

# 論文の内容の要旨

論文題目 Risk factor assessment of badminton injuries using epidemiological surveillance and medical check-up and badminton skill teaching method for injury prevention

(疫学調査・メディカルチェックを用いた  
バドミントンでの損傷危険因子評価および  
外傷・障害予防に向けたバドミントン技術教授法)

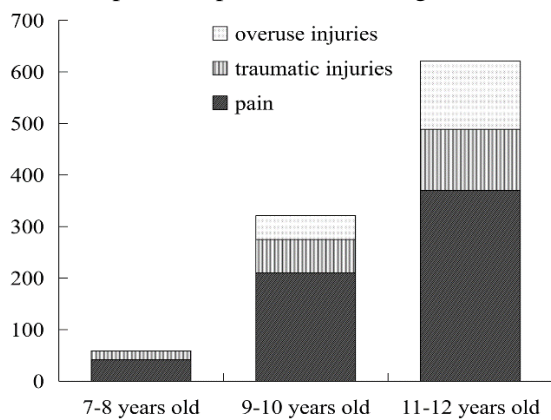
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## 【Introduction and Aims】

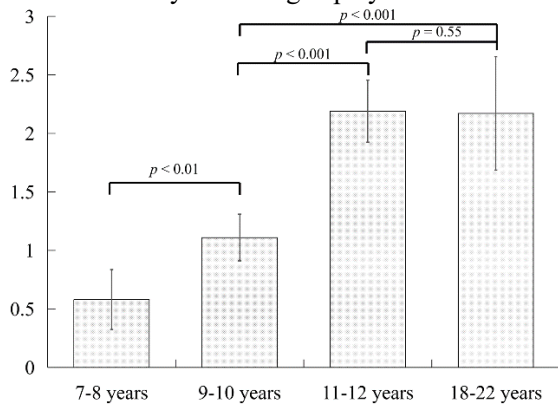
Badminton is a non-contact racket sport with more than 330 million people playing worldwide. Risk factors of badminton injuries have not been clear, and badminton skill teaching for injury prevention has not been well studied. Besides, the epidemiology of badminton injuries in school-aged players is not well understood. In this dissertation, we executed epidemiological surveillance and medical check-up to detect risk factors of badminton injuries, performed badminton forehand overhead stroke skill teaching to improve motor skill acquisition so that badminton injury prevention can be enhanced.

【Study 1: Epidemiology and risk factors of badminton injuries】 For badminton injury prevention, accurate data on epidemiology of the injury problem and risk factors must be identified. So we conducted an epidemiological study using a questionnaire to investigate the distribution and incidence of pains, traumatic injuries, and overuse injuries among elementary school-aged (n=611; 260 boys, 351 girls) and university players (n=52; 26 males, 26 females) participating in the national tournament. We also identified risk factors for shoulder pain, lumbar pain, and knee pain because pain is an alarm of injury. We found that epidemiology of badminton pains and injuries varied with age. In 7-10 year-old players, traumatic injuries occurred more than overuse injuries, but overuse injuries sharply increased with age (Fig. 1). Around half of the elementary school-aged players suffer from at

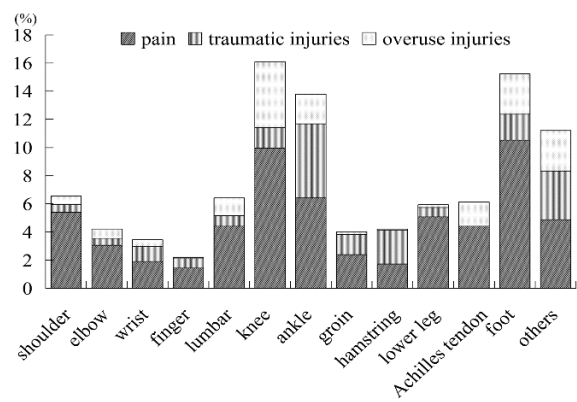
least one badminton traumatic or overuse injury, mostly involved lower limbs including knee, ankle, and foot (Fig. 2). Injury incidence rate had an upward trend with increasing age in elementary school-aged players, but injury incidence rate between 11-12 year-old players and 18-22 year-old players had no significant difference (Fig. 3). On the other hand, injury incidence rate had a downward trend with increasing badminton experience, which indicates that inexperienced techniques might be a risk factor of injuries. We found that long training time of more than 2.5 hours per day was a risk factor for shoulder pain (Table 1), and training time should be limited to  $\leq 2.5$  hours per day. In addition, shoulder pain, lumbar pain, and knee pain were statistically correlated when training time was more than 2.5 hours a day. Moreover, the results showed that lumbar pain was statistically correlated with shoulder pain independent of training time.



**Figure 1.** Badminton pain and injuries in elementary school-aged players



**Figure 3.** Injury rate per 1000 athlete-hours of exposure



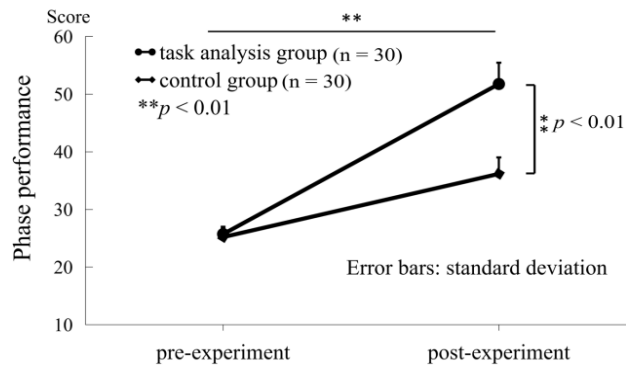
**Figure 2.** Distribution of badminton pain and injuries in elementary school-aged players

**Table 1.** Association of training time and shoulder pain in elementary school-aged players

Variables	Shoulder pain n (%)	Adjusted OR (95% CI)	<i>p</i>
Hours, per day			
$\leq 2.5$	15 (36.6)	1.00	
$> 2.5$	26 (63.4)	2.58 (1.02-6.55)	$< 0.05$

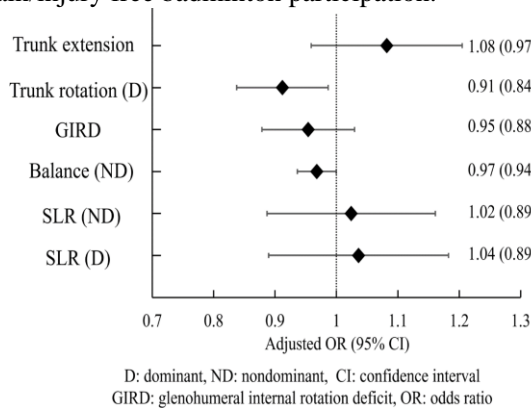
**[Study 2: Badminton teaching method using task analysis]** Inexperienced techniques were identified to be one of the risk factors for badminton injuries in study 1. Plus, recognition and motor abilities of children and adolescents are immature. In order to improve motor skill learning to enhance injury prevention for inexperienced youth badminton players, in study 2, a badminton skill teaching experiment was performed. We adopted a teaching method using task analysis (the process of breaking down complex tasks into subtasks) for badminton forehand overhead clear teaching experiment and evaluated the teaching effects in 60 novice high school male students aged 13-17 years. 30 students

were randomly assigned into task analysis group and 30 students were randomly assigned into conventional teaching group as control group. Phase performance score was used to examine the mastery of forehand overhead stroke skill. We found that task analysis teaching method is effective that not only enhancing badminton skill learning but also correcting improper phases (badminton skill technique errors) and improving motor skill abilities (Fig. 4). The results of study 2 indicated that task analysis teaching method might be a promising approach to correct inexperienced techniques and to prevent badminton injuries.

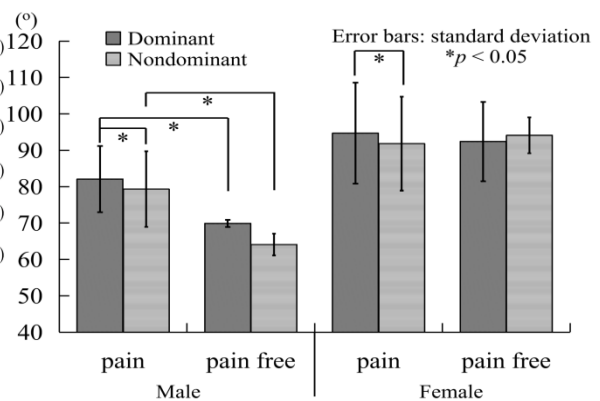


**Figure 4.** Phase performance score of forehand overhead stroke motor skill in novice high school students

**【Study 3: Risk factors of badminton injury using medical check-up】** In study 3, we examined physical fitness between elementary school-aged (n=22; 10 boys, 12 girls) and university players (n=51; 25 males, 26 females) using medical check-up. The result showed that elementary school-aged players had more flexible hamstrings and weaker balance ability compared with university players. In addition, among university players, decreased trunk rotation and weak balance ability were risk factors of shoulder pain (Fig. 5), and extra flexible hamstrings was a risk factor for lumbar pain in male players (Fig. 6). Among elementary school-aged players, 45.5% (n=10) experienced shoulder pain and 18.2% (n=4) experienced lumbar pain; while in university players, 66.7% (n=34) experienced shoulder pain and 82.4% (n=42) experienced lumbar pain. The findings might help players pay attention to physical fitness, including trunk function (core stability), balance ability and hamstring muscles strength, for pain/injury free badminton participation.



**Figure 5.** Variables associated with shoulder pain in university players



**Figure 6.** SLR between lumbar pain and pain free group in university players

**【Study 4: Intervention programs in badminton players with risk factors】** In study 4, a prospective controlled trial was performed to evaluate the effects of a neuromuscular training intervention program, including core stability, hamstring strength and dynamic balance training. 14 university badminton players participated in the intervention study and were divided into intervention group (10 players) and control group (4 players). Before training and after 6 months training, all of the 14 participants were assessed regarding shoulder and lumbar pain as well as badminton-related injuries. We found that the neuromuscular training intervention program was effective in decreasing occurrence of shoulder pain/injury and lumbar pain/injury (Table 2).

Table 2. Profiles of shoulder and lumbar pain/injury occurrence in university players

	Shoulder pain/injury		Lumbar pain/injury	
	before training	after 6 months	before training	after 6 months
	n (%)	n (%)	n (%)	n (%)
Intervention Group (n = 10)	6 (60.0)	1 (10.0)	8 (80.0)	2 (20.0)
Control Group (n = 4)	2 (50.0)	3 (75.0)	2 (50.0)	3 (75.0)

**【Discussion and Conclusion】** Firstly, using epidemiological surveillance, we detected that badminton-related pain and injuries frequently occur in lower limbs, lumbar and shoulder. And we identified that increased age, inexperienced techniques and training time of > 2.5 hours per day are risk factors for badminton injuries in school-aged badminton players in study 1. Then, in study 2, to lower the risk of inexperienced techniques, we demonstrated and provided that a teaching method using task analysis is effective in developing and modifying badminton motor skills for high school novices. Instructing inexperienced badminton players using task analysis teaching method can help learn proper badminton skill mechanics to minimize the risk of badminton injury, especially for child players whose recognition and motor abilities are immature. In study 3, we assessed the risk factors of badminton injuries using medical check-up and we identified that decreased trunk rotation, weak balance ability and extra hamstrings flexibility are risk factors for badminton injuries in university badminton players. In study 4, to lower the risk of physical dysfunction, we verified that a neuromuscular training program targeting core stability, balance ability and hamstring muscles flexibility is effective in not only decreasing incidence of badminton injuries but also improving and maintaining physical fitness. Coaches, physiotherapists, and physicians might instruct badminton players to perform the neuromuscular training program to improve physical fitness for pain/injury free badminton participation. Badminton skill teaching method using task analysis might be a promising approach for inexperienced players to correct improper badminton skill technique errors and to prevent injury.