for the ability of the toes and joints to move freely, and the absence of pressure on the dorsal aspect of the toes and nails was categorized as depth as adequate (score1) or too shallow (score2).

Age of the shoe:
This was categorized as value 1= 1-6months, 2= 6-12months, 3= >12months

Shoe material (Upper) was categorized as,
1=Lether,2=Synthetic, 3=Mesh,4=other

Shoe material (Outer) was categorized as,1=Rubber,2=Plastic, 3=Leather,4=other

Heel height
Measurement was recorded as the average of the height medially and laterally from the base of the heel to the centre of the heel-sole interface. It was categorized as 1= 0-2.5cm,2= 2.5-5cm, 3= >5cm.

Fore foot height measurement
This measurement was taken at the level of both the first and fifth metatarsophalangeal joints and the average of both recorded. It was categorized as 1=0-0.9 cm, 2=1-2 cm, 3= >2 cm.

Heel – forefoot difference
The obtained two values from earlier procedure were then normalised by dividing it by the length of the shoe. Heel – forefoot difference was categorized as, 1=Flat (0-0.9cm), 2=small heel raise (1-3cm), 3=high heels (>3cm).

Last type
The last shape was measured by bisecting the heel and forefoot areas on the shoe sole, and then measuring the angular difference between the two using a plastic goniometric ruler with its axis positioned in the centre of the shoe**.** Last type was categorized in to straight last (0 to 5°), semicurved last(5 to 15°), and curved last(> 15°).Value was given as, 1=straight (< 5°), 2=semi-curved (5 – 15°), 3=curved (> 15°).

Shoe fixation
It was categorized as Board lasted (1), Combination (2)**,** Slip lasted (3).

Forefoot sole flexion point
To measure this, a sagittal bending force was applied to the shoe's sole and the point at which the bend occurred was noted. Then it was categorized **Figure 26,** At level of MTPJs(1), Proximal to 1st MTPJ(2), Distal to 1st MTPJ.

Motion control was tested with Table 1[4]
Midsole density explored.

Heel counter stiffness
To measure this, the heel counter was pressed with firm force approximately 20 mm from its base and the angular displacement estimated. Then it was categerised as firm,hard and soft.

Figure 14 illustrate how heel counter stiffness evaluated

Midfoot sole sagittal stability
To measure this, both the rearfoot and forefoot components of the shoe were grasped and attempts were made to bend the shoe at the midfoot in the sagittal plane Figure 14. Then they were categorised as minimal, moderate and rigid.

Figure 15 illustrate how sagittal stability of shoe was tested

Midfoot sole frontal stability (torsion)

To measure this, both the rearfoot and forefoot components of the shoe were grasped and attempts were made to twist the shoe at the midfoot in the frontal plane Figure 16. Then they were categorised as minimal, moderate and rigid.

Table 1 illustrate how frontal stability of shoe was tested

MOTION CONTROL PROPERTIES SCALE

	Score			
Item	0	1	2	3
Midsole density layers	Single density		Dual density	
Fixation (upper to foot)	None	Alternative to laces (e.g. strap, Velcro, zip, etc.)	Laces (at least 3 eyelets)	
Heel counter stiffness	No heel counter	Minimal	Moderate	Rigid
Midfoot sagittal stability	Minimal	Moderate	Rigid	
Midfoot torsional stability	Minimal	Moderate	Rigid	

Score was:0-2: poor,3-6: fair, >6 : good

Cushioning:
Cushioning was graded if it were used additionally
1=None,2=heel,3=heel&forefoot

Lateral and medial midsole hardness
Here firm pressure exhibited from the examiner's thumb at medial and lateral midsole, minimal to no indentation (< 0.5 mm) was marked hard, moderate indentation (0.5 – 1.5 mm) was marked firm, and marked indentation (> 1.5 mm) was recorded as soft. Figure 17.

Figure 17 illustrate how lateral midsole harness tested

Classified as
1=soft, 2=firm,3=Hard.

Heel sole hardness
It is measured under firm pressure from the examiner's thumb at the foot (inferior heel)-shoe interface Figure18.Then categarised as soft, firm and hard.

Figure 18 illustrate how heel sole harness was tested

Wear patterns
Upper
Foot wear upper is observed for tilt pattern. Then it was categorised as neutral, medial tilt greater than 10°, which may indicate excessive pronation, or lateral tilt greater than 10°, which may indicate excessive supination.

Midsole
Foot wear midsole is observed for compression sign.Then this item was categorised as neutral, medial tilt (medial midsole compression), which may indicate excessive pronation,or lateral tilt (lateral midsole compression), which may indicate excessive supination .

Tread pattern
Tread pattern of the foot wear in its outer sole was divided into two items consisting of textured or smooth; and no wear, partly worn, or fully worn.

Outer sole wear pattern
Wear pattern of outer sole observed here. This item was then categorized as none, normal is starting posterior lateral heel and moving medially towards the first ray distally along the shoe, medial is greater medial than lateral wear at the heel and forefoot, which may indicate excessive pronation, or lateral is greater lateral than medial wear at the heel and forefoot, which may indicate excessive supination .

Wear pattern was classified as

A. Upper wear pattern was subclassified with numerical value as1=neutral**,** 2=medial tilt**,** 3=lateral tilt.

B. Midsole wear pattern as1=neutral**,** 2=medial compression and 3=lateral compression.

C. Textured pattern as 1=textured and 2=Smooth.

D. Outsole wear pattern as 1=None**,** 2=Normal**,** 3=Lateral and 4=Medial.

VALIDITY, RELIABILITY OF OUTCOME MEASURES USED:
1. The Manchester scale are reported to have r=0.77 and 0.86, when correlated with radiological method.

2. Kirsten & Irene[19] grading forefoot and rear foot angle stated that the ICC for reliability was 0.95 for the measurement of the forefoot angle, 0.91 for the relaxed rear foot angle. Researchers[28, 20] further concluded that intertester reliability for closed kinetic chain (CKC) measurements (ICC value of .75 and .95) was superior to that of Open Kinetic Chain measurements in rearfoot and fore foot angle measurement, because the error of passive foot positioning was eliminated in the CKC.

3. A study[11] explored correlation between clinical measures like arch index and normalized navicular height truncated to radiographic measures in foot arch categorization. All correlations were statistically significant, with the associations ranging from moderate to strong (r = 0.24 to 0.70). Of the two clinical measures, normalized navicular height provided the strongest association with all radiographic angles measured from both the A-P and lateral views. Thus truncated navicular height (TNH) was recommended to classify foot posture in research until further light is shed to determine foot posture variations in the sagittal, transverse or both planes to provide the best descriptor of the flat-arched foot.

4. Hattrup and Johnson described a radiographic classification which has become standard, and in fact correlates quite well with the Regnauld grading. Recently Coughlin[5] et al (2003) modified the Hattrup and Johnson classification to create new classification system to grade hallux rigidus.

5. Kappes Ups [15] clinical photographic method adopted for screening foot diseases with the approval of dermatologist as second author of this study**.**

6. Shoe assessment tool used here reported [4] to have excellent intra-rater (ICC = 0.91– 1.00) and inter-rater reliability (ICC = 0.90 – 1.00) for continuous items in the tool, including the motion control properties scale (ICC=0.91 – 0.95) with the exception of last shape (ICC=.63-.74), thumb width measurement (ICC=.69), and the difference between shoe length and foot length(ICC=0.83-.87).

STATISTICAL ANALYSIS:
Descriptive analysis of all type of foot defects, deformities and disease observed. As datas were not following normality, Spearman correlation analysis was used to see correlation between shoe components to the occurrence of foot defects, deformities and disease. To screen confounding variables age, BMI correlated to the occurrence of foot defects, deformities and disease.

RESULTS

In the result of statistical analysis, Table 2 provides percentage of gender participation in this study. Table 3 provides descriptive data of age, BMI and foot disorders observed among runners. Age has exhibited positive correlation to the incidence foot defects, deformities r=0.388, 0.36, correlation was significant at 0.01 level (p=0.00, 0.001) and to foot disease r= 0.23 significant at 0.05 level p= 0.02 Table 4. BMI on the other hand exhibited positive correlation was significant at 0.01 level, r=0.36, 0.50 to the incidence foot defects, deformities (p=0.001, 0.00). Figure 19 shows the scattered diagram of age and BMI of runners participated in this study.

Table 2 shows the percentage of gender who participated.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	66	85.7	85.7	85.7
	2.00	11	14.3	14.3	100.0
	Total	77	100.0	100.0	

Table 3. Descriptive Statistics of age, BMI with observed variables.

Variables	Mean	Std. Deviation	N
AGE	21.5844	8.37344	77
BMI	19.9429	3.25441	77
FOOTDEFECTS	1.4545	.99400	77
DEFORMITIES	.7922	1.09229	77
DISEASES	.3896	.63154	77

Table4. Correlations between Age, BMI to foot problems

		AGE	BMI	FOOT DEFECTS	DEFORMITIES	DISEASES
AGE	Pearson Correlation	1	.679**	.338**	.363**	.233*
	Sig. (2-tailed)		.000	.003	.001	.042
	N	77	77	77	77	77
BMI	Pearson Correlation	.679**	1	.367**	.503**	.113
	Sig. (2-tailed)	.000		.001	.000	.326
	N	77	77	77	77	77
FOOTDEFECTS	Pearson Correlation	.338**	.367**	1	.294**	-.013
	Sig. (2-tailed)	.003	.001		.009	.908
	N	77	77	77	77	77
DEFORMITIES	Pearson Correlation	.363**	.503**	.294**	1	.100
	Sig. (2-tailed)	.001	.000	.009		.388
	N	77	77	77	77	77
DISEASES	Pearson Correlation	.233*	.113	-.013	.100	1
	Sig. (2-tailed)	.042	.326	.908	.388	
	N	77	77	77	77	77

***. Correlation is significant at the 0.01 level (2-tailed).*

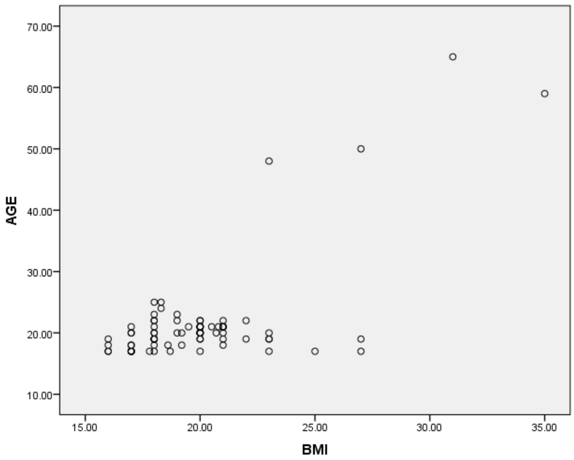

Figure 19 shows scattered diagram of age & BMI

Shoe upper material made up of mesh correlated negatively and significant at 0.01 level with foot deformities r= - 0.31with p=0.006 is shown inTable5. Shoe outer material made up of plastic correlated positively with foot defects r=0.35 at 0.01 level p=0.001 given in Table 6. Heel-forefoot height difference above 3cm correlated positively at 0.05 significant level r=0.23 with foot defects occurrence shown in Table 8. When shoe fixation components correlated Table 7, board lasting type had shown positive correlation, significant at 0.01 level r=0.36 with the p value of 0.001 to the occurrence of foot defects in shod runners. But combination type had shown negative correlation and significant at 0.01 level with foot defects r= - 0.31 with the p value of 0.05. Forefoot flexion point at prximal to first MTP joint correlated positively and significant at 0.05 level with the occurrence of foot defects r=0.19 with p=0.08 is shown in Table 13. Shoes with fair motion control exhibited negative correlation and significant at 0.05 level to foot defects r=-0.22 and p=0.02 (Table12) and medially worn upper of shoe exhibited positive correlation significant at 0.05 level r=0.26 is shown in Table9. Shoes with no midsole wear pattern (MSWP) exhibited negative correlation and significant at 0.01 level to foot deformity r=-.38 and medially tilted wear pattern positive correlated and significant at 0.01 level r=0.302 to foot deformities (Table11). Shoes with normal way of outer sole wear pattern (OSWP) exhibited positive correlation and significant at 0.05 level (Table 10) to foot diseases r=0.26 and laterally worn OSWP exhibited positive correlation and significant at 0.05 level to foot deformities r=0.23. All tables in which correlation was seen has been given. Mean age of participants were 21±8.3, BMI 19±3.25. Mean foot defects observed were 1.45±0.99 and foot deformities were 0.79±1.09 and foot diseases were 0.38±0.63. This result has not given all tables except the variables tested correlated strongly with the occurrence foot defects, deformities and diseases.

Table 5 shows correlation between shoe upper materials to foot disorder

Correlations

Spearman's rho		Shoe upper leather	Synthetic	Mesh	other	Foot defects	Foot deformities	Foot diseases
Shoe material upper Leather	Correlation Coefficient	1.000	-.239*	-.202	-.143	.079	.039	-.108
	Sig. (2-tailed)	.	.037	.079	.215	.493	.737	.349
	N	77	77	77	77	77	77	77
Synthetic	Correlation Coefficient	-.239*	1.000	-.569**	-.404**	.118	.155	-.082
	Sig. (2-tailed)	.037	.	.000	.000	.309	.178	.477
	N	77	77	77	77	77	77	77
Mesh	Correlation Coefficient	-.202	-.569**	1.000	-.341**	-.185	-.313**	.032
	Sig. (2-tailed)	.079	.000	.	.002	.107	.006	.784
	N	77	77	77	77	77	77	77
others	Correlation Coefficient	-.143	-.404**	-.341**	1.000	.019	.152	.137
	Sig. (2-tailed)	.215	.000	.002	.	.867	.188	.233

	N	77	77	77	77	77	77	77
Foot defects	Correlation Coefficient	.079	.118	-.185	.019	1.000	.148	.151
	Sig. (2-tailed)	.493	.309	.107	.867	.	.200	.191
	N	77	77	77	77	77	77	77
Foot deformities	Correlation Coefficient	.039	.155	-.313**	.152	.148	1.000	.016
	Sig. (2-tailed)	.737	.178	.006	.188	.200	.	.889
	N	77	77	77	77	77	77	77
Foot diseases	Correlation Coefficient	-.108	-.082	.032	.137	.151	.016	1.000
	Sig. (2-tailed)	.349	.477	.784	.233	.191	.889	.
	N	77	77	77	77	77	77	77

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

Table 5 shows correlation between shoe upper materials to foot disorder

Correlations

Spearman's rho		Shoe material outer of rubber	Of plastic	Of others	Foot defects	Foot deformities	Foot diseases
Shoe material outer of rubber	Correlation Coefficient	1.000	-.460**	-.778**	-.106	-.065	-.006
	Sig. (2-tailed)	.	.000	.000	.360	.574	.961
	N	77	77	77	77	77	76
Of plastic	Correlation Coefficient	-.460**	1.000	-.143	.358**	.172	.103
	Sig. (2-tailed)	.000	.	.215	.001	.135	.377
	N	77	77	77	77	77	76
Of others	Correlation Coefficient	-.778**	-.143	1.000	-.171	-.015	-.041
	Sig. (2-tailed)	.000	.215	.	.137	.898	.726
	N	77	77	77	77	77	76
Foot defects	Correlation Coefficient	-.106	.358**	-.171	1.000	.148	.092
	Sig. (2-tailed)	.360	.001	.137	.	.200	.431
	N	77	77	77	77	77	76
Foot deformities	Correlation Coefficient	-.065	.172	-.015	.148	1.000	-.004
	Sig. (2-tailed)	.574	.135	.898	.200	.	.973
	N	77	77	77	77	77	76
Foot diseases	Correlation Coefficient	-.006	.103	-.041	.092	-.004	1.000
	Sig. (2-tailed)	.961	.377	.726	.431	.973	.
	N	76	76	76	76	76	76

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6 shows correlation between shoe outer materials to foot disorder

Spearman's rho		Shoefixation board lasted	Combination	Footdefects	Footdeformities	Footdiseases
Shoefixation boardlasted	Correlation Coefficient	1.000	-.902**	.365**	.191	.076
	Sig. (2-tailed)	.	.000	.001	.096	.512
	N	77	77	77	77	76
Combination type	Correlation Coefficient	-.902**	1.000	-.319**	-.191	-.017
	Sig. (2-tailed)	.000	.	.005	.096	.885
	N	77	77	77	77	76

Footdefects	Correlation Coefficient	.365**	-.319**	1.000	.148	.092
	Sig. (2-tailed)	.001	.005	.	.200	.431
	N	77	77	77	77	76
Footdeformities	Correlation Coefficient	.191	-.191	.148	1.000	-.004
	Sig. (2-tailed)	.096	.096	.200	.	.973
	N	77	77	77	77	76
Footdiseases	Correlation Coefficient	.076	-.017	.092	-.004	1.000
	Sig. (2-tailed)	.512	.885	.431	.973	.
	N	76	76	76	76	76

Table7 illustrate correlations of shoe fixation type to foot disorders

Spearman's rho		Heel height forefoot difference 0to1cm	1 to 3 cm	Above 3 cm	Foot defects	Foot deformities	Foot diseases
Heel height forefoot difference upto1cm	Correlation Coefficient	1.000	-.770**	-.230*	-.168	.028	-.034
	Sig. (2-tailed)	.	.000	.044	.143	.808	.769
	N	77	77	77	77	77	76
1 to 3 cm	Correlation Coefficient	-.770**	1.000	-.443**	.004	-.141	.139
	Sig. (2-tailed)	.000	.	.000	.970	.221	.231
	N	77	77	77	77	77	76
Above 3 cm	Correlation Coefficient	-.230*	-.443**	1.000	.230*	.176	-.164
	Sig. (2-tailed)	.044	.000	.	.044	.126	.158
	N	77	77	77	77	77	76
Foot defects	Correlation Coefficient	-.168	.004	.230*	1.000	.148	.092
	Sig. (2-tailed)	.143	.970	.044	.	.200	.431
	N	77	77	77	77	77	76
Foot deformities	Correlation Coefficient	.028	-.141	.176	.148	1.000	-.004
	Sig. (2-tailed)	.808	.221	.126	.200	.	.973
	N	77	77	77	77	77	76
Foot diseases	Correlation Coefficient	-.034	.139	-.164	.092	-.004	1.000
	Sig. (2-tailed)	.769	.231	.158	.431	.973	.
	N	76	76	76	76	76	76

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 8 shows correlation between shoe heel height to forefoot difference to foot disorder in three parts

Spearman's rho		UW pattern Neutral	Medially tilted	Laterally tiled	Foot defects	Foot deformities	Foot diseases
UW pattern Neutral	Correlation Coefficient	1.000	-.651**	-.596**	-.056	-.176	-.025
	Sig. (2-tailed)	.	.000	.000	.626	.126	.828
	N	77	77	77	77	77	76
Medially tilted	Correlation Coefficient	-.651**	1.000	-.222	.263*	.197	-.063
	Sig. (2-tailed)	.000	.	.053	.021	.086	.588
	N	77	77	77	77	77	76
Laterally tiled	Correlation Coefficient	-.596**	-.222	1.000	-.206	.017	.099
	Sig. (2-tailed)	.000	.053	.	.073	.880	.394
	N	77	77	77	77	77	76
Foot defects	Correlation Coefficient	-.056	.263*	-.206	1.000	.148	.092
	Sig. (2-tailed)	.626	.021	.073	.	.200	.431
	N	77	77	77	77	77	76
Foot deformities	Correlation Coefficient	-.176	.197	.017	.148	1.000	-.004
	Sig. (2-tailed)	.126	.086	.880	.200	.	.973
	N	77	77	77	77	77	76
Foot diseases	Correlation Coefficient	-.025	-.063	.099	.092	-.004	1.000
	Sig. (2-tailed)	.828	.588	.394	.431	.973	.
	N	76	76	76	76	76	76

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 9 shows correlation of Upper Wear pattern to foot disorders.
Correlations

Spearman's rho		MSW pattern Neutal	Mediallytilted	Laterallytilted	Foot defects	Foot deformities	Foot diseases
MSWpattern Neutral	Correlation Coefficient	1.000	-.767**	-.546**	-.118	-.385**	.017
	Sig. (2-tailed)	.	.000	.000	.306	.001	.885
	N	77	77	77	77	77	76
Medially tilted	Correlation Coefficient	-.767**	1.000	-.119	.208	.302**	.029
	Sig. (2-tailed)	.000	.	.304	.070	.008	.801
	N	77	77	77	77	77	76
Laterally tilted	Correlation Coefficient	-.546**	-.119	1.000	-.089	.201	-.064
	Sig. (2-tailed)	.000	.304	.	.444	.080	.580
	N	77	77	77	77	77	76
Foot defects	Correlation Coefficient	-.118	.208	-.089	1.000	.148	.092
	Sig. (2-tailed)	.306	.070	.444	.	.200	.431
	N	77	77	77	77	77	76
Foot deformities	Correlation Coefficient	-.385**	.302**	.201	.148	1.000	-.004
	Sig. (2-tailed)	.001	.008	.080	.200	.	.973
	N	77	77	77	77	77	76
Foot diseases	Correlation Coefficient	.017	.029	-.064	.092	-.004	1.000
	Sig. (2-tailed)	.885	.801	.580	.431	.973	.
	N	76	76	76	76	76	76

***. Correlation is significant at the 0.01 level (2-tailed).*

Table10 shows correlation of Outersole wear pattern pattern to foot disorders
Correlations

Spearman's rho		OSW Pattern None	Normal	Mediallytilted	Laterally tilted	Foot defects	Foot deformities	Footdiseases
OSW Pattern-None	Correlation Coefficient	1.000	-.499**	-.138	-.065	-.010	-.063	-.125
	Sig. (2-tailed)	.	.000	.235	.579	.933	.590	.286
	N	76	76	76	76	76	76	75
Normal	Correlation Coefficient	-.499**	1.000	-.658**	-.359**	-.129	-.153	.268*
	Sig. (2-tailed)	.000	.	.000	.001	.265	.185	.019
	N	76	77	77	77	77	77	76
Medially tilted	Correlation Coefficient	-.138	-.658**	1.000	-.101	.147	.102	-.144
	Sig. (2-tailed)	.235	.000	.	.384	.202	.379	.215
	N	76	77	77	77	77	77	76
Laterally tilted	Correlation Coefficient	-.065	-.359**	-.101	1.000	.029	.235*	-.159
	Sig. (2-tailed)	.579	.001	.384	.	.801	.039	.170
	N	76	77	77	77	77	77	76
Footdefects	Correlation Coefficient	-.010	-.129	.147	.029	1.000	.148	.092
	Sig. (2-tailed)	.933	.265	.202	.801	.	.200	.431
	N	76	77	77	77	77	77	76
Foot deformities	Correlation Coefficient	-.063	-.153	.102	.235*	.148	1.000	-.004
	Sig. (2-tailed)	.590	.185	.379	.039	.200	.	.973
	N	76	77	77	77	77	77	76
Footdiseases	Correlation Coefficient	-.125	.268*	-.144	-.159	.092	-.004	1.000
	Sig. (2-tailed)	.286	.019	.215	.170	.431	.973	.
	N	75	76	76	76	76	76	76

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table11shows correlation of MSWmidsole wear pattern of shoe to foot disorders
Correlations

Spearman's rho		Motion Control poor	Fair	Good	Foot defects	Foot deformities	Foot diseases
Motioncontrol poor	Correlation Coefficient	1.000	-.602**	-.203	.154	.193	-.070
	Sig. (2-tailed)	.	.000	.077	.182	.093	.548
	N	77	77	77	77	77	76
Fair	Correlation Coefficient	-.602**	1.000	-.660**	-.228*	-.043	.031
	Sig. (2-tailed)	.000	.	.000	.046	.707	.789
	N	77	77	77	77	77	76
Good	Correlation Coefficient	-.203	-.660**	1.000	.135	-.128	.028
	Sig. (2-tailed)	.077	.000	.	.242	.268	.813
	N	77	77	77	77	77	76
Footdefects	Correlation Coefficient	.154	-.228*	.135	1.000	.148	.092
	Sig. (2-tailed)	.182	.046	.242	.	.200	.431
	N	77	77	77	77	77	76
Footdeformities	Correlation Coefficient	.193	-.043	-.128	.148	1.000	-.004
	Sig. (2-tailed)	.093	.707	.268	.200	.	.973
	N	77	77	77	77	77	76
Footdiseases	Correlation Coefficient	-.070	.031	.028	.092	-.004	1.000
	Sig. (2-tailed)	.548	.789	.813	.431	.973	.
	N	76	76	76	76	76	76

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

Table12 shows correlation of motion control property of shoe to foot disorders

Correlations

Spearman's rho		Fore foot Flexion point MTP level	Proximal to MTP	Distal to MTP	Footdefects	Foot deformities	Foot diseases
FFootflexpoint MTPlevel	Correlation Coefficient	1.000	-.689**	-.346**	-.052	.125	.025
	Sig. (2-tailed)	.	.000	.002	.655	.278	.827
	N	77	77	77	77	77	76
Proximal to MTP	Correlation Coefficient	-.689**	1.000	-.442**	-.102	-.249*	.044
	Sig. (2-tailed)	.000	.	.000	.378	.029	.703
	N	77	77	77	77	77	76
Distal to MTP	Correlation Coefficient	-.346**	-.442**	1.000	.196	.167	-.091
	Sig. (2-tailed)	.002	.000	.	.088	.147	.433
	N	77	77	77	77	77	76
Footdefects	Correlation Coefficient	-.052	-.102	.196	1.000	.148	.092
	Sig. (2-tailed)	.655	.378	.088	.	.200	.431
	N	77	77	77	77	77	76
Footdeformities	Correlation Coefficient	.125	-.249*	.167	.148	1.000	-.004
	Sig. (2-tailed)	.278	.029	.147	.200	.	.973
	N	77	77	77	77	77	76
Footdiseases	Correlation Coefficient	.025	.044	-.091	.092	-.004	1.000
	Sig. (2-tailed)	.827	.703	.433	.431	.973	.
	N	76	76	76	76	76	76

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table13 shows correlation of forefoot flexion point to foot disorders

Spearman's rho		MSW pattern Neutal	Mediallytilted	Laterallytilted	Foot defects	Foot deformities	Foot diseases
MSWpattern Neutral	Correlation Coefficient	1.000	-.767**	-.546**	-.118	-.385**	.017
	Sig. (2-tailed)	.	.000	.000	.306	.001	.885
	N	77	77	77	77	77	76
Medially tilted	Correlation Coefficient	-.767**	1.000	-.119	.208	.302**	.029
	Sig. (2-tailed)	.000	.	.304	.070	.008	.801
	N	77	77	77	77	77	76
Laterally tilted	Correlation Coefficient	-.546**	-.119	1.000	-.089	.201	-.064
	Sig. (2-tailed)	.000	.304	.	.444	.080	.580
	N	77	77	77	77	77	76
Foot defects	Correlation Coefficient	-.118	.208	-.089	1.000	.148	.092
	Sig. (2-tailed)	.306	.070	.444	.	.200	.431
	N	77	77	77	77	77	76
Foot deformities	Correlation Coefficient	-.385**	.302**	.201	.148	1.000	-.004
	Sig. (2-tailed)	.001	.008	.080	.200	.	.973
	N	77	77	77	77	77	76
Foot diseases	Correlation Coefficient	.017	.029	-.064	.092	-.004	1.000
	Sig. (2-tailed)	.885	.801	.580	.431	.973	.
	N	76	76	76	76	76	76

***. Correlation is significant at the 0.01 level (2-tailed).*

DISCUSSION

With the outcome of analysis, age has exhibited positive correlation with the incidence foot defects, deformities and diseases with statistical significance. BMI on the other hand exhibited positive correlation to the incidence foot defects, deformities with statistical significance. Shoe upper material made up of mesh correlated negatively with foot deformities. Shoe outer material made up of plastic correlated positively with foot defects with statistical high significance. However plastic outer material was reported to improve the aesthetics of footwear [4]. Heel-forefoot height difference above 3cm correlated positively with foot defects occurrence with statistical significance. High-heeled shoes have also been implicated in the development of low back pain[24], osteoarthritis of the knee [17,18] and forefoot [6,30] and hallux valgus and calluses in older people. A study reported moderate shank curve shoes even out plantar pressure and reduces the occurrence of foot problems [31]. When shoe fixation components correlated, board lasting type had shown positive correlation with high significance to occurrence of foot defects. It has also shown positive correlation with foot deformities as well. Board lasting footwear is thought to provide greater stability, however, it is heavier, may be less comfortable and is considered a more expensive manufacturing process than slip lasting [23]. Combination type had shown negative correlation with foot defects with high significance and also with foot deformities negatively. Slip lasted shoe fixation type could not be correlated to foot problems as only 3 runners used who participated in this study. Forefoot flexion point at proximal to first MTP joint correlated negatively with the occurrence of foot deformities had shown high significance. Forefoot flexion point at distal to first MTP joint correlated positively with the occurrence of foot defects had shown the significance. A flexion point distal to the level of the first metatarso phalangeal joint (1st MPJ) may limit gait efficiency due to altered kinematics which result from inhibition of normal 1st MPJ function [12].Truncated navicular height (TNH) was used to classify foot posture in this study. Yet this would not be a best descriptor of the flat-arched foot in terms of analyzing variation of foot posture in the sagittal, transverse or both planes. FPI-6 can be an option. But yet Mark W et al (2008) reported that FPI-6 should be used with extreme caution and may actually have limited value, especially from a research perspective [23].

CONCLUSION

This study exclusively screened the defects, deformities and diseases of shod runner's foot with valid tools. When shoe's general components correlated to the occurrence of foot defects, deformities and diseases of shod runner's, age, BMI, shoe upper made up of mesh, outer material made up of plastic and heel-forefoot height difference of above 3cm, board lasting type, combination type of shoes and forefoot flexion point proximal more than distal has shown correlation. Motion control, upper and midsole, outer sole wear pattern exhibited correlation with statistical significance. This study will give new dimension to shoe makers in order to reduce the incidence of foot defects, deformities and diseases in runners. Runners and coaches intern can be selective for better shoe that can help lessen the foot ailments and in turn to heighten the performance.

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