

# The ankle joint dorsiflexion range of motion in the closed kinematic chain of judokas and football players – pilot study

## Authors' Contribution:

- A Study Design
- B Data Collection
- C Statistical Analysis
- D Manuscript Preparation
- E Funds Collection

Dávid Líška <sup>1ABD</sup>, Erika Liptaková <sup>2CE</sup>, Ladislav Batalik <sup>3ABE</sup>,  
Sebastian Rutkowski <sup>4ABE</sup>

<sup>1</sup> Faculty of Arts, Department of Physical Education and Sports, Matej Bel University, Banská Bystrica, Slovakia

<sup>2</sup> Faculty of Economics, Department of Applied Mathematics and Business Informatics, Technical University of Košice, Košice, Slovakia

<sup>3</sup> Department of Rehabilitation, University Hospital Brno, Brno, Czech Republic

<sup>4</sup> Department of Physical Education and Physiotherapy, Opole University of Technology, Opole, Poland

**Received:** 05 March 2021; **Accepted:** 19 April 2021; **Published online:** 30 April 2021

**AoBID:** 14317

## Abstract

- Background and Study Aims:** Judo is a sport that requires combination of multiple demanding training attributes. Little is known about the impact of a long-term practice on the ankle joint dorsiflexion range of motion. The aims of this pilot study is knowledge about dorsiflexion range of motion in the judokas in comparison to the football players.
- Material and Methods:** The sample included 20 judokas with a mean age of 20.15 years ( $\pm 4.17$ ). The mean weight of the judokas was 82.15 kg ( $\pm 15.5$ ). The mean height of the judokas was 180.40 cm ( $\pm 7.46$ ). The control group consisted of 22 football players with a mean age of 21.63 ( $\pm 3.40$ ). The mean weight of the football players was 75.90 kg ( $\pm 6.67$ ). The mean height of the football players was 181.27 cm ( $\pm 5.86$ ).
- Results:** The mean right ankle joint dorsiflexion range of motion in judokas was  $43.15^\circ$  ( $\pm 6.71$ ). The mean right ankle joint dorsiflexion range of motion in football players was  $41.02^\circ$  ( $\pm 5.72$ ). The mean left ankle joint dorsiflexion range of motion in judokas was  $43.90^\circ$  ( $\pm 6.68$ ). The mean left ankle joint dorsiflexion range of motion in football players was  $42.09^\circ$  ( $\pm 7.17$ ). Non-significant difference was finding between groups in right ( $p = 0.357$ ) or left ( $p = 0.284$ ) ankle joint dorsiflexion range of motion.
- Conclusions:** Greater ankle joint dorsiflexion range of motion was found in judokas. Better adaptation in favour of the judokas means greater variability in the movement of the ankle towards the dorsiflexion in the judoist training process. Judo leads to better adaptation in the ankle joint towards dorsiflexion in ankle joint in compared to football players. However, results were no statistically significant.
- Keywords:** adaptation • contact sport • weight bearing lunge test
- Copyright:** © 2021, the Authors. Published by Archives of Budo
- Conflict of interest:** Authors have declared that no competing interest exists
- Ethical approval:** The study was approved by the local research committee
- Provenance & peer review:** Not commissioned; externally peer-reviewed
- Source of support:** This research was funded by the Ministry of Health (Czech Republic); conceptual development of research organization (FNBr, 65269705)
- Author's address:** Dávid Líška, Faculty of Arts, Department of Physical Education and Sports, Matej Bel University, Tajovského 40, 974 01 Banská Bystrica, Slovakia; e-mail: david.liska27@gmail.com

**Athlete** – *noun* **1.** someone who has the abilities necessary for participating in physical exercise, especially in competitive games and races **2.** a competitor in track or field events [30].

**Player** – *noun* someone taking part in a sport or game [30].

**Contact sport** – *noun* any sport in which physical contact between players is an integral part of the game, e.g. boxing, rugby or taekwondo [30].

**Dorsiflexion** – *noun* flexion towards the back of part of the body, e.g. Raising the foot at the ankle. Compare **plantar flexion** [30].

**Plantar flexion** – *noun* the bending of the toes downwards [30].

**Proximal** – *adjective* used for describing a body part that is close to the main trunk of the body [30].

**Load** – *noun* **1.** a weight or mass which is supported **2.** the force that a body part or structure is subjected to when it resists externally applied forces **3.** the amount of something, usually weight, that a body part can deal with at one time [30].

**Performance** – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [30].

**Tactics** – *plural noun* the art of finding and implementing means to achieve immediate or short-term aims [30].

**Technique** – *noun* a way of performing an action [30].

## INTRODUCTION

Judo is a dynamic, high intensity sport that requires complex abilities and tactical skills for success [1, 2]. Judo competitors are divided into weight classes. Judo requires high coordination and cognitive and emotional control [3, 4]. Other important attributes are strength [5], endurance [6] of the upper and the lower limbs, speed, anaerobic power, core muscles function and grip force [7-10]. Rapid force generation is an important part of performance during traction [11]. The judoka competes barefoot and can move the ankle joint freely, which leads to ankle-foot mechanism for adaptation [12].

Football is one of the most popular sports, that is known for its repetitive activities, such as acceleration, deceleration or change of direction [13]. Football is a contact sport and requires high level of physical capacity and tolerance to high-intensity loads. Football players wear football boots during training or a match. The foot is fixed by the football boot.

The foot and the ankle are the basis of the support of the human body. Optimal biomechanical functions are required to maintain a static upright posture and to make dynamic movements. The ankle joint dorsiflexion occurs naturally during different lower limbs movements. The ankle joint dorsiflexion is necessary for normal walking. The ankle joint dorsiflexion has an important function in biomechanical movements, which is a necessity in sports requiring landing. Reduced ankle joint dorsiflexion may affect the function not only in the ankle, but also in the proximal joints. Reduced ankle joint dorsiflexion increases the risk of different injuries. Lower limb injuries, such as sprained ankle, anterior cruciate ligament injury, patellar tendinopathy and Achilles tendinopathy are associated with the limitation of the ankle joint dorsiflexion [14-16]. A limited ankle joint dorsiflexion is associated with the chronic instability of the ankle [17]. For these reasons, limited ankle joint range of motion, especially the dorsiflexion range of motion while carrying a weight, has a direct impact on sports performance. Therefore. The aim of this pilot study is knowledge about the ankle joint dorsiflexion range of motion in the judokas in comparison to the football players.

## MATERIAL AND METHODS

### Participants

Two groups of athletes were included in this study. The first group included judokas ( $n = 20$ ); the control group consisted of football players ( $n = 22$ ). Only athletes who practiced the given sport for more than seven years were included into this study. Athletes who practiced more than one sports discipline and athletes suffering from acute lower limbs injuries and from infectious disease were not included. Testing of athletes took place in the DUKLA Banská Bystrica Military Sports Centre (Slovakia). Testing was not conducted during and after training to assure that the training process would not affect the ankle range of motion.

The sample included 20 judokas. The mean age of judo athletes was 20.15 years ( $\pm 4.17$ ); the mean weight was 82.15 kg ( $\pm 15.5$ ) and the mean height of the judokas was 180.40 cm ( $\pm 7.46$ ). The control group included 22-football players. The mean age of football players was 21.63 ( $\pm 3.40$ ); the mean weight of the football players was 75.90 kg ( $\pm 6.67$ ) and the mean height was 181.27 cm ( $\pm 5.86$ ) (Table 1).

### Weight bearing lunge test

The most common method of testing the ankle joint dorsiflexion is the weight bearing lunge test. The Weight-bearing lunge test or Dorsiflexion Lunge Test is used to assess the dorsiflexion range of movement at the ankle joint. The weight bearing lunge test is a functioning and reliable method for indirect valuation of the dorsiflexion by measuring the shift of tibia across the back of the foot in the loading position. The weight bearing lunge test shows high reliability [18-20]. Weight bearing lunge test was measurement by Tiltmeter App.

### Statistical analysis

The results were collected in an Excel spreadsheet and subsequently subjected to statistical analysis using software IBM SPSS Statistics 19. Due to the small size of the sample files, the Mann-Whitney U test was used to assess the difference in the mean values for the right and left-ankle joint between two groups of sportsmen. The estimation of the results is based on the following indicators: frequency (N, n); mean (M); minimum (Min); Maximum (Max); standard deviation (SD or  $\pm$ ); significance level, probability ( $p$ ).

**Table 1.** Subjects' biometric data.

Athletes	Variable	Mean	SD	Minimum	Maximum
Judo (n = 20)	weight (kg)	82.15	15.50	57	105
	height (cm)	180.40	7.46	170	195
	age (years)	20.15	4.17	18	31
	right	43.15	6.71	33	57
	left	43.90	6.68	33	54
Football (n = 22)	weight (kg)	75.90	6.67	60	87
	height (cm)	81.27	5.86	172	190
	age (years)	21.63	3.40	18	29
	right	41.02	5.72	28	53
	left	42.09	7.17	2	59

## RESULTS

The mean right ankle joint dorsiflexion range of motion in the judokas was  $43.15^\circ (\pm 6.71)$ . The mean right ankle joint dorsiflexion range of motion in the football players was  $41.02^\circ (\pm 5.72)$ . The mean left ankle dorsiflexion range of motion in the judokas was  $43.90^\circ (\pm 6.68)$ . The mean left ankle joint dorsiflexion range of motion in the football players was  $42.09^\circ (\pm 7.17)$  (Table 2). Non-significant difference was finding between groups in right ( $p = 0.357$ ) or left ( $p = 0.284$ ) ankle joint dorsiflexion range of motion (Table 3).

## DISCUSSION

Efficient techniques are important for success in judo; they should be applied accurately and adequately using opportunity, strength and speed. Training and judo matches are performed barefoot. This leads to the stimulation of nerve receptors in the feet and allows the ability to adapt to the ambient conditions to maintain the optimal

postural control. In general, high-intensity training in judo causes significant neuromuscular, physiological and hormonal reactions [21]. In terms of adaptation, the nature of movements in judo during training may affect the musculoskeletal system. In comparison to the football players, the ankle is free and the judoka is barefoot, which may lead to significantly higher ankle joint dorsiflexion.

This is a pilot study that focused on the range of motions towards dorsiflexion ankle joint in judokas. The movement in the ankle of judoists towards dorsiflexion may be more variable than that of football players. The movement of a judoka on a tatami is in a closed kinematic chain, which probably allows a greater range of motion dorsiflexion than football players. A frequently performed activity in football is a football kick. A football kick requires more plantar flexion, while dorsal flexion is not required. Plantar flexion is probably higher in footballers than in judoist, but further studies are needed to confirm this hypothesis.

**Table 2.** Comparison between the judokas and the football players' ankle joint dorsiflexion ( $^\circ$ ).

Athletes	Ankle	Mean	SD	Min	Max
judo (n = 20)	right	43.15	6.71	33	57
	left	43.90	6.68	33	54
football (n = 22)	right	41.02	5.72	28	53
	left	42.09	7.17	26	59

**Table 3.** Statistical characteristic.

Ranks				
Ankle	Athletes	N	Mean Rank	Sum of Ranks
Right ankle	judo	20	23.33	466.50
	football	22	19.84	436.50
	total	42		
Left ankle	judo	20	23.63	472.50
	football	22	19.57	430.50
	total	42		
Grouping variable "athletes"				
test statistics			ankle dorsiflexion	
			right	left
Mann-Whitney U			183.50	177.50
Wilcoxon W			436.50	430.50
test Z			-0.92	-1.07
Asymptotic Significance (2-tailed) p			0.357	0.284

Limited ankle joint dorsiflexion may increase the risk of injury on impact forces after a vertical jump landing. Limited ankle joint dorsiflexion is associated with increased knee valgus. One of the most common injuries in judo is the anterior cruciate ligament injury, which is associated of the limited ankle joint dorsiflexion [22]. The knee valgus may contribute to the anterior cruciate ligament injury in judokas [23]. Judo training leads to other specific adaptations of the musculoskeletal system. This issue has been verified in the review by Ciaccioni et al. [24]. Thirty-four studies have been included into this study that researched the impact of judo on the density of bone. Higher mineral density has been finding in judokas. The effects of judo on the mineral bone density in adolescents have also been verified in the study by Ito et al. [25]. Higher mineral bone density has been finding in judokas in comparison to the control group.

Judokas had greater ankle joint dorsiflexion range of motion in this study. It can be explained by more frequent usage of the dorsiflexion range of motion during training than the football players. Greater ankle joint dorsiflexion range of motion was finding in the judokas. However, this result was not significant.

Reduced ankle joint dorsiflexion has a negative impact on the function of the lower limbs and biomechanics of sports performance. Identification of the reduction of the ankle joint range of motion is significant factor in clinical practice. Identification of risk cases may help to adjust the optimal compensation program. Limited ankle joint dorsiflexion is associated with influencing the biomechanics of sports performance. This association has been verified in the study by Dill et al. [26]. The sample included 40 active participants. Twenty of them had limited ankle joint dorsiflexion range of motion and twenty of them had normal ankle joint range of motion. Higher knee flexion and ankle shift in squat were recorded in probands with limited dorsiflexion range of motion using the weight bearing lunge test.

Changes in the ankle joint range of motion may occur during the season. This research problem has been tested by Moreno-Pérez et al. [27]. Forty professional football players participated in this perspective monitoring study. Participants were football players from two different Spanish league teams. The ankle joint dorsiflexion was measured using the LegMotion system at different points in time during the season. The results

indicated a significant increase in the upper limb dorsiflexion (5.8%) right after the match, while the same indicator decreased in the next 48 hours after the match by 2.65%, in comparison to the values in both lower limbs after the match. The ankle joint dorsiflexion indicated a significant decrease in comparison to the preseason level in the dominant limb (-8.1%; -9.6% in the middle of the season and after the season) and the nondominant limb (-12.5%; -13.8% in the middle of the season and after the season). Decrease of this indicator was also found in the dominant limb in comparison to the preseason and the middle of the season (-6.3%). According to Moreno-Pérez et al. [25], this progressive decline of the ankle joint dorsiflexion may indicate increased risk of injury and should be resolvable by preventive actions.

Dorsiflexion occurs in the talocrural joint. This association has been verified and compared with the radiological findings in the study by Smith et al. [28]. In the final phase of the movement in the weight bearing lunge test, 91.8% of the movement was recorded in the talocrural joint. Test validity using a mobile phone application has been verified in the study by Banwell et al. [29].

The sample included 21 patients who undertook 168 measurements. High inter-rater reliability and intra-rater reliability were recorded (ICC 0.90).

This study included a small sample. It would be appropriate to research a cross-sectional testing on a higher sample in follow-up studies. This study included professional athletes. It would be appropriate to include athletes with lower capabilities in follow-up studies. It is assumed that the best performing athletes will have better predispositions to perform the given sport in comparison to semi-professional athletes.

## CONCLUSIONS

Greater ankle joint dorsiflexion range of motion was finding in judokas. Better adaptation in favour of the judokas means greater variability in the movement of the ankle towards the dorsiflexion in the judoist training process. Judo leads to better adaptation in the ankle joint towards dorsiflexion in ankle joint in compared to football players. However, results were no statistically significant.

## REFERENCES

- Franchini E, Del Vecchio FB, Matsushigie KA et al. Physiological profiles of elite judo athletes. *Sports Med* 2011; 41(2): 147-166
- García-Luna MA, Cortell-Tormo JM, Valero-Cotillas JA et al. Functional movement screen differences between male and female young judokas athletes. *Arch Budo* 2020; 16: 119-127
- Koshida S, Ishii T, Matsuda T et al. Biomechanics of judo backward breakfall for different throwing techniques in novice judokas. *Eur J Sport Sci* 2017; 17(4): 417-424
- Nowak PF, Kuśnierz C, Görner K et al. Determinants of health-related behaviours of judo athletes. *Arch Budo* 2017; 13: 335-342
- Jagiello W, Kalina RM, Tkaczuk W. Development of strength abilities in children and youth. *Biol Sport* 2004; 21(4): 351-368
- Jagiello W, Kalina RM, Tkaczuk W. Age peculiarities of speed and endurance development in young judo athletes. *Biol Sport* 2001; 18(4): 281-295
- Jagiello W, Kalina RM. Properties of Motor Development in Young Judokas. *J Hum Kinet* 2007; 17: 113-120
- Barbado D, Lopez-Valenciano A, Juan-Recio C et al. Trunk Stability, Trunk Strength and Sport Performance Level in Judo. *PLoS One* 2016; 11(5): e0156267
- Muddle TWD, Fukuda DH, Wang R et al. Effects of a 10-Week Introductory Judo Course on Postural Control During a Bilateral Reactionary Gripping Task. *Motor Control* 2017; 21(4): 373-389
- Gołaś A, Nitychoruk M, Żak M et al. Optimizing visual processing efficiency using neurofeedback training in judo athletes. *Arch Budo Sci Martial Art Extreme Sport* 2019; 15: 105-112
- Helm N, Prieske O, Muehlbauer T et al. Effects of judo-specific resistance training on kinetic and electromyographic parameters of pulling exercises in judo athletes. *Sportverletz Sportschaden* 2018; 32(2): 134-142
- Andrzejewska J, Burdukiewicz A, Stachoń A et al. The foot structure of combat sports athletes. *Arch Budo* 2019; 15: 121-130
- Dolci F, Hart NH, Kilding A et al. Movement Economy in Soccer: Current Data and Limitations. *Sports (Basel)* 2018; 6(4): 124
- Backman LJ, Danielson P. Low range of ankle dorsiflexion predisposes for patellar tendinopathy in junior elite basketball players: a 1-year prospective study. *Am J Sports Med* 2011; 39(12): 2626-2633
- Hoch MC, Farwell KE, Gaven SL et al. Weight-Bearing Dorsiflexion Range of Motion and Landing Biomechanics in Individuals With Chronic Ankle Instability. *J Athl Train* 2015; 50(8): 833-839
- Rabin A, Kozol Z, Finestone AS. Limited ankle dorsiflexion increases the risk for mid-portion Achilles tendinopathy in infantry recruits: a prospective cohort study. *J Foot Ankle Res* 2014; 7: 48
- Vallandingham RA, Gaven SL, Powden CJ. Changes in Dorsiflexion and Dynamic Postural Control After Mobilizations in Individuals With Chronic Ankle Instability: A systematic review and meta-analysis. *J Athl Train* 2019; 54(4): 403-407
- Chisholm MD, Birmingham TB, Brown J et al. Reliability and validity of a weight-bearing measure of ankle dorsiflexion range of motion. *Physiother Can* 2012; 64(4): 347-355
- Williams CM, Caserta AJ, Haines TP. The TiltMeter app is a novel and accurate measurement tool for the weight bearing lunge test. *J Sci Med Sport* 2013; 16(5): 392-395
- Searle A, Spink MJ, Chuter VH. Weight bearing versus non-weight bearing ankle dorsiflexion measurement in people with diabetes: a cross sectional study. *BMC Musculoskelet Disord* 2018; 19(1): 183

21. Ouergui I, Ardigò LP, Selmi O et al. Changes in Perceived Exertion, Well-Being, and Recovery During Specific Judo Training: Impact of Training Period and Exercise Modality. *Front Physiol* 2020; 11: 931
22. Wahlstedt C, Rasmussen-Barr E. Anterior cruciate ligament injury and ankle dorsiflexion. *Knee Surg Sports Traumatol Arthrosc* 2015; 23(11): 3202-3207
23. Akoto R, Lambert C, Balke M et al. Epidemiology of injuries in judo: a cross-sectional survey of severe injuries based on time loss and reduction in sporting level. *Br J Sports Med* 2018; 52(17): 1109-1115
24. Ciaccioni S, Condello G, Guidotti F et al. Effects of Judo Training on Bones: A Systematic Literature Review. *J Strength Cond Res* 2019; 33(10): 2882-2896
25. Ito IH, Kemper HCG, Agostinete RR et al. Impact of Martial Arts (Judo, Karate, and Kung Fu) on Bone Mineral Density Gains in Adolescents of Both Genders: 9-Month Follow-Up. *Pediatr Exerc Sci* 2017; 29(4): 496-503
26. Dill KE, Begalle RL, Frank BS et al. Altered knee and ankle kinematics during squatting in those with limited weight-bearing-lunge ankle-dorsiflexion range of motion. *J Athl Train* 2014; 49(6): 723-732
27. Moreno-Pérez V, Soler A, Ansa A et al. Acute and chronic effects of competition on ankle dorsiflexion ROM in professional football players. *Eur J Sport Sci* 2020; 20(1): 51-60
28. Smith MD, Lee D, Russell T et al. How Much Does the Talocrural Joint Contribute to Ankle Dorsiflexion Range of Motion During the Weight-Bearing Lunge Test? A Cross-sectional Radiographic Validity Study. *J Orthop Sports Phys Ther* 2019; 49(12): 934-941
29. Banwell HA, Uden H, Marshall N et al. The iPhone Measure app level function as a measuring device for the weight bearing lunge test in adults: a reliability study. *J Foot Ankle Res* 2019; 12: 37
30. Dictionary of Sport and Exercise Science. Over 5,000 Terms Clearly Defined. London: A & B Black; 2006

**Cite this article as:** Líška D, Liptaková E, Batalik L et al. The ankle joint dorsiflexion range of motion in the closed kinematic chain of judokas and football players – pilot study. *Arch Budo* 2021; 17: 145-150