

The impact of existing and modify wrestling shoes on foot posture deformities in 12-13 years old athletes

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Abstract

Background and Study Aim In the early years when sports footwear became compulsory, the importance of shoe design was not considered in terms of athletes' health. Since the early years of wrestling shoe use, these gears have been manufactured according to the rules of competition, and modifications have been very limited. In this regard, this study aims to determine the effect of existing wrestling shoes on foot deformation.

Material and Methods The study was carried out with the participation of 108 young male athletes who had the same training on the same ground for three years in the Wrestling Training Center. The athletes were divided into two groups, an experimental and a control group. While the control group wore wrestling shoes produced by widely used brands, the experimental group wore newly designed wrestling shoes. Foot arch values and images of both groups were determined using a podoscope device at the beginning and end of the study. The evaluations were made according to the Staheli arch index.

Results The results of the statistical analysis revealed that differences were found in the footprint measurement values of the control group. It was determined that this difference in the footprints was greater among the freestyle wrestlers. The decrease in the averages between the first and second measurement values of the group using the newly designed wrestling shoes was found to be highly positive and in a linear direction. Also, it was determined that the pain score values of the control group were higher than the scores of the experimental group after training.

Conclusions The results revealed that there were deformations in the feet of the control group wrestlers wearing available wrestling shoes. It was observed that freestyle wrestling athletes had more deformation than Greco-Roman style wrestlers, and leg pains were more prevalent after training and competitions. Based on these results, it was concluded that the design of wrestling shoes produced with today's technology needs to be redesigned.

Keywords: wrestling, athlete health, sports shoes, wrestling shoes, flatfoot, leg pain

Introduction

Wrestling athletes competed for bare feet on the dirt floor at the 1896 Athens First Modern Olympics, while in London in 1908, they competed for the first time on thick, soft cushions with leather shoes tightly wrapped around the ankles on their feet [1]. These shoes with ankle support worn at the 1908 London Olympics have been used to this day, maintaining similar characteristics without much change. As a rule, wrestling shoes must have no heels and wrap the foot in tight laces [2].

The physical structures constructed by sports branches are not the same in terms of posture and anthropometric characteristics because their movement angles and requirements are different [3]. Studies report that the postural structures and necessities of sports branches are distinct from

each other [4]. As a performance sport, wrestling requires physical health and balance in addition to characteristics such as physiological, psychological, technical, tactical, strength, and agility traits. Of these characteristics, balance has a special place in wrestling. Foot posture plays an important role in maintaining balance [1].

Many studies report that the existing wrestling shoes cause flatfoot deformity [1, 5, 6]. Flatfoot is the straightening or disappearing of one of the longitudinal or transverse foot arches at the sole. This condition obstructs the facility of springing and prevents normal movement during walking and running. Flatfoot is also defined as "deformity caused by decreased height or complete collapse of the medial longitudinal arch of the foot" [7]. Pes planus is defined as the decreased or complete loss of medial longitudinal arch (MLA) height of the foot. In pes planus, the head of the talus is replaced planar from the medial and navicular bone. This relocation

leads to loss of height in the MLA by stretching the arch-formed tendon of the tibialis posterior muscle [8]. When the medial longitudinal arch decreases, heel eversion occurs due to the overpronation of the foot compared to normal foot, and by shifting the body weight inwards, pressure is exerted on the MLA, and therefore, the tension is created on the MLA [9]. If the medial longitudinal arch undergoes structural or functional deterioration or disappears completely, the ability of the foot to dampen the ground reaction force decreases, its effect in keeping balance decreases, difficulties in walking emerge, and the endurance of the muscles decreases [10]. In a survey study conducted by Prvulović et al. for years between 2002 and 2018, it was determined that the most common deformity among foot deformations in athletes with different sports backgrounds was the flatfoot disorder. In addition, in this study, they found that athletes who had flatfeet achieved lower results when performing motor tasks compared to the individuals with normal foot structure in terms of time and reaction speed [11]. As can be seen from these studies, it is very important for athletes' health and performance to investigate the reasons why athletes develop flatfeet and to find solutions.

It is known that the population of athletes with flatfeet is high in the wrestling branch and that wrestling shoes are the main factors that cause this upsurge [1, 5, 6]. In this context, the need for a new wrestling shoe design contributes to the significance of this study.

The number of studies investigating the foot structure of athletes is very limited. Therefore, the effects of wrestling shoes on foot structure have not been clearly understood yet. As a result, this study may help determine the effects of new wrestling shoes on the foot structure of athletes after wrestling in these new shoes. In other words, this study aims to redesign wrestling shoes, which are thought to disrupt the foot structure of wrestlers, and to investigate their effects on athletes.

Materials and Methods

Participants.

A total of 108 male volunteering athletes, aged 12-13, who were novice wrestlers participated in the study. The participants were athletes of the Wrestling Training Center (in Turkey), where young wrestlers are enrolled through selection and are given boarding school education. Of the participants, 51.9% were 12 years old, and 48.1 % were 13 years old. In terms of their wrestling styles, 50% of the participants were competing in freestyle, and 50% were Greco-Roman-style wrestlers. Students who exercised regularly at least three days a week and whose foot sole values were normal according to the Staheli index [12, 13, 14] were selected for the research. The participants were informed about

the research before the investigations. The athlete candidates were divided into an experimental and a control group with 54 participants in each group. The control group wore the two most used brands of wrestling shoes that were available on the market. On the other hand, the experimental group wore the newly manufactured wrestling shoes. Many changes were made in these new shoes. In the present wrestling shoes, which were found to cause foot deformity and balance disorders in previous studies, the outer sole, inner sole, heel part, shoe surface, laces and ankle parts of the boot were revised. Both groups underwent the same training on the same ground. In the three-year study, the weekly training program of the athletes was renewed every six months. The six-month weekly training program of the athletes was prepared. To assess the deformations caused by the shoes, the foot soles were imaged using a podoscope at the beginning and end of the study. Informed consent was obtained from all participants. The research was conducted in accordance with the ethical principles of the Helsinki Declaration. The study was approved by the Clinical Research Ethics Committee of Inonu University (2018/106).

Research Design.

The study was conducted between August 2018 and June 2021. Three-year training programs for athletes were prepared in the Wrestling Training Centers (WTC) where the study was conducted. These training programs were divided into six-month periods, and the content was modified. In the weekly training program for the first six months, the athletes trained four days a week. In this phase, the adaptation of the athletes to the WTC and the development of basic motoric properties were targeted. Information about the conditions of the athletes was collected by making physical tests after the first six months. The athletes performed all their training, except sports games, in their wrestling shoes. The training was made five days a week in the second six-month period. The basic postures and grips in wrestling, as well as the teaching of ground techniques, were started at this stage. During the first six-month period of the second year, the weeks were planned as five days of training and one day of sports games. Football was played when the weather was conducive to playing football. When this was not the case, wrestling basketball was played on the mat. In the second half of the second year, more time was allocated to basic wrestling and gymnastics skills. The athletes started to play control matches among themselves. In the first six months of the third year, more time was devoted to versatile technical and tactical work. The athletes made partner drills in addition to studies with their body weight, and they worked with small weights. The number of control matches and the work on the

wrestling style (freestyle or Greco-Roman) chosen by the athlete were emphasized in this period. In the last six months of the study, the number of control matches was increased as athletes were eligible to wrestle.

Throughout the study, redesigned shoes were given to athletes whose foot size grew in the experimental group, while the control group was given wrestling shoes from existing brands.

Data Collection.

Measurements of Footprints

Faster and more accurate results were obtained in the foot sole measurements and footprint evaluation using a podoscope device (Chinesport S.P.A. Udine, Italy). In this method, the person stands still on a glass surface, and the image of the foot is reflected on the mirror underneath. This image is then recorded on the computer and the planimetric index values that are calculated with the highest sensitivity determine whether the arch of the foot is normal, cavus, or flatfoot [15]. All pre-measurement conditions such as the time between removing the shoes and starting the test, standing on the glass surface with bare feet, were the same for all participants. After the feet soles of the participants were wiped with alcohol and dried, the participants were asked to stand on the podoscope in an upright and still position distributing their body weight evenly on both feet. They were positioned with their heads upright, facing straight across. The images obtained were analyzed using the Global Postural System/PODATA software. The overall foot sole structure was evaluated employing Staheli's plantar arch index (SI). The SI index is the ratio obtained by dividing the narrowest width of the middle of the foot into the widest width of the heel area. According to this method, ratios between 0,50 and 0,70 are normal, while ratios above 0,70 are considered pes planus [12, 13]. While calculating the Staheli index $SI=a/b$, the measurement areas were expressed as; a: the narrowest width of the middle

of the foot, b: widest width of the heel area [12, 13, 14].

Determination of Leg Pain Values

In the evaluation of pain, a visual analogue scale was used to determine athletes' pain complaints, the most severe pains that occur after training or matches, pains during running, pains during squatting, and pains when climbing stairs and descending stairs. The visual analogue scale (VAS), which was used to translate some values that cannot be measured numerically into numeric values, was numbered at equal intervals from 0 to 10 on a 10 cm line. The number 0 stood for 'no pain at all,' whereas the number 10 indicated 'unbearable pain.' In this manner, the participants were asked to mark the severity of the pain they perceived [16].

Statistical Analysis.

The data obtained from the research group was analyzed using the SPSS 22 package program. Since the data showed normal distribution, parametric test methods were utilized. The frequency and percentage dispersions of demographic variables were calculated. Independent samples t-test was performed in pairwise comparisons of independent variables. Paired samples correlation test was used for correlation analysis, whereas paired samples t-test was utilized for the comparison of first and second measurement values. The level of statistical significance was set at $p<0.05$ in the study.

Results

According to Table 1, there was no statistically significant difference between the first and second measurement values in terms of the wrestling style variable (freestyle or Greco-Roman) in the experimental group ($p>0.05$)

As demonstrated in Table 2, no statistical significance was found in terms of the variable of wrestling style (freestyle or Greco-Roman) in the first measurement values in the control

Table 1. Footprint analysis results of the experimental group by the wrestling style variable

Wrestling Style		n	Mean	SD	t	p
1 st Measurement	Freestyle	27	0.61	0.048	-0.333	0.741
	Greco-Roman	27	0.62	0.042		
2 nd Measurement	Freestyle	27	0.60	0.046	1.195	0.237
	Greco-Roman	27	0.59	0.040		

Table 2. Footprint analysis results of the control group by the wrestling style variable

Wrestling Style		n	Mean	SD	t	p
1 st Measurement	Freestyle	27	0.63	0.040	1.575	0.121
	Greco-Roman	27	0.61	0.050		
2 nd Measurement	Freestyle	27	0.71	0.133	2.128	0.038*
	Greco-Roman	27	0.65	0.085		

* $p<0.05$

group ($p>0.05$). However, a statistically significant difference was determined between the second measurement values ($p<0.05$).

The means of the first and second Staheli Index values of the experimental group were presented in Table 3. As seen in these findings, there was a decrease in the mean values of the second measurement.

The correlation coefficient between the first and second measurement values of the experimental group were presented in Table 4. There was a statistically significant relationship between first and second measurement values of the experimental group ($p<0.05$). The decrease in averages between first and second measurement values was in a strong positive linear direction.

According to Table 5, it was determined that the difference obtained from the comparison between the first and second measurement values was statistically significant in the experimental group ($p<0.05$).

The means of the first and second Staheli Index

values of the control group were presented in Table 6. It was seen that there was an increase in the averages of the second measurement values.

Table 7 indicates that the correlation coefficient between the first and second measurement values in the control group is $r=0.826$, and it is statistically significant ($p<0.05$). The increase in averages between first and second measurement values was in a strong positive linear direction.

As demonstrated in Table 8, the difference obtained from the statistical comparison between the first and second measurement values of the control group was determined to be statistically significant ($p<0.05$).

As Table 9 indicates, there was a statistically significant difference in pain scale values between the experimental and control groups in the research group in favor of the experimental group ($p<0.05$).

As presented in Table 10, it was determined that there was a statistically significant difference in pain scale values in terms of the freestyle and

Table 3. Descriptive statistics of measurement values of the experimental group (Paired Samples Statistics)

Variables	n	Mean	SD	Std. Error Mean
1 st Measurements	54	0.62	0.045	0.006
2 nd Measurements	54	0.60	0.043	0.005

Table 4. Correlation analysis between measurement values of the experimental group (Paired Samples Correlations)

Variables	n	r	p
1 st Measurement & 2 nd Measurement	54	0.789	0.000*

* $p<0.05$

Table 5. The analysis results between the 1st and 2nd measurement values of the experimental group (Paired Samples test)

Experimental group	Paired Differences					t	df	p
	Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 st Measurement-2 nd Measurement	0.01611	0.02864	0.00390	0.00829	0.02393	4.133	53	0.000*

* $p<0.05$

Table 6. Descriptive statistics of measurement values of the control group (Paired Samples Statistics)

Variables	Mean	n	SD	Std. Error Mean
1. Measurement	0.62	54	0.046	0.006
2. Measurement	0.68	54	0.115	0.015

Table 7. Correlation analysis between measurement values of the control group (Paired Samples Correlations)

Variables	n	r	p
1 st Measurement & 2 nd Measurement	54	0.826	0.000*

* $p<0.05$

Table 8. The analysis results between the 1st and 2nd measurement values of the control group (Paired Samples test)

Control group	Paired Differences					t	df	p
	Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 st Measurement-2 nd Measurement	-0.06481	0.08149	0.01109	-0.08706	-0.04257	-5.845	53	0.000*

*p<0.05

Table 9. Pain scale analysis of the study group (Experimental-Control)

Groups	n	Mean	SD	t	p
Pain Scale Experimental	54	0.2222	0.63444	-4.158	0.000*
Control	54	1.5741	2.30342		

*p<0.05

Table 10. Pain scale analysis results of the study group according to the wrestling style variable

Wrestling style	n	Mean	SD	t	p
Pain Scale Freestyle	54	1.7596	1.9814	2.431	0.005*
Greco-Roman	54	0.6667	1.61362		

*p<0.05

Greco-Roman style wrestling status of the study group (p<0.05). Accordingly, the pain scale values of the freestyle wrestling athletes were higher.

Discussion

Approximately half of the athletes in the study were 12 years old (51.9%), while the other half was 13 years old (48.1%). The participants were selected from the athletes who qualified to study boarding at Wrestling Training Centers. Of the participants, 50% were freestyle wrestlers, and 50% were Greco-Roman wrestlers. The participants applied to the same training program for three years.

No difference was found between the first and last measurements in the footprint images of the participants. However, differences were found in the footprint measurement values of the control group. It was determined that this difference in the footprints was greater among the freestyle wrestlers. In the relevant literature, the findings of the study by Aydog et al. [17] are in parallel with the findings of our present study. In addition, the results of our study that indicate a significant relationship between freestyle and Greco-Roman wrestling styles and the pes planus condition are in line with the research by Aak et al. [1] and Tařkiran et al. [18]. The reason that flatfoot deformity is more prevalent in freestyle wrestlers than in Greco-Roman style might be because freestyle wrestlers bend forward more, stand with their feet sideways apart for balance, and they pull and push their opponent forward, backward, and sideways. Owing to the shock-absorbing feature of the shoe sponge, the

contact surface of the sole surface with the mat may be more than desired. This may lead us to consider that flatfoot deformity has a higher incidence among freestyle wrestlers because of this condition. Furthermore, the fact that the surrounding of the shoe is overly wrapped prevents the movement of the Achilles tendon. The failure of the Achilles tendon to stretch supports the idea that there is a predisposition effect on the higher incidence of flatfoot deformity among freestyle wrestlers.

The decrease in the averages between the first and second measurement values of the group using the newly designed wrestling shoes was found to be highly positive and in a linear direction. This finding demonstrates that the manufactured shoes brought the foot sole values of the athletes to the ideal norms over time. On the other hand, the mean values of the second measurements of the control group who were using pre-existing wrestling shoes increased. The increase in the means between the first and second measurements was highly positive and in a linear direction. Considering this finding, it can be said that if wrestlers continue to use existing wrestling shoes, there will be an increase in foot sole deformation, and the existing shoes will cause permanent flatfoot problems. As a result of their pes planus scan in 685 athletes who wrestled regularly, Tařkiran et al. [19] determined that as the year of doing sports increased, the incidence of developing pes planus in freestyle wrestlers (25.7% pes planus cases) was higher than Greco-Roman wrestlers (15.6% pes planus cases). This data indicates that the rate of developing flatfoot increases in parallel

to the wrestling age of athletes. The findings of our research are in line with the studies by Taşkıran et al. [18]. In their study that supports the findings in this current research, Wojtys et al. [20] stated that intensive training made at early ages has effects on the posture.

In the present study, it was determined that the pain score values of the control group were higher than the scores of the experimental group after training. In the control group, the pain score values of freestyle wrestlers were also found to be higher when the wrestling style is considered. People who have flatfeet cannot absorb shock and spread it to their feet due to their lack of natural foot arches. The forces applied to the soles of the feet and the upper part of the body cause chain reactions to all body connections, especially in the spine and lumbar spine [21]. This condition leads to pain in individuals with flatfeet after activities such as standing [22], walking, and running [7]. Violante et al. [23] and Oskay and Yakut [24] concluded that there was a positive relationship between individuals with flatfeet and lumbar pain. Similarly, Kaufman et al. [25] maintained that pes planus triggered pain sensation in feet, stiffness, imbalance

in feet muscles, the tension in ligaments, rapid exhaustion while walking, and most importantly, stress fractures. As these results demonstrate, flatfeet cause many posture disorders.

Conclusions

In light of the findings of this study, it is possible to say that wrestling shoes need to be redesigned. Pes planus deformity should be considered in sports branches in the selection of athletes and the processes of sporting rehabilitation. In the future, research on athletes' success rates in tournaments after deformity prevention practices and the impact and solution of athlete equipment on athlete health can be investigated to contribute to the literature.

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Conflict of interest

The authors state that there is no conflict of interest

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