

# Foot and Ankle Problems in Muay Thai Kickboxers

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**Background:** Muay Thai kickboxing is a common sport that uses the foot and ankle in fighting. Muay Thai kickboxing trainees usually receive training in Thailand. Foot and ankle problems in this group of people who usually train barefoot remain unexplored.

**Objective:** To evaluate the prevalence of common foot and ankle problems in Muay Thai kick boxers.

**Material and Method:** The present study is a cross-sectional survey of Muay Thai kick boxers practicing in northern Thailand. Interviews were conducted and foot and ankle examinations were evaluated. Foot morphology was examined using a Harris mat footprint.

**Results:** One hundred and twenty-three Muay Thai kickboxers from nine training gyms were included in this study. Common foot and ankle problems found in the Muay Thai kick boxers were callosity (59%), gastrocnemius contracture (57%), toe deformities (49.3%), wounds (10%) and heel pain (9%). Callosity was most commonly found on the forefoot (77.5%), on the plantar first metatarsal (55.3%) and on the big toe (33.3%). An association was found between a tight heel cord and a history of foot injury with prolonged periods of weekly training. Toe deformities such as hallux rigidus (37.6%) were also associated with prolonged periods of training ( $p = 0.001$ ). No correlation was found between type of foot arch and foot and ankle problems.

**Conclusion:** Plantar forefoot callosities and wounds as well as toe deformities including tight heel cords are some of the foot and ankle problems commonly found in Muay Thai kick boxers. They are associated with prolonged periods of barefoot training. The unique pattern of training and of the kicks in Muay Thai might be a path mechanism, leading to the development of foot and ankle problems.

**Keywords:** Foot ankle, Muay Thai, Kickboxing, Callosity, Gastrocnemius contracture, Toe deformity, Hallux

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Muay Thai kickboxing is an ancient martial art in Thailand. Muay Thai boxers fight with their fists, elbows, knees, shins and feet. In northern Thailand, there are many Thai boxing camps in rural areas training young Thai kick boxers. They train and fight in communities that have a strong sense of love for that martial art.

Common foot and ankle problems have been explored in many groups, including shod and unshod sports people. Among the shod sports, National Collegiate Athletic Association injury surveillance data have reported problems in the group of women's soccer participants. Ankle ligament sprains, knee internal

derangement and concussions were three common injuries in that group<sup>(1,2)</sup>. Among the unshod sports, martial arts practitioners represent a special population for foot and ankle exploration. They regularly use parts of their lower extremities in training and while fighting including the foot and ankle. Lower extremity injuries are commonly found in karate and taekwondo practitioners. Lystad et al found that the most common injury to the lower extremities in taekwondo is contusion, while foot injuries such as digital fractures have been reported in karate participants<sup>(3)</sup>.

Muay Thai kickboxers are a unique group among the unshod population in that they do not wear shoes while practicing or while fighting. Both feet are used in kicking, climbing and punching during a fight, activities which can theoretically increase the risk of developing foot and ankle problems. The aim of the present study was to analyze the prevalence of

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common foot and ankle problems and associated factors in Muay Thai kickboxing<sup>(4,5)</sup>.

## Material and Method

Following approval by the Institutional Review Board of Chiang Mai University, 123 Muay Thai boxers from the northern part of Thailand were included in the study over a period of 12 months (January 2012 to December 2012). Muay Thai boxers who had previous foot and ankle surgeries were excluded. All subjects underwent an interview, a physical examination by a fellowship-trained orthopaedic surgeon, and a Harris mat imprint study.

An interview questionnaire designed to obtain information on the age, body weight, height, level of training, weekly duration of training, and the number of fights participated in was administered. Data were collected at Muay Thai kickboxing camps in the northern region of Thailand. Interviews were conducted in person by orthopaedic residents and medical students to ensure that all questions were fully answered. The purpose of the interview was explained to the participants and a consent form was signed.

An examiner (TV), a fellowship-trained orthopaedic surgeon, gave a foot and ankle examination to all Muay Thai boxers. Data on skin abnormalities including callosity, ulceration and infection were recorded. Deformities of toes, mid foot, hind foot, and ankles were evaluated. Passive ankle motion was measured and recorded using a goniometer with the patient sitting. Ankle motion was assessed by passive ankle dorsiflexion with the knee flexed at 90 degrees and fully extended. The goniometer was placed on the lateral aspect of the foot and ankle with the proximal arm aligned along the axis of the fibula and the distal arm aligned along the plantar axis of the foot. Gastrocnemius contracture was defined as a limitation of passive ankle dorsiflexion of less than 10 degrees<sup>(6)</sup>. Foot morphology such as pes planus or cavus was analyzed with a Harris mat imprint study. Two Harris mats were used to obtain data on both feet. Muay Thai boxers were requested to stand about 18 inches behind two Harris mats. Subjects walked forward, stepping with both feet onto the center of the Harris mats. They then continued walking forward beyond the mats, leaving imprints of their feet. Footprint measurements, Chippaux-Smirak index (CSI), and the midline foot axis (MFA) were evaluated. CSI was calculated as the ratio of the maximum width of the metatarsals to the minimum width of the arch<sup>(7)</sup>. The MFA (the distance from the medial edge of the midfoot imprint to the

scale at the point that bisects a line drawn from the middle of the second toe imprint to the middle of the heel imprint) was used to identify foot deformities<sup>(8,9)</sup>.

The CSI was used to classify feet as normal (CSI = 29.9%), mild flatfoot (CSI = 30-39.9%), moderate flatfoot (CSI = 40-44.9%), or severe flatfoot (CSI 45%). In addition, the MFA indicates a high arch if a score is less than -2, a neutral arch if the score is -1 to +1, and a low arch is more than +2<sup>(7-9)</sup>. The CSI and MFA were calculated using a computerized measurement model with a reliability of 0.8 when compared to manual measurement.

All information collected was stored on a Microsoft Excel spreadsheet and an SPSS database for analysis. Chi-square analysis was used for the analysis of the associated factors in Muay Thai Kickboxing. Results were considered statistically significant when *p*-value were less than 0.05.

## Results

### Demographic data

One hundred and twenty-three Muay Thai boxers (111 males and 12 females) from nine camps in the northern part of Thailand were included in the study. The average age was 25.4 years (range 9 to 55 years). The mean body mass index was 22.2 kg/m<sup>2</sup> (range 13.6 to 31.2 kg/m<sup>2</sup>). There were 42 beginners (34.1%), 39 amateurs (31.7%) and 42 professionals (34.1%). The beginner boxer is a minimal training routine consisting of learning how to hit the heavy bag, doing shadow boxing in front of a mirror and jogging every day, as well as an occasional practice bout inside the ring. They may experience one or two competition in a year. The amateurs spend sometimes of their careers preparing for a competition or bout. The training is much more stringent. The professional boxer is a person who earns a living in a boxer career frequently engaged in by amateurs. Of the group, 75 Muay Thai boxers (61%) had fought fewer than five times in the past year, while 30 Muay Thai boxers (24.4%) had fought more than fifteen times per year and 18 Muay Thai boxers (14.6%) had fought from five to fifteen times per year.

Of the Muay Thai boxers, 70 (56.9%) had a history of foot and ankle injuries including wounds, fractures and numbness; most (53.9%) had one to three times injuries. In terms of duration of training per week, 48 Muay Thai boxers (39%) trained for less than 20 hours, 44 (35.8%) for 20 to 40 hours, and 30 (25.2%) for more than 40 hours. Among the Muay Thai boxers, 36 (29.5%) had been competing for less than one year,

48 (39.4%) had been competing for 1 to 5 years and 38 (31.1%) had been competing for more than 5 years.

#### **Foot and ankle examination**

Five common foot and ankle problems of Muay Thai boxers were callosity (59%), tight heel cords (57%), toe deformities (49.3%), wounds (10%) and heel pain (9%). The callosity was mostly present on the forefoot (77.5%), followed by the malleoli (16.3%), the mid foot (3.1%) and the heel (3.1%). Callosity was present bilaterally in 95% of Muay Thai boxers. In the forefoot area, the callosities were commonly found at the plantar aspect of first metatarsal head (55.3%), the big toe (33.3%), the lesser toes (6.1%) and the fifth metatarsal head (5.3%). Multiple callosities in one foot were found in 9.7% of the boxers. The most common presentation of multiple callosities was a combination of the first metatarsal head and the big toe (4%). Callosity was associated both with a career of Muay Thai kickboxing of more than a year and also with a previous history of foot and ankle injuries ( $p = 0.005$  and  $<0.001$ , respectively). However, there was no association between callosity and gastrocnemius contracture. Gastrocnemius contracture tended to be associated with a previous history of foot and ankle injuries and with prolonged duration of training each week ( $p = 0.080$  and  $0.100$ , respectively).

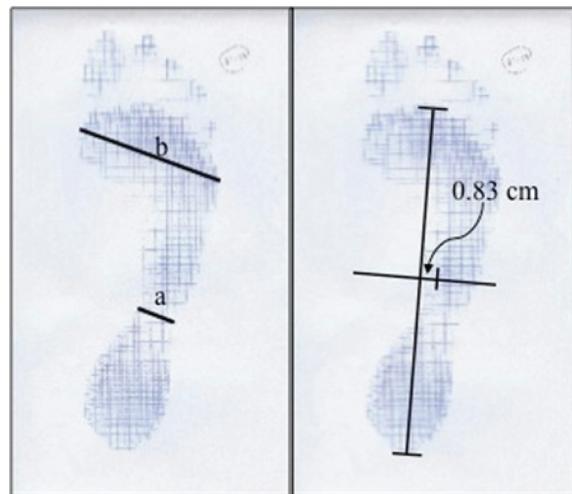
Toe deformities were also common, including the hallux and the lesser toes. Of the boxers studied, 37.6% had hallux rigidus, 9.3% had hallux valgus and 2.4% had claw toes. Toe deformities were significantly more common in Muay Thai boxers who trained more than 20 hours per week ( $p = 0.001$ ).

Wounds were usually in the forefoot area (92%) and the ankle (8%). Wounds were present on the first metatarsal head (52.2% of subjects), the big toe (26.1%), the fifth metatarsal head (13%) and the lesser toes (8.7%). There was no statistically significant association between wounds and weekly duration of training or length of boxing career.

Heel was pain present in 9% of the boxers including plantar heel pain (4%), posterior heel pain (4%) and retrocalcaneal bursitis (1%). There was no statistically significant association between heel pain and duration of weekly training or length of boxing career. Obesity and age were not associated with any foot or ankle problems.

#### **Harris mat imprint studies**

The mean MFA score was -0.09 (range -2.4 to 3.1). Most Muay Thai boxers (69.1%) had a normal



**Fig. 1** Footprints showing measurement of the Chippaux-Smirak index (CSI) (a/b) and the mid foot axis (MFA).

arch, 19.1% had a high arch, and 11.8% had a low arch. The mean CSI was 0.34 (range 0.11 to 0.71). Frequencies of mild, moderate, and severe flatfoot were 36.6%, 16.3%, and 17.5%, respectively. There were no statistically significant associations between foot shape and duration of weekly training, length of boxing career or gastrocnemius contracture (Fig. 1).

#### **Discussion**

A high prevalence of foot and ankle problems was found in Muay Thai boxers in northern Thailand. The most common problem was callosity, followed by gastrocnemius contracture, toe deformities, wounds and heel pain. Prolonged periods of training each week and longer boxing careers might have increased the risk of developing foot problems, especially callosity and toe deformities. The effect of gastrocnemius contracture, surprisingly, was not associated with foot and ankle problems.

Callosity and wounds of the feet and ankles in Muay Thai boxers were found in the same area in this study. Those locations - forefoot, malleoli, mid foot and heel - might be explained in two ways. Firstly, Muay Thai boxers usually train without shoes for a long period of time each day. They train by dancing on their tiptoes and quickly turning from side to side. Moreover, they use their first metatarsal joint and big toe as a pivot point when kicking and dancing which may cause increased pressure on the forefoot at the plantar surface of the first metatarsal head and the big toe. A significant association was found between

length of boxing career and callosity. Secondly, Muay Thai boxers use their feet for kicking. One of the most common kicking actions is a front kick in which the metatarsal heads and big toe are used to kick another boxer or to push him away. This action may be a cause of increased contact pressure on the plantar aspect of the forefoot<sup>(10)</sup>. Callosity on the malleoli was also present in Muay Thai boxers. That may be explained by the action of sidekicks that use the medial malleolus to kick another boxer and the action of warding off blows that use the outside of the ankle and the lateral malleolus to block kicks (Fig. 2). In the general population, callosity is found in 18 to 24% of individuals, with the incidence increasing with age. The prevalence is also high in sports such as running (57%)<sup>(11)</sup>. In the present study, 59% of the boxers displayed the problem, an incidence rather higher than in the general population, but similar to runners. Callosity can cause symptoms of pain and wound breakdown. Wounds may become infected which can result in osteomyelitis, especially in Muay Thai boxers who have poor hygiene practices<sup>(10,12)</sup>.

The high prevalence of toe deformities in Muay Thai boxers was associated with prolonged periods of training each week. The prevalence of hallux rigidus in the subjects studied was higher than that in the general population. This may be due to the Muay Thai action of dancing and kicking that regularly uses the first metatarsophalangeal joint<sup>(13,14)</sup>, putting repetitive force on the sagittal plane. That may also be a cause of osteophyte formation or arthritis<sup>(15)</sup>. The prevalence of hallux valgus is not different from the general population<sup>(16)</sup>, which favors the genetic theory of hallux valgus development rather than the effects of shoes or activities<sup>(17-19)</sup>. Lesser toe deformities are also common and associated with the same factors, but the



**Fig. 2** Unique activities of Muay Thai kickboxers, front kicking and side kicking.

incidence is lower than in the general populations<sup>(20-22)</sup>; that lower incidence might be explained by the lack of prolonged compression effect from shoes.

Gastrocnemius contracture is also a common problem in Muay Thai boxers. In the general population, tight heel cord (defined as less than 10 degrees passive dorsiflexion in knee flexion and extension) is found in 44% of people<sup>(6)</sup>. In the present study, up to 57% of the subjects displayed this problem. Prolonged training including dancing on the tiptoe without shoes may be a cause of gastrocnemius muscle contracture. However, no association was found between other foot and ankle problems and gastrocnemius contracture, which might be due to the lack of compression effect from shoes or to the small number of Muay Thai boxers included in the present study. The prevalence of either plantar or posterior heel pain was not very high. That finding might be the result of the lack of shoe compression and the relatively young mean age of Muay Thai boxers in the present study (most studies reporting on common conditions causing heel pain include older subjects, into their fourth or fifth decades<sup>(23)</sup>).

The results of the present study are important for identifying potential preventive strategies. The forefoot callosity and wounds indicate a mechanical overload of the forefoot. In addition, the high prevalence of gastrocnemius contracture can cause altered load transition through the plantar aspect of the forefoot<sup>(6,24)</sup>. Muay Thai boxers who have these problems may need to regularly stretch their gastrocnemius muscles to prevent abnormal foot pressure distribution on the callosity and the wounds, and to prevent foot and ankle pain. Stretching may also result in decreased callosity formation. The present study included only boxers from the northern region of Thailand due to the logistical problems of recruiting boxers from a larger area which potentially introduced a sampling bias. In addition, radiographic study was not utilized to confirm bony abnormalities.

### Conclusion

Plantar forefoot callosities and wounds, as well as toe deformities including tight heel cord were some of the foot and ankle problems commonly found in Muay Thai kickboxers. These problems are also commonly seen in other sports that involve prolonged periods of barefoot activity. The unique patterns of practicing and kicking in Muay Thai kickboxing might be a pathomechanism in the development of those foot and ankle problems.

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## What is already known on this topic?

There were no previous studies of prevalence in foot ankle in unshod monk. There was a study of foot and ankle injury in Taekwondo and some contact sport. The interesting is to understand and process to prevention in next study.

## What this study adds?

Adding new knowledge that are the problem of callosity, ulcers and tight heel cord lead us to study more about how to prevent and treating problems for avoiding chronic foot ankle problems in the Monks.

## Potential conflicts of interest

None.

## References

1. Dick R, Putukian M, Agel J, Evans TA, Marshall SW. Descriptive epidemiology of collegiate women's soccer injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2002-2003. *J Athl Train* 2007; 42: 278-85.
2. Dick R, Agel J, Marshall SW. National Collegiate Athletic Association Injury Surveillance System commentaries: introduction and methods. *J Athl Train* 2007; 42: 173-82.
3. Lystad RP, Pollard H, Graham PL. Epidemiology of injuries in competition taekwondo: a meta-analysis of observational studies. *J Sci Med Sport* 2009; 12: 614-21.
4. Gartland S, Malik MH, Lovell ME. Injury and injury rates in Muay Thai kick boxing. *Br J Sports Med* 2001; 35: 308-13.
5. Gartland S, Malik MH, Lovell M. A prospective study of injuries sustained during competitive Muay Thai kickboxing. *Clin J Sport Med* 2005; 15: 34-6.
6. DiGiovanni CW, Kuo R, Tejwani N, Price R, Hansen ST Jr, Czirnecki J, et al. Isolated gastrocnemius tightness. *J Bone Joint Surg Am* 2002; 84-A: 962-70.
7. Chen KC, Yeh CJ, Kuo JF, Hsieh CL, Yang SF, Wang CH. Footprint analysis of flatfoot in preschool-aged children. *Eur J Pediatr* 2011; 170: 611-7.
8. Coughlin MJ, Kaz A. Correlation of Harris mats, physical exam, pictures, and radiographic measurements in adult flatfoot deformity. *Foot Ankle Int* 2009; 30: 604-12.
9. Grebing BR, Coughlin MJ. Evaluation of Morton's theory of second metatarsal hypertrophy. *J Bone Joint Surg Am* 2004; 86-A: 1375-86.
10. Duffin AC, Kidd R, Chan A, Donaghue KC. High plantar pressure and callus in diabetic adolescents. Incidence and treatment. *J Am Podiatr Med Assoc* 2003; 93: 214-20.
11. Spink MJ, Menz HB, Lord SR. Distribution and correlates of plantar hyperkeratotic lesions in older people. *J Foot Ankle Res* 2009; 2: 8.
12. Höglund HC, Jeannot E, Delmi M, Chastonay P. Non traumatic lesions of the foot, calluses and nails: socioeconomic impact of an unexplored issue. *Rev Med Suisse* 2011; 7: 2148-52.
13. Coughlin MJ, Shurnas PS. Hallux rigidus: demographics, etiology, and radiographic assessment. *Foot Ankle Int* 2003; 24: 731-43.
14. Beeson P, Phillips C, Corr S, Ribbands WJ. Hallux rigidus: a cross-sectional study to evaluate clinical parameters. *Foot (Edinb)* 2009; 19: 80-92.
15. Vaseenon T, Amendola A. Update on anterior ankle impingement. *Curr Rev Musculoskelet Med* 2012; 5: 145-50.
16. Nix S, Smith M, Vicenzino B. Prevalence of hallux valgus in the general population: a systematic review and meta-analysis. *J Foot Ankle Res* 2010; 3: 21.
17. Glasoe WM, Nuckley DJ, Ludewig PM. Hallux valgus and the first metatarsal arch segment: a theoretical biomechanical perspective. *Phys Ther* 2010; 90: 110-20.
18. Perera AM, Mason L, Stephens MM. The pathogenesis of hallux valgus. *J Bone Joint Surg Am* 2011; 93: 1650-61.
19. Hannan MT, Menz HB, Jordan JM, Cupples LA, Cheng CH, Hsu YH. High heritability of hallux valgus and lesser toe deformities in adult men and women. *Arthritis Care Res (Hoboken)* 2013; 65: 1515-21.
20. Bascareviae ZLj, Vukasinoviae ZS, Bascareviae VD, Stevanoviae VB, Spasovski DV, Janiciae RR. Hallux valgus. *Acta Chir Iugosl* 2011; 58: 107-11.
21. Goud A, Khurana B, Chiodo C, Weissman BN. Women's musculoskeletal foot conditions exacerbated by shoe wear: an imaging perspective.

- Am J Orthop (Belle Mead NJ) 2011; 40: 183-91.
22. Mirzashahi B, Ahmadifar M, Birjandi M, Pournia Y. Comparison of designed slippers splints with the splints available on the market in the treatment of hallux valgus. Acta Med Iran 2012; 50: 107-12.
  23. Abdulmassih S, Phisitkul P, Femino JE, Amendola A. Triceps surae contracture: implications for foot and ankle surgery. J Am Acad Orthop Surg 2013; 21: 398-407.
  24. Chen WM, Park J, Park SB, Shim VP, Lee T. Role of gastrocnemius-soleus muscle in forefoot force transmission at heel rise-A 3D finite element analysis. J Biomech 2012; 45: 1783-9.

### **ปัญหาเท้าและข้อเท้าของนักมวยไทย**

**ธนวัฒน์ วงศินท์, ปิยะพงศ์ อินทรสมพันธ์, ทองเอก วัฒนโรจนaphr, สันสนีย์ เอื้อพันธ์วิริยะกุล, นิพนธ์ ชีรอำนวย, พนิจ พิสิษฐ์กุล**

**ภูมิหลัง:** มวยไทยเป็นศิลปะการต่อสู้ที่ใช้เท้าและข้อเท้า เป็นศิลปะประจำชาติไทย ปัญหาเท้าและข้อเท้าพบได้บ่อยเนื่องจากเป็นกีฬาที่เด่นโดยไม่ใช้รองเท้า

**วัตถุประสงค์:** เพื่อศึกษาอุบัติการณ์การเกิดปัญหาเท้าและข้อเท้าที่พบบ่อยของนักมวยไทย

**วัสดุและวิธีการ:** เป็นการศึกษาโดยการสำรวจ stemming ตรวจร่างกาย และพิมพ์เท้านักมวยไทยในภาคเหนือ

**ผลการศึกษา:** นักมวยไทย 123 คน จากค่ายมวย 9 แห่ง พบริวัติ 59 เปอร์เซ็นต์ กล้ามเนื้อน่องตึง 57 เปอร์เซ็นต์ นิ้วเท้าผิดรูป 49.3 เปอร์เซ็นต์ แพด 10 เปอร์เซ็นต์ ปวดสันเท้า 9 เปอร์เซ็นต์ ผิวหนังแข็งพนมมากที่ปลายเท้า 77.5 เปอร์เซ็นต์ โดยเฉพาะใต้กระดูกเท้าที่ 1 55.3 เปอร์เซ็นต์ และใต้ปลายนิ้วหัวแม่เท้า 33.3 เปอร์เซ็นต์ มีแนวโน้มว่ากล้ามเนื้อน่องตึงstemพันธ์ กับประวัติการเกิดการบาดเจ็บของเท้าและสัมพันธ์กับช่วงโคงการฝึกซ้อมที่ยาวนาน นิ้วเท้าผิดรูปสัมพันธ์กับช่วงโคงการฝึกซ้อมที่ยาวนานอย่างมีนัยสำคัญ ไม่มีความสัมพันธ์ระหว่างรูปเท้าที่พิคปอดกับปัญหาเท้าและข้อเท้า

**สรุป:** โรคผิวหนังแข็งได้ฝ่าเท้าส่วนหน้า แพด และนิ้วเท้าผิดรูปสัมพันธ์กับกล้ามเนื้อน่องตึงซึ่งพบบ่อยในนักมวยไทย อุบัติการณ์นี้สัมพันธ์กับช่วงโคงการฝึกซ้อมที่ยาวนาน การเขย่งเท้า และรูปแบบการเตะของนักมวยไทย เป็นสาเหตุสำคัญของปัญหาเท้าและข้อเท้าที่พบบ่อย