THE RESEARCH ON THE DISTURBUTION OF PRESSURE ON THE SOLES OF ELITE MIDDLE DISTANCE RUNNERS (800-1500 m)[3]

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ABSTRACT

The aim of this research is to analyze the impact of long-term trainings of middle distance runners in athletics to the distribution of pressure on the soles by comparing the peak pressure which belongs to the areas of the soles of healthy individuals, average maximal pressure, and pressure-time integral pedobarographic parameters; with elite male middle distance runners.18 elite middle distance runners (age average; 20.25±3.6) who have no feet complaint and who have taken part in Turkish National Championships of Athletics; and as the control group, 25 voluntary males (age average; 26.10±2.40) have participated in this research. The sole pressure measurement of the volunteers was made by using EMED-SF (Novel H, Munich, Germany) plantar pressure analysis system (pedobarographic analysis). The data used SPSS 18.0 package program. According to the measurement of elite middle distance runners' and control group's 11 measuring range in both right and left foot, and with regard to the comparisons among peak pressure, average maximal pressure, and pressure-time integral; the variation between the averages of right and left foot 2. Metatarsus was found statistically meaningful (P<0.01-0.05). As a result, it is ascertained that, trainings cause variances in the parameters of peak pressure, average maximal pressure, and pressure-time integral; which belong to the areas on the soles of elite middle distance runners. It is important to say that characteristic running types - which have been seen as a result of life-long trainings - affect the sole pressure distributions; ergonomic design, which is used in the production of middle distance running shoes, is made according to this particular branch; yet the differences between the toes of take-off foot (generally left) and the tossing foot (generally right) in pressure distribution especially in the production of shoes for middle distance runners must be considered.

Keywords: Athletics, middle distance runners, sole, pressure, metatarsus

ELİT ORTA MESAFE (800-1500 m) KOŞUCULARINDA AYAK TABANI BASINÇ DAĞILIMLARININ ARAŞTIRILMASI*

ÖZ

Bu araştırmanın amacı elit erkek orta mesafe (800-1500 m) koşucular ile sağlıklı bireylerin ayak tabanını oluşturan bölgelere ait zirve basınç, ortalama maksimal basınç ve basınç zaman integrali pedobarografik parametrelerinin karşılaştırması yapılarak, atletizm sporunda orta mesafe koşucularının uzun süreli antrenmanlarının ayak tabanı basınç dağılımlarına etkisinin araştırılmasıdır. Çalışmaya ayak şikayeti olmayan ve Türkiye Atletizm Milli Takımında yarışmalara katılan elit seviyede 18 erkek orta mesafe koşucusu (yaş ortalaması; 20,25±3,6) ile kontrol grubu olarak 25 erkek gönüllü (yaş ortalaması;26.10±2.40) katılmıştır. Çalışmaya alınan gönüllülerin ayak taban basınç ölçümleri, EMED-SF (Novel H, Münih, Almanya) plantar basınç analiz sistemi (pedobarografik analiz) kullanılarak yapılmıştır. Verilerin analizinde SPSS 18.0 paket programı kullanılmıştır. Elit orta mesafe koşucuları ile kontrol grubuna ait sağ ve sol ayak 11 temas alanı ölçümleri sonucunda, zirve basınç, ortalama maksimal basınç ve basınç–zaman entegrali değerleri arasındaki karşılaştırmalarda sağ ve sol ayak 2. Metatars başlarına ait ortalamalar arasındaki fark istatistiksel olarak (P<0.01-0.05) anlamlı bulunmuştur. Sonuç olarak yapılan antrenmanların elit orta mesafe koşucularının ayak tabanını oluşturan bölgelere ait zirve basınç, ortalama maksimal basınç ve basınç zaman integrali parametrelerinde değişikliklere neden olduğu tespit edilmiştir. Uzun yıllar boyunca yapılan antrenmanlar sonucu görülen karakteristik koşu biçimlerinin ayak tabanı basınç dağılımlarını etkilediği ve orta mesafe koşu ayakkabılarının üretiminde görülen ergonomik tasarımın bu branşa özgü biçimde gerçekleştirildiği ancak özellikle orta mesafeciler için ayakkabı üretiminde, sıçrama ayağı (genellikle sol) ve savurma ayağı (genellikle sağ) parmaklarının basınç dağılımlarındaki farklılıkların dikkate alınması gerektiği söylenebilir.

Anahtar Kelimeler: Orta mesafe koşucuları, ayak tabanı, basınç, metatars

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INTRODUCTION

Athletics, which is the core of Olympics, and which is based on meter and time dimensions of the events needing basic movement forms such as walking, running, throwing, and jumping, only when they are in the light of science and technique is one of the oldest sports in the world[22]. 100, 200, and 400 m races are known and classified as 'sprints', 5000 m and above are known as 'long distance', and 800-1500 m races are known as 'middle distance' in athletics. That is why middle distance race is a race event which includes both speed and endurance[15].

Running and walking - which can be defined as repetitive movements of lower extremities and moving forward of the body rapidly - consist of mainly two phases: standing (support) and swinging[8]. A man takes one step forward while walking, steps on his foot, and lifts up his other foot and moves it forward. In the walking loop, the time when the foot is in the air is defined as swinging, and the time when it is on the floor is called as the standing (support) phase. The moment that a lower extremity is on the ground is the beginning of the support phase. Once this extremity leaves the ground, support phase finishes and swinging phase starts. When the same extremity is on the ground again, the walking loop is completed[8,21].

Pedobarography is commonly used to search normal foot mechanics. It, as a complement of walking anatomy, enables the reaction force of the ground to be measured sensitively[6,9,13]. In recent years, with the newly developed methods in the measurement of sole pressure, the research made to measure the load in each metatarsus head quantitatively has been increased[1,4,10,12,14,20,21]. Despite the speed in the improvement of these devices, information about the types of pressure distribution in the heads of metatarsus is still debated[7]. Another important part of the plantar pressure analysis is the identification of the pressure distribution on various parts of the foot[3].

The aim of this study is to search the impact of middle distance races to the sole pressure distributions in athletics in male elite middle distance runners (800-1500 m) and healthy individuals living a sedentary lifestyle; by comparing peak pressure, average maximal pressure, and pedobarographic parameters in pressure-time integral, which belong to the parts of the soles.

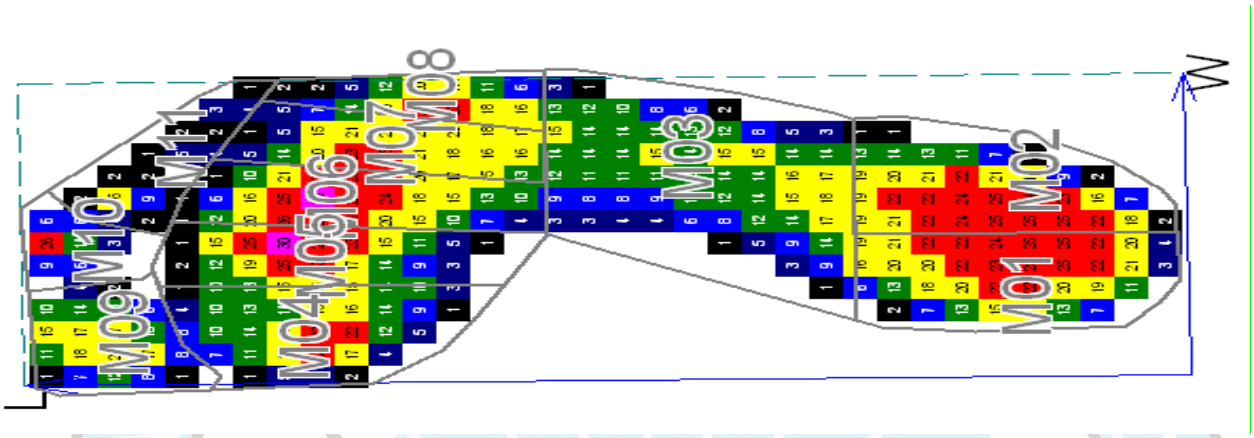
METHOD

Material and Procedures

This research has been done by T.R. Gazi University Medical Faculty Local Ethics Committee with the consent of ethics committee for non-pharmacologic clinical studies in 25 February 2008 and 074 decree no.18 elite middle distance runners (age average; 20.25±3.6) who have no feet complaint and who have taken part in competitions in the name of Turkish National Team of Athletics; and as the control group, 25 voluntary males (age average; 26.10±2.40) have participated in this research. Those who have severe foot deformity, neurologic disease that affects motion system and peripheral neuropathy; and those who have gone through foot or tarsus surgery before, and who have fracture in this part of the body are not included in this study.

Pedobarographic analysis (the sole pressure measurement) of the volunteers has been done. Pedobarographic analysis has been done by using EMED-SF (Novel H, Munich, Germany) plantar pressure analysis system. This system consists of a platform having a 44.4 x 22.5 cm size, 75 Hz sampling rate, and two receivers per cm². A 7x1 m wooden platform is mounted on this platform, and it is covered with very thin leather.

The volunteers were made to take at least three steps freely before seeing the foot pedobarography in 7-meters-tread-wheel. Measurements were done in barefoot; and one static and two dynamic measurements per foot were made. The sole was divided into 11 parts named mask, and each part has been evaluated in terms of contact area (cm) and maximum strength (N). (Picture 1)



Picture-1: The view of foot mask in pedobarography (M01: Medial Heel, M02: Lateral Heel, M03: Medial Foot, M04: 1st Metatarsal Head, M05: 2nd Metatarsal Head, M06: 3rd Metatarsal Head, M07: 4th Metatarsal Head, M08: 5th Metatarsal Head, M09: Thumb, M10: 2nd toe, M11: 3rd, 4th, 5th Toes)

Statistical Evaluation

The analysis of the data has been done in SPSS 18 package. Averaging two measurements of subject and control groups; if there is a statistically significant difference among the averages or not, the Mann Whitney U test, physical structure, and the size of linear relationship among the variables which belong to the soles have been studied by calculating Pearson's (r) index. In the measurements 95% confidence interval and P < 0.01 – 0.05 relevance levels have been accepted.

RESULTS

Table 1. The physical characteristics of subjects (1) and control group (2) in the study

Variables	Group	Mean	S.D	X1 - X2	Min.	Max.	Mann-Whitney U	P
Age (year)	1	20.25	3.678	- 5.85	16.00	27.00	34.000	000[a]**
	2	26.10	2.403		22.00	29.00		
Height (cm)	1	174.37	5.863	- 7.93	164.00	183.00	64.000	.002**
	2	182.30	8.574		164.00	192.00		
Body Weight (kg)	1	66.25	3.714	- 21.75	58.00	71.00	30.000	.000**
	2	88.00	3.142		64.00	110.00		
BMI (kg/m²)	1	21.66	1.824	- 4.93	19.60	25.00	40.000	.000**
	2	26.59	3.375		19.11	30.86		

**** P < 0.01 * P < 0.05**

The difference in elite middle distance runners' and control group's age, height, body weight, and BMI averages have been found significant in P<0.01 level. It is confirmed that age, height, body weight, and body index values of the volunteers in the control group are higher than the athletes' in the experimental group (Table 1).

Table 2. The Comparison of the Right and Left Foot Peak Pressure of subjects (1) and control group (2) in the study

Variables	Group	Right Foot (N/cm2)				Left Foot (N/cm2)			
		Mean	S.D	Mann-Whitney U	P	Mean	S.D	Mann-Whitney U	P
Total Foot-TOTAL	1	50.00	12.71	79.500	.010**	54.57	11.89	69.500	.014**
	2	70.52	26.29			76.35	25.77		
MO1: Medial Heel	1	35.15	6.150	76.500	.008**	41.35	6.926	128.500	.687
	2	46.37	13.96			46.40	16.59		
MO 2: Lateral Heel	1	34.71	6.137	87.500	.021**	39.10	6.560	132.500	.793
	2	41.87	10.00			39.20	7.836		
MO 3: Medial Foot	1	13.87	6.783	119.500	.196	12.53	5.655	97.000	.132
	2	15.02	4.697			15.05	4.260		
MO 4: Foot 1st Metatarsal Head	1	22.21	12.79	83.000	.014**	32.64	18.81	139.500	.986
	2	35.25	22.91			29.72	13.91		
MO 5: Foot 2nd Metatarsal Head	1	36.18	8.231	48.500	.000**	35.28	9.126	69.500	.014**
	2	65.25	27.53			60.35	29.45		
MO 6: Foot 3rd Metatarsal Head	1	36.43	6.869	59.500	.001**	37.46	11.70	67.500	.011**
	2	49.00	13.23			55.60	21.42		
MO 7: Foot 4th Metatarsal Head	1	30.87	12.19	139.500	.514	33.03	14.33	127.500	.661
	2	28.67	5.624			32.82	10.43		
MO 8: Foot 5th Metatarsal Head	1	29.56	16.92	158.000	.949	33.75	21.53	106.000	.234
	2	28.50	10.36			40.85	25.30		
MO 9: Foot Thumb	1	32.84	18.56	105.500	.083	31.53	12.29	68.500	.012**
	2	41.67	21.33			48.55	24.02		
MO 10: Foot 2nd toes	1	22.90	10.30	132.000	.372	18.57	5.121	124.000	.575
	2	21.12	12.98			18.27	8.836		
MO 11: Foot 3rd.4th.5th toes	1	14.93	5.799	143.500	.599	14.39	3.932	85.000	.054*
	2	13.32	8.206			10.42	7.056		

**** P < 0.01 * P < 0.05**

In the comparisons among the peak pressure values of 11 contact areas in right and left feet - which belong to the elite middle distance runners and control group - the difference between the average of right foot total, heel medial, heel lateral, and 1st, 2nd, 3rd metatarsus head; and the average of left foot total, 2nd, 3rd metatarsus head, big toe, and 3rd, 4th, 5th toes have been found significant (P<0.01-0.05) statistically (Table 2).

Table 3. The Comparison of the Right and Left Foot Maximum Pressure Strength [N] of subjects (1) and control group (2) in the study

Variables	Group	Right Foot				Left Foot			
		Mean	S.D	Mann-Whitney U	P	Mean	S.D	Mann-Whitney U	P
Total Foot- TOTAL	1	16.28	3.002	124.000	.252	17.18	1.956	124.000	.576
	2	17.22	2.905			17.69	3.112		
MO1: Medial Heel	1	19.96	3.328	76.000	.007**	22.18	3.135	113.000	.345
	2	23.97	4.335			23.97	5.665		
MO 2: Lateral Heel	1	17.52	2.638	97.000	.045*	18.44	1.643	127.500	.662
	2	19.94	3.745			19.19	3.434		
MO 3: Medial Foot	1	6.022	2.531	134.000	.408	4.992	1.727	84.500	.052*
	2	6.05	1.522			6.07	1.640		
MO 4: Foot 1st Metatarsal Head	1	12.22	5.924	102.500	.067	15.92	6.334	121.000	.506
	2	15.88	6.619			14.56	4.396		
MO 5: Foot 2nd Metatarsal Head	1	20.00	5.022	56.000	.001**	20.75	5.274	69.000	.013**
	2	28.64	7.638			28.78	9.509		
MO 6: Foot 3rd Metatarsal Head	1	20.13	4.687	108.000	.098	19.92	5.506	72.000	.017
	2	23.15	4.255			26.65	7.704		
MO 7: Foot 4th Metatarsal Head	1	15.78	6.452	137.000	.464	13.65	4.830	104.000	.208
	2	14.64	2.893			16.15	4.693		
MO 8: Foot 5th Metatarsal Head	1	13.05	5.986	128.000	.308	12.09	6.148	102.500	.189
	2	11.38	3.170			14.83	6.432		
MO 9: Foot Thumb	1	15.01	6.305	156.000	.899	13.89	4.393	106.000	.234
	2	14.91	4.740			16.34	4.766		
MO 10: Foot 2nd toes	1	11.24	4.032	115.000	.152	9.883	3.008	85.000	.054
	2	9.44	3.764			7.74	2.898		
MO 11: Foot 3rd.4th.5th toes	1	6.205	2.038	135.500	.435	5.676	1.580	75.000	.023*
	2	5.54	2.970			4.18	1.951		

**** P < 0.01 * P < 0.05**

In the comparisons among the average maximal pressure values of 11 contact areas in right and left feet - which belong to the elite middle distance runners and control group - the difference between the average of right foot heel medial, heel lateral, and 2nd metatarsus head; and the average of left foot in the center, 2nd metatarsus head, and 3rd, 4thand 5th toes have been found significant (P<0.01-0.05) statistically (Table 3).

Table 4. The Comparison of the Right and Left Foot Time-Pressure Integral [N] of subjects (1) and control group (2) in the study

Variables		Right Foot				Left Foot			
	Grup	Mean	S.D	Mann-Whitney U	P	Mean	S.D	Mann-Whitney U	P
Total Foot-TOTAL	1	20,69	4.546	83.000	.014**	20.45	5.470	64.000	.008**
	2	27.22	8.740			27.70	8.469		
MO1: Medial Heel	1	6.538	2.078	45.000	.000**	8.013	2.425	109.000	.278
	2	10.69	3.304			10.54	5.226		
MO 2: Lateral Heel	1	6.438	2.053	44.000	.000**	7.347	1.887	93.000	.100
	2	9.86	2.474			9.05	3.071		
MO 3: Medial Foot	1	4.008	2.432	112.000	.126	2.731	1.354	60.500	.005**
	2	4.78	1.755			4.51	1.597		
MO 4: Foot 1st Metatarsal Head	1	6.515	2.885	95.000	.039*	9.652	6.494	136.000	.889
	2	10.08	5.804			8.43	3.387		
MO 5: Foot 2nd Metatarsal Head	1	9.073	2.161	51.000	.001**	8.816	2.209	51.500	.002**
	2	16.42	5.834			15.93	6.309		
MO 6: Foot 3rd Metatarsal Head	1	9.675	1.943	55.000	.001	9.226	2.147	44.500	.001**
	2	14.46	3.957			15.76	5.548		
MO 7: Foot 4th Metatarsal Head	1	9.040	3.485	156.000	.899	8.123	3.583	87.000	.064
	2	9.09	2.564			10.25	3.445		
MO 8: Foot 5th Metatarsal Head	1	7.419	4.539	140.000	.524	6.810	4.763	84.000	.050*
	2	7.82	2.804			10.29	5.769		
MO 9: Foot Thumb	1	9.913	6.290	149.000	.726	7.760	4.598	81.000	.039**
	2	11.0	7.306			11.55	5.220		
MO 10: Foot 2nd toes	1	4.809	2.641	154.500	.861	3.555	1.275	126.500	.637
	2	4.94	3.711			4.02	2.164		
MO 11: Foot 3rd.4th.5th toes	1	3.151	1.426	156.500	.911	2.657	.926	113.500	.354
	2	3.42	2.612			2.45	1.788		

**** P < 0.01 * P < 0.05**

In the comparisons among the time pressure integral values of 11 contact areas in right and left feet - which belong to the elite middle distance runners and control group - the difference between the average of right foot total, heel medial, heel lateral, and 1st, 2nd metatarsus head; and the average of left foot total, center of the foot, 2nd, 3rd and 4th metatarsus head, and big toe have been found significant (P<0.01-0.05) statistically (Table 4).

Table 5. The correlation among the variables of the physical structure and soles of subjects (1) and control group (2) in the study

	Age		Height		Body Weight		BMI	
Variables	1	2	1	2	1	2	1	2
The total peak pressure of the right foot	.257 .130	.006 .981	.480** .003	.387 .091	.681** .000	.639** .002	.550** .001	.484* .031
The total peak pressure of the left foot	.456** .007	.176 .457	.599** .000	.426 .061	.719** .000	.675** .001	.564** .001	.555* .011
The average maximum pressure of the right foot	.041 .814	.484* .031	.015 .931	-.094 .694	.373* .025	.499* .025	.454** .005	.678** .001
The average maximum pressure of the left foot	.185 .296	.160 .501	.148 .405	.102 .670	.397* .020	.559* .010	.404* .018	.637** .003
Right foot time-pressure integral	.395* .017	.105 .660	.553** .000	.370 .108	.699** .000	.686** .001	.539** .001	.560* .010
Left foot time-pressure integral	.513** .002	.287 .220	.623** .000	.446* .049	.767** .000	.801** .000	.586** .000	.659** .002

**** P < 0.01 * P < 0.05**

The importance of the linear relationship among the continuously measured variables was examined by calculating Pearson's (r) index, to be able to make categorical comparisons among the variables which belong to the physical structure and soles of the elite middle distance runners and control group. Significant and positive relationships were confirmed in (P<0.01-0.05) level among the comparisons between the age, height, body weight, BMI; and the peak pressure, average maximal pressure, and time pressure integral (Table 5).

DISCUSSION and CONCLUSION

In our research, the values of peak pressure, average maximal pressure, and time pressure integral of the parts that belong to the soles of middle distance runners were examined; and the comparisons with the control group which consists of healthy individuals were made.

The difference between the middle distance runners and control group in terms of age, height, body weight, and body mass index was found statistically significant. It was seen that athletes were younger when the age of them was examined; age and body weight of middle distance runners were lower than the control groups' in the examination of age and body weight, and also the age and the body weight increased regularly. When the body mass index was examined, it was found as 21. 66 ± 1. 8 in the athletes while in the middle distance runners it was 26. 59 ± 3.3. Also, body mass index of the control group was higher than the other athletes in a significant level. This situation might be derived from the fact that subjects in the control group are deprived of physical activity in their lives.

In the comparisons among the peak pressure values of 11 contact areas in right and left feet - which belong to the elite middle distance runners and control group - the difference between the averages (Table 2) in the athletes; right foot total 41.04%, heel medial 31.92%, 1st metatarsus head 58.71%, 2nd metatarsus head 80.34%, 3rd metatarsus head 34. 50; and left foot total 39.91%, 2nd metatarsus head 71.06%, 3rd metatarsus head 48.42%, and big toe 53.98% low, while 3rd, 4th, 5th toes are 38.09% higher than the control groups'. It is stated that in the peak pressure values of the other

contact areas of right and left feet (the center of the foot, 4th and 5th metatarsus heads, and 2nd toes), control group has got higher values but they are not significant statistically.

In a study about the effect of basketball on the soles, according to the sum of right and left feet and the comparison of peak pressure in 11 contact areas, which belong to male elite basketball players and a control group consisting of healthy individuals, there are variations in terms of averages. It is stated that the professional basketball players' right foot 1. Metatarsus head is 58.56%, right big toe is 32.49% smaller; and their right foot 4. Metatarsus value is 48.37% bigger than the healthy individuals who do physical exercises[17]. Likewise, in a study about the effect of volleyball on the soles, the sum of right and left feet of the professional female volleyball players and a control group, and the comparison of peak pressure on 11 contact areas were made. The differences between the averages of volleyball players and the control group are found like that, volleyball players have higher values in terms of peak pressure on the soles at the rate of 36.8% right foot sum, and 19,8% the center of left foot as compared with the control group[2]. It is clear in the comparisons of peak pressure between all the subject players in both basketball and volleyball. and the individuals in control groups there are very few changes in the parameters and the results look similar. In our study about middle distance runners, unlike the results above, there are statistically significant differences between the control group and the experimental group in 11 parameters; while peak pressure values of the control group are higher than the middle distance runners' in almost all parameters. The reason of it might be the fact that, despite the proximity of the body weight and the body mass index of experimental group and control groups in basketball and volleyball, the individuals in the control group are 32.83% heavier than middle distance runners; and also there are statistically significant differences between body weight and body mass index values. Besides, another important variation in this study is about toes. It is stated that in the 3rd, 4th, 5th toes of left foot the average values of the athletes are higher at a statistically significant level, and also the average values of the players are not statistically significant but they are higher than the data of the control group in the 2nd, 3rd, 4th, 5th toes of the left foot and 2nd toe of the left foot. This situation might be a result of the fact that middle distance runners use their toes and the front edge of their sole more actively than the basketball and volleyball players.

In the sum of right and left foot of middle distance runners and the control group, and in the 11 contact areas average maximal pressure comparison, the difference in the averages (Table3) in athletes the right sole medial is 20.09%, heel lateral is 13.8%, metatarsus head is 43.20%, and the center of left foot is 21.59%, 2. Metatarsus head is 38.69% lower than the control group; while 3rd, 4th and 5th toes are found as 35.78% higher. In the other contact areas on right and left feet, the average maximal pressure values are found as similar. According to a study about wrestling, in the comparisons among the average maximal pressure values of 11 contact areas in right and left feet - which belong to the elite wrestlers and a control group - in the wrestlers' group the difference between the average of right foot sum is 10.45%, heel medial is 23.49%, 2nd metatarsus head is 37.49%, 3rd metatarsus head is 8.43%, and the left foot sum is 10.63%, heel medial is 15.57%, 2. Metatarsus head is 35. 24%, 3. Metatarsus head is 20.86%, and 5. Metatarsus head is 35.93% higher than the control group[1]. It is clearly stated in other resources that increase of the maximal pressure on the sole causes the balance to weaken, the body to brandish a lot, and it leads to the

sense function disorders in sub-members[1,11,16]. The values obtained from a study about wrestlers show parallelism with this study, and it is seen that there are different studies once a literature review is made. In a study they did about ice hockey players, Uzun and others (2012) stated that the average maximal pressure in ice hockey players have lower values in right foot 2. Metatarsus head and left big toe in comparison with the control group, and the maximal pressure in other areas are very close to the values of the control group[18]. The fact that the average maximal pressure values of ice hockey players and the control group are close to each other, indicates that ice hockey has no significant impact on average maximal pressure on the sole. By looking at the values obtained from the study, it can easily be said that it is an expected result for the average maximal pressure values of the individuals in the control group to be so high in the sum of right and left foot as compared with middle distance runners. However, it is a fact that the average maximal pressure values in the left foot 3rd, 4th, 5th toes are high in a statistically significant level on behalf of the athletes; and also the average values in all the toes of right feet and 2nd toes in the left feet are not statistically significant but they are higher than the control group's data. This situation exists in average values of peak pressure, and it might be because of the fact that usage of spikes that is special to the branch has an effect on the toes to be able to range the performance of middle distance runners up; and it also might be because of the increase of the load on the front foot, especially on toes during severe trainings. Besides, the reason why the pressure gathers in the front foot is because speed and running action in middle distance trainings are based on front soles and back parts of the toes[5].

In the sum of right and left foot of middle distance runners and the control group, and in the 11 contact areas time pressure integral comparison, the difference in the averages (Table 4) in athletes the right foot sum is 31.56%, heel medial is 63.50%, heel lateral is 53.15%, 1. Metatarsus head is 54.71%, 2. Metatarsus head is 80.97%, 5. Metatarsus head is 51.10%, and big toe was found 48.84% lower. From 22 contact areas in right and left foot sum, all the other contact areas - except the left foot 1. Metatarsus head, and 3rd, 4th, 5th toes – the values of time pressure integral that belong to the middle distance runners were lower. In a study about the time pressure integral of professional female football players and a control group full of healthy individuals, it was found that there are significant differences in the sum of right and left feet, 5 areas in the right sole, and 2 areas in the left sole; and also the values of female players were found as lower in all the areas except 4 areas in the sole[19]. In a study about wrestling time pressure integral of 11 contact areas in right and left feet - which belong to the elite wrestlers and a control group - in the control group the difference between the averages, right heel medial is 20,92%, 2nd metatarsus head is 41.91%, 3rd metatarsus head is 17.84%, and the left foot 2nd metatarsus head is 45.08%, 3rd metatarsus head is 31.33%, and 5th metatarsus head is 51.32% higher than the wrestlers' group[1]. Likewise, in the study about ice hockey players, the average values of time pressure integral are higher in the control group[18]. The existing literature review is like supporting the values obtained from the study; and the studies about elite basketball and volleyball players show that there are very few differences in the parameters of comparisons between the soles and time pressure integral. The study indicates that the biggest change in the parameters of the soles has been in time pressure integral. The fact that the values of time pressure integral in elite middle distance runners are lower that those who do not play any sports shows that, the sole quickly cuts out the contact with the ground as soon as it touches the ground.

This might be a result of the trainings based on decreasing the touching time of the foot on the ground, and especially decreasing the reaction time.

According to the results of the study, a linear and positive relationship was found (P<0.01-0.05) in all the comparisons of age, height, body weight, body mass index - except the comparisons between the age and the peak pressure on right-left foot, average maximal pressure on right-left foot; and between the height and average maximal pressure on right-left foot (Table 5). The reasons why the pedobarographic records of the middle distance runners are low might be the fact that the values of body weight and body mass index are lower than the control group; and besides, their balance features are developed or the sub-members are stronger. It is confirmed by a study done with a dynamic pedobarographical method on obese and non-obese adults that, there is a positive relationship between body mass index and total plantar strength (r=0.50, P=0.000), and total contact area. Besides, there is a linear and positive relationship in the studies about basketball, volleyball, wrestling, and football, and they support this study[1,2,4,17,19].

Middle distance races (800-1500 m) are accepted as one of the most difficult category in athletics, and an athlete needs to train continuously and for long years to become elite. It is thought changes in the pressure on the sole change for them to do exercises helping the improvement of strength like long distance runners, and exercises including sprints and technique arrangement like short distance runners. Moreover, they need to do combined exercises including running drills (abc), running coordination, and various jumping movements; and especially using special running shoes frequently leads to the pressure on the soles change.

Nowadays from the shoes used by the runners in different distances it can be understood that, a more balanced (flat) foot bed is designed for long distance runners to use more energy in an economical way; while the heel part of short distance runners' shoes is produced as higher to reduce the time for the foot to stay on the ground. As for middle distance runners, they thought need to use a shoe which has lower heel than the short distance runners', and higher heel than the long distance runners'. The aim for that is to reduce the time for the foot to stay on the ground, and to maintain the performance for the long time by keeping it on the top.

As a result, the trainings cause changes in the peak pressure, which belong to the soles of elite middle distance runners, average maximal pressure and time pressure integral parameters of the elite middle distance runners. It can be said that characteristic running types, which are seen as a result of lifelong trainings, affect the sole pressure distributions and the ergonomic design of middle distance running shoes are made according to this branch; but especially in the production of shoes for middle distance runners, the differences in pressure distribution on the toes in the splash foot (usually left) and the tossing foot (usually right) need to be taken into consideration.

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