"IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology",
Vol. 12, no. 1 (2012), pp. 30–35

KINESIOLOGY

Martin Zvonar[A,D,E,F,G], Katerina Lutonska[B,E,F], Zdenko Reguli[A,D,E], Martin Sebera[C], Tomas Vespalec[B]
Faculty of Sport Studies, Masaryk University in Brno (the Czech Republic)
e-mail: zvonar@fsps.muni.cz

Influence of combative sports on state of plantar pressure

Submission: 10.10.2010; acceptance: 19.10.2011

Key words: skinesiology, plantar pressure, martial arts, health

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 there 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 in 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 established mainly the pressure distribution on planta pedis while walking, and consequently the static pressure distribution in standing. In the research 16 respondents were involved of which 8 performed karate on a hard floor and 8 on a soft floor (tatami). Research was done in the autumn months of 2009 at laboratory of kineziology at Faculty of Sport Studies, Masaryk University in Brno.

Based on our data we can tell that karateka´s (practising on a hard floor) transverse and longitudinal arch has a different shape comparing to the arch of karateka´s practising on tatami and there are also significant marks proving a positive influence of solid pad used in this sport for the right posture of the foot arch. From an orthopedic view we can claim, that pad has very favorable 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.

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, there 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 on the 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 [Green 2001; Vít 2005; Reguli 2005; Štefanovský 2009]. We choose karate, as an example for this research.

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 the previous research we can find explanation of these processes [Eils 2004; Bus, De Lange 2005; Duvač, Kasa 2005; Psalman 2007; Čihounková, Vít 2009; Zvonař, Lutonská 2009].

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.

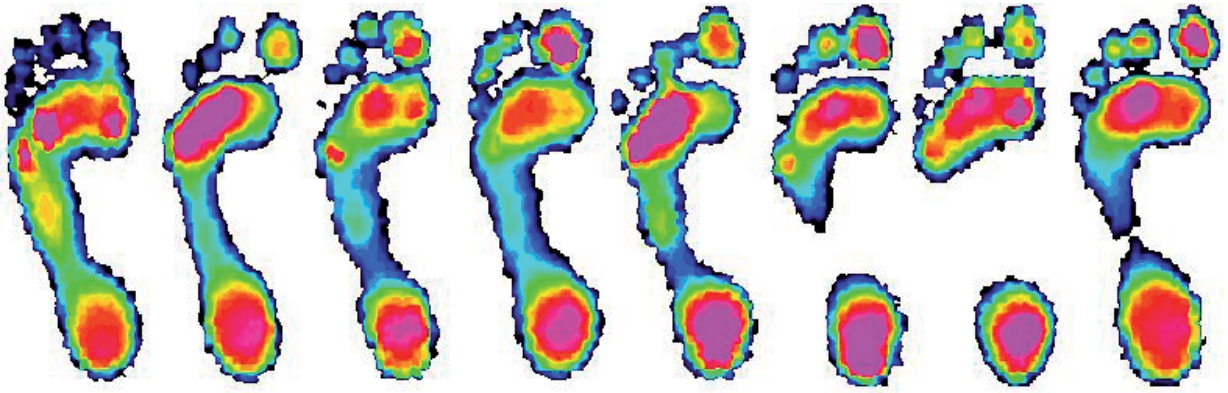

Fig. 1. Maximal pressure – group S

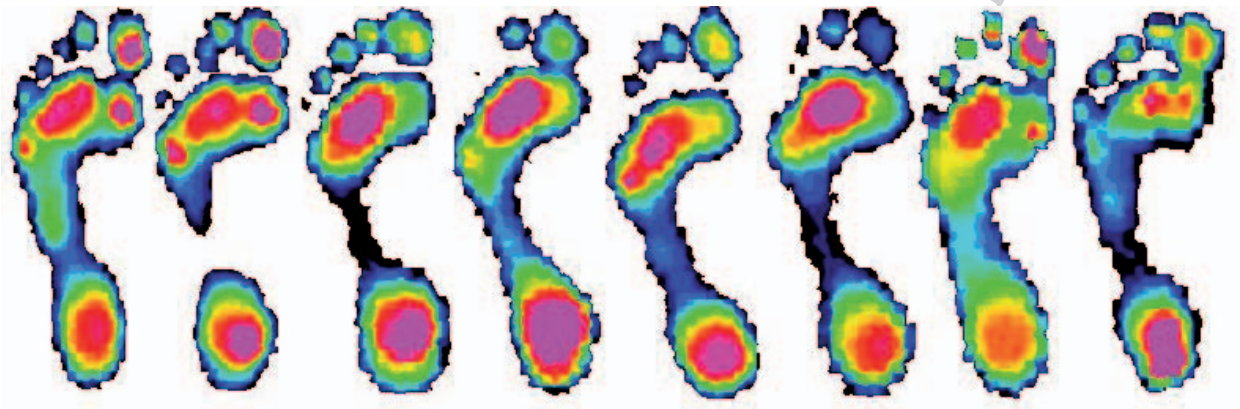

Fig. 2. Maximal pressure – group T

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 divided planta into 6 areas. For each area we measured maximal pressure, peak pressure and time of contact with floor. We used the third step method and we averaged three attempts for each subject foot. In the research there 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 (a gym with tatami surface and a 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 [Birtane, Tuna 2004; Rosenbaum 2006]. 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 show the distribution of maximum pressure on the left foot for all of 16 subjects. Scans in Figure 1 belong to the karatekas who exercise on the solid surface (group S), Figure 2 presents scans of the 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 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 subjects 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.

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

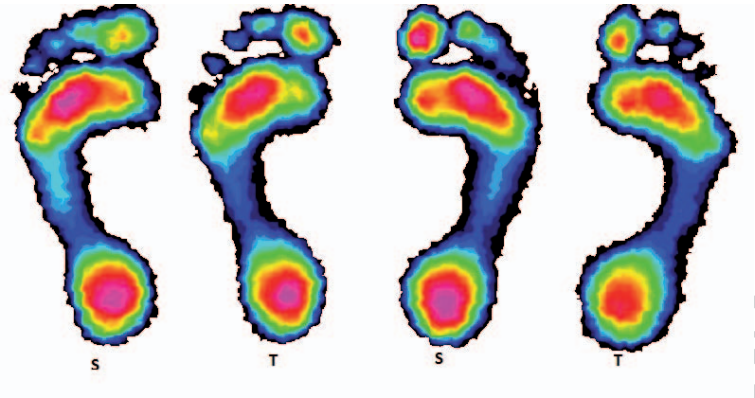

Fig. 3. Virtual averaged maximal pressure distribution scans

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

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 the 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 the 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 of 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.

Discussion

For better understanding, the times of various contact areas are shown graphically in Figures 4 and 5 in accordance with the standard method base on a 3-step protocol [Bus 2005]. Areas come into contact with the base gradually, also gradually leaving it, but more than 40% of the time the foot contacts the pad, all three areas contacting the ground are observed simultaneously. Individual lines in the graphs represent values alternately for group T and group S.

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, which is corresponding with the results in study of obese people [Britane 2004], the highest maximum pressure of the left big toe was noticed in the group T.

All measured values were statistically analyzed. To determine expected statistically significant differences Cohen effect coefficient *d* was calculated. Its value reflects statistical

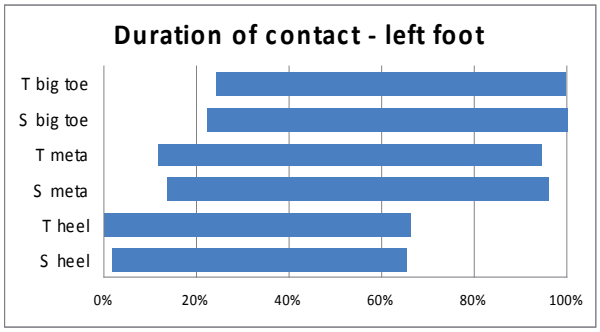

Fig. 4. Duration of contact

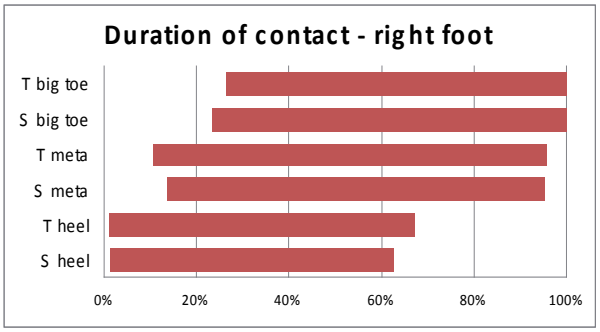

Fig. 5. Duration of contact

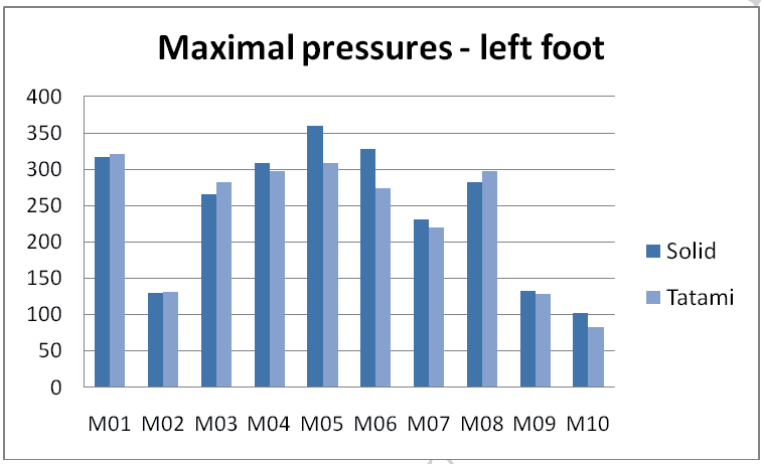

Fig. 6. Graph of maximal pressures

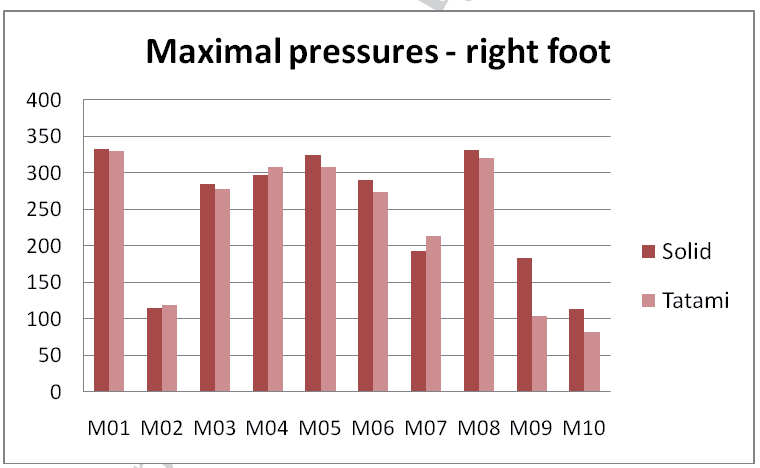

Fig. 7. Graph of maximal pressures

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 ($d_l = 0.74$, $d_r = 0.97$), 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 ($d_l = 0.42$, $d_r = 0.15$) which could point to a better state of transverse arch more stimulated by movement on a harder surface.

Conclusion

As statistically significant was identified both absolute ($d = 0.98$) and relative ($d = 0{,}80$) higher

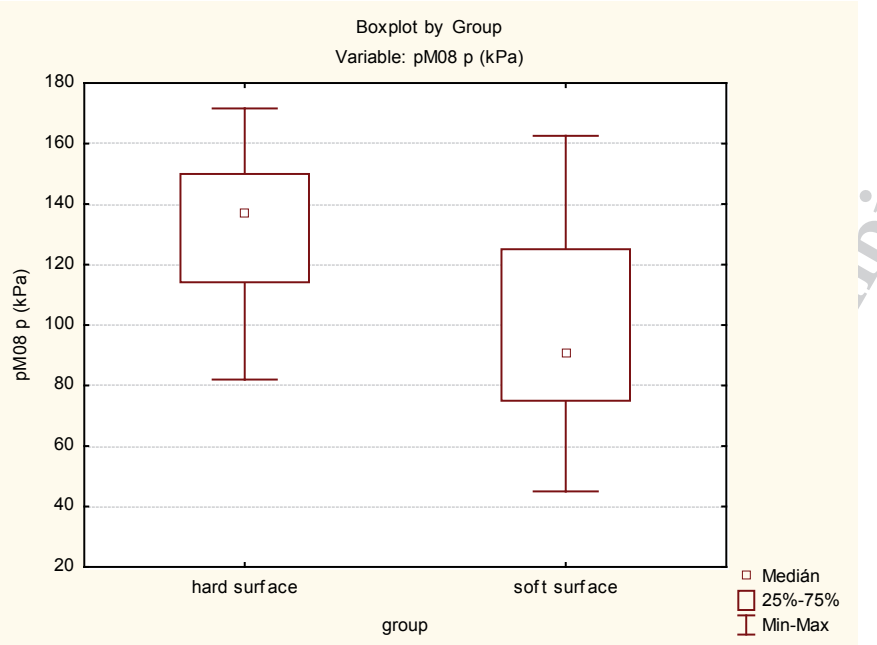

Fig. 8. Comparison of pressures under the big toe between groups S and T

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 (d_l = 0,70; d_r = 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.

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 (d_l = 0.07, d_r = 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.
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., University of Amsterdam. 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*, Katedra telesnej výchovy a športu Fakulty humanitných vied UMB v Banskej Bystrici, Banská Bystrica, pp. 108-118. 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, 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.
6. NOVEL (2006), *Novel scientific*, München.
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.
8. Reguli Z. (2005), *Úpolové sporty (distanční studijní text)*, Masarykova univerzita, Brno. 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 Sientific Meeting, München.
10. Štefanovský M. (2009), *Džudo I. Teória a didaktika*, FTVŠ UK, Bratislava. ISBN 978-80-8113-009-0
11. Green T.A. (2001), *Martial arts of the world: an encyclopedia*, ABC-CLIO Ltd., Santa Barbara, 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*, Masarykova univerzita, Fakulta sportovních studií, Brno. 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*, FSpS MU, Brno. ISBN 978-80-210-5006-8

Wpływ sztuk walki na stan siły nacisku na podeszwę stopy

Słowa kluczowe: kinezjologia, nacisk stopy, sztuki walki, zdrowie

Streszczenie

Projekt badawczy koncertuje się na badaniu dotyczącym kształtowania się łuku stopy wśród zawodników uprawiających sztuki walki. Autorzy tekstu skoncentrowali się na możliwych różnicach związanych z typem podłoża używanego w danym sporcie. Po poprzednich doświadczeniach związanych szczególnie z ćwiczeniami na bardziej miękkich podłożach oczekiwano negatywnych skutków w obrębie łuku stopy oraz wpływu nacisku podeszwy stopy podczas normalnego chodzenia.

Większość sportów walki wymaga miękkiej powierzchni dla sportowców, więc sale gimnastyczne są przeważnie pokryte matą tatami. Autorzy zakładają interakcję między powierzchnią a systemem wspierającym nogę. Z jednej strony poruszanie się po giętkiej, stąd częściowo niestabilnej powierzchni, może prowadzić do wzmocnienia mięśni podbicia, z drugiej jednak strony powierzchnia po kontakcie z podeszwą tworzy wsparcie dla łuku stopy, co może prowadzić do braku bodźców dla aktywnego zaangażowania mięśni wspierających łuk stopy.

Celem projektu było udowodnienie potencjalnego narażenia łuku stopy w czasie walki sportowej na miękkiej powierzchni oraz jeśli to możliwe do określenia charakteru owego działania. Projekt realizowany był przy użyciu platformy pedobarograficznej Emed i stwierdzał głównie rozłożenie nacisku na okolice podeszwy w czasie chodzenia oraz w konsekwencji statyczny rozkład nacisku w pozycji stojącej. W badaniu uczestniczyło 16 respondentów, z których 8 ćwiczyło karate na twardej powierzchni, a 8 na miękkiej (tatami). Badanie prowadzone było jesienią 2009 roku w laboratorium kinezjologii na Wydziale Studiów Sportowych na Uniwersytecie Masaryka w Brnie.

Opierając się na badaniach autorzy stwierdzają, iż podłużny i poprzeczny łuk stopy karateków ćwiczących na twardej powierzchni ma nieco inny kształt w porównaniu do karateków ćwiczących na macie tatami. Istnieją także pewne oznaki udowadniające pozytywny wpływ twardych powierzchni używanych w tym sporcie dla właściwej pozycji łuku stopy. Z ortopedycznego punktu widzenia autorzy twierdzą, iż rodzaj podłoża ma istotny wpływ na łuk stopy, chociaż nie są w stanie definitywnie określić, które podłoże ma większy wpływ na łuk podłużny stopy. Stawiają także pytanie czy istnieje potrzeba kompensacji bodźców dla sportowców uprawiających sztuki walki jedynie na miękkiej powierzchni.