Incidence of injuries to the lower limbs joints in kung fu athletes

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B Data Collection
C Statistical Analysis
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Abstract

Background and Study Aim: This study evaluated the influence of competitive practice and training aspects on incidence of injuries to the lower limbs joints in formalized (taolu) and combat (sanshou) kung fu athletes.

Material/Methods: One hundred and twenty-seven kung fu athletes (taolu, n=82; sanshou, n=45) were interviewed about kung fu practice (practice time, competition time and competition level), training volume (days of training per week and hours per training session) and injury profiles (incidence and type). Continuous variables were compared by non-parametric Kolmogorov-Smirnov test (disciplines and competition levels as grouping variables). The effects of categorical variables (kung fu practice) on injury profiles were analyzed using the Pearson's chi-square test. The level of significance was set at $p<0.05$.

Results: Our data exhibited large frequency of injury reports (70.1%) and significantly differences on injury profiles between disciplines and competition levels. Taolu athletes, despite the lower practice/competition time (–51.5 and –41.8%, respectively), presented frequency of injury reports twofold greater, longer daily training volume (23.3%) and higher incidence of lower limbs joints injuries than sanshou athletes (35.4% and 11.8%, respectively).

Conclusions: Our results suggest a link between injury profiles (incidence and type) and specific characteristics of kung fu disciplines.

Key words: kung fu • incidence of injuries • lower limbs joints

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Background

Studies involving different combat sports (karate, judo, taekwondo and muay thai) observed higher incidence of acute than chronic injuries with prevalence of traumatic damages to the head, upper and lower limbs [1–11] in contrast to non-combat sports.

According to literature, the higher incidence of chronic injuries in non-combat sports (such as running, volleyball or soccer) results of repeated stress promoted by excess training volume or training intensity [12–14].

Wushu (also called kung fu in English) has become popular outside China and acquired the status of combat sport [15]. While hundreds of branches and styles exist, kung fu can essentially be classified into two disciplines: formalized (taolu) and combat (sanshou). Formalized kung fu is usually a set of choreographed movements, whereas combat kung fu is characterized by regulated one-on-one sparring [15,16].

Both kung fu disciplines, however, have specific characteristics that enable the development of acute and chronic injuries to the lower limbs joints (knee and ankle) related to competition and training [7,16–20].

Kung fu – traditional Chinese martial arts that cultivate a practitioner's internal and external qualities and abilities, essentially classified into two disciplines: formalized (taolu) and combat (sanshou).

Incidence of injuries – rate of damage of a living organism caused by impact of energy from outside.

Lower limbs joints – joints of the part of the body from the hip to the toes (knee and ankle).

Table 1. Practice aspects and training volume between Kung fu disciplines.

Disciplines	TM PRT	TM CMP	TR x/W	TR h/D	n (%)
Taolu[A]	5.90±4.04	4.67±3.34	4.93±1.30	2.78±0.92	82 (64.6)
Sanshou	8.93±5.52[A]	6.62±4.24[A]	4.96±1.13	2.13±0.69[A]	45 (35.4)
Δ% (Taolu = 100%)	–51.5*	–41.8*	–0.6	23.3*	

Data are presented as mean ± standard deviation. TM PRT, practice time (years); TM CMP, competition time (years); TR x/W, days of training per week (practices per week); TR h/D, hours per training session (hours per practice); n, number of subjects; %, relative frequencies; Δ% (Taolu=100%), relative differences between disciplines (%). [A] indicates significantly differences from taolu ($p<0.05$). * Indicates significantly relative differences ($p<0.05$).

Table 2. Practice aspects and training volume between competition levels.

Level	TM PRT	TM CMP	TR x/W	TR h/D	n (%)
NT[A]	5.34±4.02	3.89±2.58	4.86±1.18	2.51±0.66	69 (54.3)
IN	8.91±5.01[A]	7.11±4.24[A]	5.03±1.31	2.60±1.12	58 (45.7)
Δ% (NT = 100%)	–66.9*	–82.7*	–3.7	–3.8	

Data are presented as mean ± standard deviation. NT, national level; IN, international level; TM PRT, practice time (years); TM CMP, competition time (years); TR x/W, days of training per week (practices per week); TR h/D, hours per training session (hours per practice); n, number of subjects;%, relative frequencies; Δ% (NT=100%), relative differences between competition levels (%). [A] indicates significantly differences from national level ($p<0.05$). * Indicates significantly relative differences ($p<0.05$).

The sanshou fighting techniques allow the occurrence of acute injuries from direct trauma or during kicking and twisting motions [16,18,19] while the taolu routines (or nandus), involving similar gymnastics jumps and landings, promote overuse injuries by repetitive overload stress [7,17,20].

In the last two decades, Brazil has been increasing the performance of their kung fu athletes due to improvement of training methods and participation in international competitions. As a result, the incidence of acute and chronic injuries in this population has been increasing. The aim of the present study was to investigate the influence of competitive practice and training aspects on incidence of injuries to the lower limbs joints in formalized (taolu) and combat (sanshou) kung fu athletes.

Material and Methods

Data acquisition

The research has been conducted on the target group of 127 kung fu athletes (82 taolu and 45 sanshou practitioners) at national team trials of Brazilian Confederation of Kung Fu (CBKW) along the 2008-09 seasons.

Data were obtained by one on one method of interview using a pre-tested questionnaire consisted of four sections: personal data, kung fu practice (discipline practiced, practice time, competition time and competition level), training volume (days of training per week and hours per training session) and injury profiles (incidence and type).

Statistical analysis

Continuous variables were tested for normality with Shapiro-Wilk's W test and compared by non-parametric Kolmogorov-Smirnov test (disciplines and competition levels as grouping variables). Continuous variables data are presented as mean ± standard deviation. The effects of categorical variables (kung fu practice) on injury profiles were analyzed using the Pearson's chi-square test and differences between proportions were compared as follows bellow:

$$|t| = \sqrt{[(N1*N2)/(N1+N2)]}*|p1-p2|/\sqrt{(p*q)};$$
$$p = (p1*N1+p2*N2)/(N1+N2);$$
$$q = 1 - p;$$
Degrees of freedom = N1 + N2–2.

The level of significance was set at $p<0.05$. Statistical analysis was performed using STATISTICA data analysis software system (version 8.0, StatSoft, Inc., 2007. United States).

Results

Taolu athletes presented significantly lower times of practice and competition (–51.5 and –41.8%, respectively; $p<0.05$) and higher daily training volume (23.3%; $p<0.05$) compared to sanshou athletes. No significant difference was observed for days of training per week between disciplines (Table 1).

No significantly differences were observed between competition levels (national or international) for days

Table 3. Practice aspects and training volume between disciplines according to competition levels.

Disciplines	Level	TM PRT	TM CMP	TR x/W	TR h/D	n (%)
Taolu[A]	NT	4.97±3.68	3.54±2.33	4.92±1.27	2.57±0.71	49 (38.6)
Sanshou		6.25±4.72	4.75±3.01	4.70±0.92	2.35±0.49	20 (15.7)
Δ% (Taolu=100%)		–25.7	–34.2	4.5	8.6	
Taolu[B]	IN	7.27±4.20	6.35±3.91	4.94±1.37	3.09±1.10	33 (26.0)
Sanshou		11.08±5.24[B]	8.12±4.53	5.16±1.25	1.96±0.79[B]	25 (19.7)
Δ% (Taolu=100%)		–52.4*	–27.8	–4.4	36.6*	

Data are presented as mean ± standard deviation. NT, national level; IN, international level; TM PRT, practice time (years); TM CMP, competition time (years); TR x/W, days of training per week (practices per week); TR h/D, hours per training session (hours per practice); n, number of subjects;%, relative frequencies; Δ% (Taolu=100%), relative differences between disciplines (%). [A] indicates significantly differences from taolu national level ($p<0.05$). [B] indicates significantly differences from taolu international level ($p<0.05$). * Indicates significantly relative differences ($p<0.05$).

Table 4. Practice aspects and training volume between non-injured and injured athletes.

Injuries	TM PRT	TM CMP	TR x/W	TR h/D	n (%)
No[A]	5.33±4.68	3.83±3.16	4.63±1.30	2.63±0.67	38 (29.9)
Yes	7.67±4.74[A]	6.02±3.86[A]	5.07±1.19	2.52±0.98	89 (70.1)
Δ% (No=100%)	–44.0	–57.1*	–9.4	4.4	

Data are presented as mean ± standard deviation. NO, non-injured athletes; YES, injured athletes; TM PRT, practice time (years); TM CMP, competition time (years); TR x/W, days of training per week (practices per week); TR h/D, hours per training session (hours per practice); n, number of subjects;%, relative frequencies; Δ% (NO = 100%), relative differences between non-injured and injured athletes (%). [A] indicates significantly differences from non-injured athletes ($p<0.05$). * Indicates significantly relative differences ($p<0.05$).

of training per week and hours per training session. National level athletes presented significantly lower practice and competition times (–66.9 and –82.7%, respectively; *p<0.05*) than the international level athletes (Table 2).

No significantly differences were observed to continuous variables between national level taolu and sanshou athletes. International level taolu athletes presented significantly lower practice time and higher daily training volume (–52.4 and 36.6%, respectively; *p<0.05*) compared to international level sanshou athletes (Table 3).

We founded large frequency of injury reports and significantly differences on injury profiles between disciplines and competition levels. Athletes who reported never experienced an injury (no, non-injured athletes; n=38, 29.9%) presented significantly lower practice time and competition time (–44.0 and –57.1%, respectively; *p<0.05*) than those who reported already had suffered injuries (yes, injured athletes; n=89, 70.1%) (Table 4).

International level athletes exhibited the biggest difference between rates of injured and non-injured individuals (37.8% and 7.9%, respectively; *p<0.05*). The p-level was obtained by relationship between competition levels and injury reports (Pearson[B], Table 5).

Taolu athletes presented significantly higher frequency of injury reports compared to sanshou athletes (48.0% and 22.0%, respectively; *p<0.05*). The p-level was obtained by comparison of injury rates between disciplines (Difference between proportions*, Table 5).

Our data also exhibited significantly differences for the injury type incidence between disciplines. Taolu athletes presented significantly higher incidence of lower limbs joints injuries in comparison to sanshou athletes (35.4% and 11.8%, respectively; *p<0.05*). The p-level was obtained by comparison of incidence of lower limbs joints injuries between disciplines (Difference between proportions, Table 6).

Discussion

Formalized and combat kung fu disciplines have specific characteristics that enables the development of acute and chronic injuries to the lower limbs joints (knee and ankle) related to competition or training [7,16–20] unlike others combat sports [1–11].

Table 5. Injury reports.

Disciplines	Level	Injuries n (%)					
		Yes		No		Totals	
Taolu	NT	31	(24.4%)	18	(14.2%)	49	(38.6%)
	IN	30	(23.6%)	3	(2.4%)	33	(26.0%)
	Total	61	(48.0%)	21	(16.5%)	82	(64.6%)
Sanshou	NT	10	(7.8%)	10	(7.8%)	20	(15.7%)
	IN	18	(14.2%)	7	(5.5%)	25	(19.7%)
	Total	28	(22.0%)*	17	(13.4%)	45	(35.4%)
Totals		89	(70.1%)[A]	38	(29.9%)	127	(100.0%)
	Totals						
	NT	41	(32.3%)	28	(22.1%)	69	(54.3%)
	IN	48	(37.8%)[B]	10	(7.9%)	58	(45.7%)
		x^2		df		p	
	Pearson[A]	11.80		df=3.00		p=0.00	
	Pearson[B]	8.19		df=1.00		p=0.00	
	Difference between proportions *					p=0.02	

Data are presented as absolute and relative frequencies. YES, injured athletes; NO, non-injured athletes; NT, national level; IN, international level; n, number of subjects (absolute frequencies);%, relative frequencies. [A] indicates significantly differences from non-injured athletes ($p<0.05$). [B] Indicates significantly differences from international level non-injured athletes ($p<0.05$). * Indicates significantly differences from total taolu injured athletes ($p<0.05$).

Table 6. Incidence of injuries between disciplines according to competition levels.

Disciplines	Level	Injuries N (%)							
		Other		None		Ankle + knee		Totals	
Taolu	NT	9	(7.1%)	18	(14.2%)	22	(17.3%)	49	(38.6%)
	IN	7	(5.5%)	3	(2.4%)	23	(18.1%)	33	(26.0%)
	Total	16	(12.6%)	21	(16.5%)	45	(35.4%)	82	(64.6%)
Sanshou	NT	6	(4.7%)	10	(7.9%)	4	(3.2%)	20	(15.7%)
	IN	7	(5.5%)	7	(5.5%)	11	(8.7%)	25	(19.7%)
	Total	13	(10.2%)	17	(13.4%)	15	(11.8%)*	45	(35.4%)
Totals		29	(22.8%)	38	(29.9%)	60	(47.2%)	127	(100.0%)

	x^2	df	p
Pearson	17.29	df=9	p=0.04
Difference between proportions *			p=0.02

Data are presented as absolute and relative frequencies. NT, national level; IN, international level; n, number of subjects (absolute frequencies);%, relative frequencies. * Indicates significantly differences from total of ankle and knee injured taolu athletes ($p<0.05$).

The aim of the present study was to investigate the influence of competitive practice and training aspects on incidence of injuries to the lower extremity joints in formalized (taolu) and combat (sanshou) kung fu athletes. Our data exhibited large frequency of injury reports and significantly differences on injury profiles between disciplines and competition levels.

Pieter, after systematic review of the epidemiology of injuries in different combat sports, found high rate of

injury to the knee, ankle and foot in the ones that fighting techniques involves kicking and requires speed and power of the lower limbs [5]. Actually, the large incidence of lower limb injuries obtained in our study (47.2%, ankle and knee added; Table 6) is similar as those described by others combat sports studies.

Zetaruk, Violán, Zurakowski and Micheli compared the incidence of injuries of five different martial arts (shotokan karate, aikido, taekwondo, kung fu and tai chi) and observed that kung fu athletes presented higher frequency of injury to the lower limbs (35.9%) compared to other anatomical regions [7]. Kazemi, Shearer and Choung assessed the training characteristics, competition preparation habits and injury profiles of taekwondo athletes and observed that lower limb was the region most injured in first-time injuries, at an incidence of 46.5% [21]. Pappas compared the incidence of injuries across different combat sports (boxing, wrestling and martial arts) and found higher frequency of injuries to the lower limbs of martial arts athletes (41.6%) in comparison with boxing (4.5%) and wrestling (20.5%) and prevalence of strains and sprains (31.0%) [22].

No significantly relationship was found between overall frequency of injury reports and training volume (days of training per week and hours per training session; Table 4). However, we observed rise on frequency of injury reports proportional to practice/competition time (Table 4) and differences for the injury profiles (incidence and type; Tables 5 and 6) between disciplines. Taolu athletes, despite the lower practice/competition time (–51.5 and –41.8%, respectively), presented frequency of injury reports twofold greater, longer daily training volume (23.3%) and higher incidence of lower limbs joints injuries in comparison to sanshou athletes (35.4% and 11.8%, respectively).

These data suggest that the injury profiles (incidence and type) of kung fu athletes are mainly related to the specific characteristics of discipline practiced, in agreement with previous observations of others authors [5,16,17,19]. Different studies, for example, indicate as potential determinants of injury to the lower limbs joints in taolu athletes, the repetitive jumps and landings performed during nandu routines [7,17,22–24].

Vertical jumping ability is of considerable importance in numerous athletic events and demands a high ability to generate strength and work in the muscles involved, mainly in the quadriceps muscle [25]. Due to such demand, muscle imbalances between extensor and flexor muscles may be present, causing an overloading on the muscle-tendinous structures of the knee and ankle joints [17,25–27]. Lian, Engebretsen and Bahr examined the prevalence of knee injuries (or jumper's knee) across different sports that involve repetitive jumps and landings. The authors observed higher prevalence of jumper's knee in volleyball and basketball (44.6% and 31.9%, respectively), and concluded that athletes of sports characterized by high demands on speed and power for the leg extensors are more exposed to suffer injuries [26]. Vanezis and Lees state that the prevalence of jumper's knee varies greatly between sports – with a high prevalence in sports characterized by high-impact ballistic loading of the knee extensors and low prevalence in sports with low loads – suggesting that there is a link between the prevalence of jumper's knee and total tendon load [27].

Besides specific characteristics of discipline, the larger daily volume of training also can explain the higher incidence of knee and ankle injuries in taolu athletes. Kudlacz & Cynarski and Kudlacz & Wojciech evaluated the incidence of injuries in different martial arts and combat sports and found higher frequency of injuries sustained during training (43.0%) compared to the competition (25.0%) [6,28].

The high incidence of injuries during training can be explained by the fact that athletes are more exposed to risk factors inherent to this competition phase, since, during training, some situations are exhaustively repeated, in an attempt to achieve maximal performance [12–14,29–31].

Conclusions

Different studies indicate as potential determinants of injury to the lower limbs joints in taolu athletes, the repetitive jumps and landings performed during nandu routines. On the other hand, injury profile of sanshou discipline is very similar as those observed in others combat sports of which fighting techniques involves punches, kicks and projections (such as karate, taekwondo and muay thai).

These techniques allow the occurrence of acute injuries among the opponents, from direct trauma or during kicking and twisting motions, and provides a higher incidence of acute injuries than those promoted by repetitive overload stress, with prevalence of traumatic damages to the head, upper and lower limbs.

Our results, in conclusion, suggest a link between injury profiles (incidence and type) and specific characteristics of kung fu disciplines. Injuries to the lower limbs joints in taolu athletes results from overuse by repetitive overload stress and presented a chronic aspect. Sanshou athletes, in contrast, are more exposed to suffer acute injuries from direct trauma.

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