12 - INFLUENCE OF SPORTS ON STATE OF PLANTAR PRESSURE

MARTIN ZVONAR, KATERINA KOLAROVA,
ZDENKO REGULI, MARTIN SEBERA, TOMAS VESPALEC
Faculty of Sport Studies, Masaryk University in Brno, Czech republic

INTRODUCTION

The article is focused on plantar pressure research among combative sportsmen. We focused on possible differences related to the type of pad used for specific sport. After previous experiences, especially with softer surfaces, can be expected negative effects on the foot arch and influence on plantar pressure distribution during normal walking. Japanese combat sports are usually practiced barefoot. There are few types of typical movements depending of type of typical techniques used. For example judo, aikido and aikibudo are using mainly throws, joint lock, etc., karate, kempo, and some of jujutsu systems are using mainly kicks and thrusts [Štefanovský 2009, Vít 2005, Reguli 2005, Green 2001]. We choose karate as an example for this research.

OBJECTIVES

Most combative sports need soft surface for athletes, so gyms are usually covered with the tatami. We assume surface specific interaction with supporting the leg system: on the one hand, locomotion on a flexible thus partially unstable pad may lead to strengthen foot muscles. On the other hand, pad after contact with sole makes foot arch support, which can lead to lack of stimuli for active involvement of muscles supporting foot arch. It is important for good balance and good power distribution during transitions, kicks and thrusts. In previous researches we can find explanation of these processes [Zvonař, Lutonská 2009, Čihounková, Vít 2009, Psalman 2007, Duvač, Kasa 2005, Bus, De Lange 2005, Eils 2004].

AIMS

The aim of the research was to prove potential effect of karate on the soft ground on the state of foot arch, and if it is possible to determine the nature of the action.

MATERIAL AND METHODS

The research was realized with pedobarographic platform Emed [Novel 2006]. We focused mainly on the pressure distribution on planta pedis while walking. We used the third step method and we averaged three attempts for each proband's foot. In the research were involved 16 men aged from 18 to 40 years of which 8 regularly perform karate on solid floorboards, below collectively designated as a group S and 8 karatekas who exercise on tatami, below collectively designated as a group T. Research measuring took place in two different gyms in Brno (gym with tatami surface and gym with hard surfaces – wooden floor) in winter months of 2009.

RESULTS

Emed system which was used for our research offers many possibilities how to process, evaluate and also display the measured values [Rosenbaum 2006, Birtane and Tuna, 2004]. Pictorial, graphical and numerical outputs, which we present, show variables, which we expected to, demonstrate most obvious differences in the comparison between the two experimental karate groups.

A figure 1 and 2 shows the distribution of maximum pressure on the left foot for all of 16 probands. Scans in Figure 1 belong to karatekas who exercise on the solid surface (group S), Figure 2 presents scans of karate sportsmen who exercise on tatami (Group T). Comparing these scans we find no significant differences between groups, just higher maximum pressure under the longitudinal arch in group S.

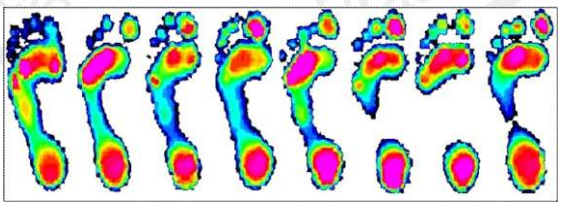


Figure 1: Maximal pressure – group S

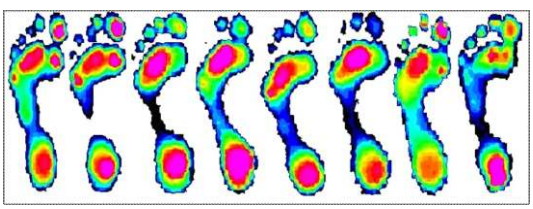
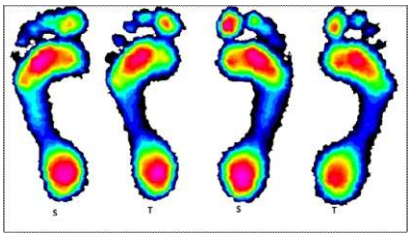


Figure 2: Maximal pressure – group T

Figure 3 shows the virtual images of distribution of maximum pressures for each group. These views are the result of averaging the measured data of all probands in the single group. The letter S denotes virtual scans of group S, which exercises on

solid surface, the letter T indicates the group T, which exercises on tatami. At this figure can be seen in addition to already mentioned finding of higher pressure under the longitudinal arch in the group S also better balanced distribution of pressure in metatarsal area of the same group.



3: Virtual averaged maximal pressure distribution scans

In table 1 you can see averege values of some parameters we focused on. On the compared values is the higher one always accentuated.

Area M02 / T is the area under the longitudinal arch and the area under whole feet ratio. These values are very balanced in both groups. M01 is a heel, META means the 2nd, 3rd and 4th metatarsal, M08 is a big toe. The table shows the average pressures recorded in these areas. We can see that the absolute average pressure in all monitored areas are higher in the group S.

Relatively, which means in proportion to the average pressure of whole foot (avrg T), is lower load of the area 2nd, 3rd and 4th metatarsal in the group S. Higher relative load of heel was indicated for each leg in second group (left heel in group T, right heel in group S), big toes are still more loaded in group S.

The last values in the table are the percentage the observed area contact time - 100% is the time from the first to the last contact during unwinding the feet. From this perspective we found that heel and metatarsal are loaded longer in the group T. On the contrary, the big toe is loaded longer in the group S.

Table 1: Averaged values of parameters

	SOLID SURFACE		TATAMI	
	Left foot	Right foot	Left foot	Right foot
area M02/T	0,159	**0,164**	**0,164**	0,160
M01 [kPa]	**163,82**	**158,09**	153,22	144,19
META [kPa]	**157,86**	**155,05**	150,52	146,83
M08 [kPa]	**113,18**	**131,92**	100,55	98,64
avrg T [kPa]	**79,44**	**75,61**	72,32	70,44
pres M01/T	2,078	**2,096**	**2,111**	2,047
pres META/T	1,978	2,045	**2,102**	**2,083**
pres M08/T	**1,444**	**1,754**	1,384	1,391
M01 [%]	63,53	61,31	**66,26**	**66,20**
META [%]	82,71	81,82	**83,07**	**84,24**
M08 [%]	**77,82**	**76,68**	65,87	73,58

For better understanding, the times of various contact areas are shown graphically in Figures 4 and 5. Areas come into contact with the base gradually, also gradually leaving it, but more than 40% of the time the foot contacts the pad, are observed all three areas contacting the ground simultaneously. Individual lines in the graphs represent values alternately for group T and group S.

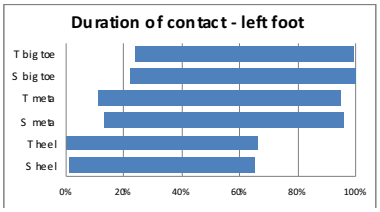


Figure 4: Duration of contact

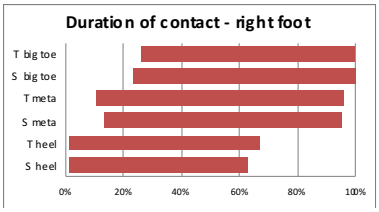


Figure 5: Duration of contact

Figures 6 and 7 show the comparison of maximum pressure on the left and right foot which is divided into following areas: M01 - heel, M02 - the middle legs, M03 - first metatarsal, M04 – second metatarsal, M05 - third metatarsal, M06 - fourth metatarsal, M07 - fifth metatarsal, M08 – big toe, M09 – second finger, M10 - the other fingers. Progress and values of maximum pressures are similar in both groups, just on the left foot there are visibly higher maximum pressures in the metatarsal area in the group S and on the right leg in the same group are higher maximum pressures under toes. Interestingly, although there was higher load of both big toes in group S in all previous outputs, the highest maximum pressure of the left big toe was noticed in the group T.

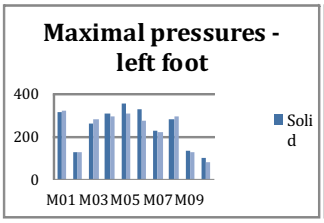


Figure 6: Graph of maximal pressures

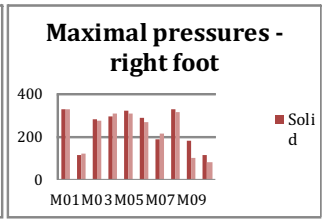


Figure 7: Graph of maximal pressures

DISCUSSION

All measured values were statistically analyzed. To determine expected statistically significant differences was calculated Cohen effect coefficient d. Its value reflects statistical significance of the result: if d is greater than 0.8 the effect is large, d from interval from 0.5 to 0.8 indicates medium effect, the effect of d value less than 0.2 is considered to be small. For each of our conclusions, we present this coefficient for both left and right foot separately.

The results show that men who perform karate on solid surfaces have higher absolute values of the average whole foot pressure (dl = 0.74, dr = 0.97), and higher pressures in monitored areas (25 <d <74). Of the areas statistically most significant (d = 0.73) higher pressure was found under the right heel of the group S. This difference could be caused by more energetic walking or possibly by a higher average weight.

We also discovered a lower relative load of the middle metatarsal area in the group S (dl = 0.42, dr = 0.15) which could point to a better state of transverse arch more stimulated by movement on a harder surface.

As statistically significant was identified both absolute (d = 0.98) and relative (d = 0,80) higher pressure under the right big toe in the group S (figure No. 8). Similar findings on the left foot were statistically insignificant. Another finding relating to the big toe is a load time. The group S loaded big toes longer then the group T (dl = 0,70; dr = 0.37). From this information we conclude that karatekas who exercise on the solid surface involve toes by unwinding of the foot much more than men perform karate on tatami. This corresponds with previous findings of lower medium metatarsal loading and thus also relatively better state of transverse arch.

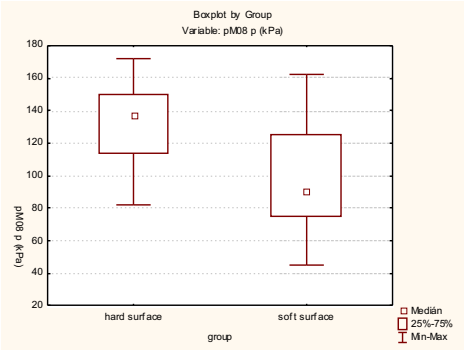


Figure 8 Comparison of pressures under the big toe between groups S and T

Longer contact time of the heel and the metatarsal area in the group T remained with their d coefficients below medium significance.

Lowest Cohen coefficient values (dl = 0.07, dr = 0.05) were calculated for the area under the longitudinal arch and the area under whole foot ratio which appeared to be almost identical in both groups and feet. That is why we cannot reliably answer the question which group tends more to have longitudinal flat feet, respectively, which surface stimulates longitudinal arch better. This finding also would not provide a meaningful value due to d coefficients in most cases lower then 0.2 and also due to low number of respondents.

Still we can claim that pad has demonstrable effect on foot pressure distribution and its values. So there is a place for a larger research and a question for public if there is any need of stimuli compensation for combative sportsmen using just tatami.

REFERENCES

1.Birtane M., Tuna H. (2004). The evaluation of plantar pressure distribution in obese and non-obese adults Clinical biomechanics vol. 19., Physical Medicine and Rehabilitation Department of Trakya University Hospital, Edirne 2004

2.Bus, S.A., De Lange, A. (2005). A comparison of the 1-step, 2-step and 3-step protocols for obtaining barefoot plantar pressure data in the diabetic neuropathic foot. Clinical biomechanics vol. 20., Amsterdam: University of Amsterdam, 2005. ISSN 0268-0033

3.Čihounková J., Vít M. (2009). Držení těla a dechová cvičení v karate. In Rozvoj profesionálnych kompetencií učitel´ov telesnej výchovy na základných a stredných školách z úpolových športov. vyd. první. Banská Bystrica : Katedra telesnej výchovy a športu Fakulty humanitných vied UMB v Banskej Bystrici, 2009. od s. 108 - 118, 11 s. ISBN 978-80-8083-831-7

4.Duvač I., Kasa J. (2005): Standardization of the testing equipment balance master. In: 9th International Scientific Conference SPORT KINETICS 2005, Rimini, Italy, 2005, p.120.

5.Eils E. et al. (2004). Characteristic Plantar Pressure distribution Patterns during Soccer-Specific Movements. The American Journal of Sports Medicine vol. 32., 2004

6.NOVEL. (2006). Novel scientific, München, 2006

7.Psalman V. (2007): Special balance exercises and their positive influence for sport performance. In: 12th annual Congress of the EUROPEAN COLLEGE OF SPORT SCIENCES, Jyvaskyla, Finland, 2007.Reguli Z.

8.(2005) . Úpolové sporty (distanční studijní text). Brno : Masarykova univerzita, 2005. 133 s. ISBN 80-210-3700-8.

9.Rosenbaum D. (2006). Plantar pressure distribution measurements for the assessment of foot function: Technical Background, Recommendations for Data Collection and Processing, and Clinical Applications In Emed scientific meeting, München

10.Štefanovský M. (2009). Džudo I. Teória a didaktika. Bratislava : FTVŠ UK, 2009. 103 s. ISBN 978-80-8113-009-0

11.Green T.A. (2001). Martial arts of the world: an encyclopedia. Santa Barbara : ABC-CLIO Ltd, 2001. 894 pp. ISBN 1576071502

12.Vít M. (2005). Aikibudó: Bojová umění jako sportovní aktivita dětí a mládeže. In Sport a kvalita života. Sborník článků a abstrakt mezinárodní konference konané 10. - 11. 11. 2005 v Brně. Brno : Masarykova univerzita, Fakulta sportovních studií, 2005. 6 s. ISBN 80-210-3863-2.

13.Zvonař M., Lutonská K. (2009). Analýza distribuce plantárního tlaku prostřednictvím pedografické plošiny Emed. In Sport a kvalita života 2009. 1. vydání. Brno : FSpS MU, 2009. 9 s. ISBN 978-80-210-5006-8.

INFLUENCE OF SPORTS ON STATE OF PLANTAR PRESSURE
ABSTRACT

The project is focused on plantar posture research among combative sportsmen. We concentrate on possible differences related to the type of pad used for specific sport. After previous experience especially with softer surfaces can be expected negative effects on the foot arch and influence on plantar pressure distribution during normal walking. Most combative sports need soft surface for athletes so gyms are usually covered with the tatami. We assume surface specific interaction with supporting leg system: on the one hand, locomotion on a flexible thus partially unstable pad may lead to strengthen foot muscles, on the other hand pad after contact with sole makes foot arch support, which can lead to lack of stimuli for active involvement of muscles supporting foot arch. The aim of the project was to prove potential exposure combative sports on the soft ground on the state of foot arch and if possible to determine the nature of the action. The research was realized with pedobarographic platform Emed and it was established mainly the pressure distribution on planta pedis while walking, and consequently the static pressure distribution in standing. In the research was involved 30 respondents of which 15 perform karate and 15 aikido. Research was in the years 2009 - 2011 at FSpS MU Brno. Based on our data we can tell that karatist´s transverse and longitudinal arch has different shape compare to the arch of aikido combatants and there are also significant marks proving a possitive influence of solid pad used in this sport for the right posture of the foot arch. From orthopedic view we can claim, that pad has very favourable effect for arch and there is the question for public if there is any need of stimuli compensation for combative sportsmen using just soft surface.

KEY WORDS: Kinesiology, martial arts, sport, health

INFLUENCE DU SPORT SUR L'ÉTAT DE LA PRESSION PLANTAIRE
RÉSUMÉ

Le projet est axé sur la recherche posture plantaire chez les sportifs de combat. Nous nous concentrons sur d'éventuelles différences liées au type de tapis utilisé pour le sport spécifique. Après une expérience précédente en particulier avec des surfaces plus douces on peut s'attendre à des effets négatifs sur la voûte plantaire et l'influence sur la distribution des pressions plantaires lors de la marche normale. La plupart des sports de combat besoin de surface douce pour les athlètes parce que les gymnases sont généralement recouverts de tatami. Nous supposons que l'interaction de surface spécifique à l'appui du système jambe: d'une part, la locomotion sur un coussin souple ainsi partiellement instable peut conduire à renforcer les muscles du pied, sur le pavé d'autre part après le contact avec la semelle rend le soutien de la voûte plantaire, ce qui peut conduire à un manque de stimuli pour la participation active des muscles de soutien de la voûte plantaire. L'objectif du projet était de démontrer les sports d'exposition potentielles combatifs sur le sol mou sur l'état de la voûte plantaire et si possible de déterminer la nature de l'action. La recherche a été réalisée avec la plate-forme Emed pedobarographique et il a été établi principalement la distribution de pression sur le planta pedis tout en marchant, et par conséquent la répartition de la pression statique en règle. Dans la recherche a été impliqué 30 répondants, dont 15 effectuent le karaté et 15 l´aïkido. La recherche se déroulait dans les années 2009 - 2011 à la Faculté des études sportives de l´Université Masaryk de Brno. Sur la base de nos données, nous pouvons dire que l´arche transversale et longitudinale des karatékas a une forme différente à comparer à l'arc des aïkidokas et il ya aussi d'importantes traces prouvant une influence possitive de tapis solide utilisé dans ce sport pour la posture droite de la voûte plantaire. Du point de vue orthopédique nous pouvons affirmer, que ce tapis a un effet très favorable pour l´arc et il y a la question pour le public s'il y a un besoin de stimuli de compensation pour les sportifs de combat en utilisant seulement surface molle.

MOTS CLÉS: Kinésiologie, arts martiaux, sport, santé

LA INFLUENCIA DE LOS DEPORTES EN EL ESTADO DE LA PRESIÓN PLANTAR
RESUMEN

El proyecto se centra en la investigación de la postura plantar en deportistas de deportes de combate Nos concentramos en las posibles diferencias relacionadas con el tipo de tapiz que se usa para el deporte específico. Después de experiencias previas, especialmente con superficies más blandas se pueden esperar efectos negativos en el arco del pie y esto puede influenciar la distribución de la presión plantar durante la marcha normal. La mayoría de los deportes de combate necesitan superficies suaves para los atletas, por dicha razón los gimnasios suelen estar cubiertos de tatami. Suponemos que la interacción específica de la superficie con el sistema de soporte de la pierna: por un lado, la locomoción sobre un tapiz flexible y parcialmente inestable, puede conducir a fortalecer los músculos del pie, y por otra parte el tapiz después de hacer contacto con la suela se convierte en soporte para el arco del pie, lo que puede conducir a la falta de estímulos para la participación activa de los músculos que soportan el arco del pie. El objetivo del proyecto era probar la exposición potencial de los deportes de combate en suelo blando sobre el estado del arco del pie y si fuera posible determinar la naturaleza de la acción. La investigación se realizó con una plataforma EMED y se estableció principalmente la distribución de la presión sobre la planta del pie mientras se camina, y por lo tanto la distribución de la presión estática al estar de pie. En la investigación participaron 30 encuestados, 15 de los cuales practican karate y 15 aikido 15. La investigación se llevó a cabo en los años 2009 - 2011 en la Facultad de Ciencias del Deporte de la Universidad Masaryk en Brno. Con base a los datos podemos decir que el arco transversal y longitudinal de los karatecas tiene una forma diferente al arco de los combatientes de aikido y también hay marcas importantes que demuestran la influencia positiva de un tapiz sólido, el cual se utiliza en este deporte ayuda a la postura correcta del arco del pie. Desde el punto de vista ortopédico podemos afirmar, que el tapiz tiene un efecto muy favorable para el arco del pie y se plantea la cuestión para el público si existe la necesidad de compensación de estímulos para deportistas de deportes de combate utilizar sólo superficies suaves.

PALABRAS CLAVE: Kinesiología, artes marciales, deporte, salud

INFLUÊNCIA DO ESPORTE SOBRE O ESTADO DA PRESSÃO PLANTAR
RESUMO

O projeto é orientado para a pesquisa da postura plantar no caso dos esportistas de combate. Nós nos concentramos para as diferenças eventuais relacionadas com o tipo do tapete utilisado para um esporte específico. Após uma experiência anterior, nomeadamente com as superfícies mais macias podemos chegar aos efeitos negativos para o arco plantar e influência sobre a distribuição das pressões plantares durante a marcha normal. A maioria dos esportes de combate precisa de uma superfície mais macia para os atletas porque os ginásios são normalmente cobertos por tatame. Nós achamos que a interação de uma superfície específica sobre o apoio do sistema de pernas é: de um lado, a locomoção numa alfmofada flexível parcialmente instável pode levar ao reforço dos músculos do pé, num pavimento, de um outro lado, depois do contato com a sola apoia o arco plantar o que pode levar à falta do estímulo para a participação ativa dos músculos de apoio do arco plantar. O

objetivo do projeto foi demonstrar o potencial dos esportes no solo mole sobre o estado do arco plantar e se é possível, determinar a natureza durante essas atividades. A pesquisa foi realizada com Emed, plataforma bedobarográfica e foi estabelecida principalmente a distribuição da pressão sobre planta pedis andando e, portanto, a distribuição da pressão estática válida. Na pesquisa foram envolvidos 30 respondentes dos quais 15 fazem o karatê e 15 aïkido. A pesquisa foi realizada entre os anos 2009 - 2011 na Faculdade dos Estudos Esportivos da Universidade Masaryk de Brno. Em base de nossos dados podemos dizer que o arco transversal e longitudinal dos caratecas tem uma forma diferente comparando com o arco dos aiquidocas e há aqui também sinais importantes que provam uma influência positiva do tapete sólido utilisado neste esporte para uma boa posição do arco plantar. Do ponto de vista ortopédico podemos afirmar que este tapete tem um efeito muito favorável para o arco e assim existe uma questão para o público se há necessidade do estímulo de compensação para os esportistas de combate usando apenas uma superfície mole.

PALAVRAS-CHAVE: Cinesiologia, artes marciais, esporte, saúde