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Low Back Pain in School-Aged Martial Arts Athletes in Japan: A Comparison among Judo, Kendo, and Karate

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Martial arts, such as judo, kendo, and karate, are popular worldwide, not only among adults but also among children and adolescents. Although low back pain (LBP) is considered to be a common problem in these sports, it has been scarcely studied, especially in young athletes. The purpose of this study was to elucidate the point prevalence of and factors related to LBP among school-aged athletes in judo, kendo, and karate. A cross-sectional study was conducted in school-aged athletes (age, 6-15 years; n = 896) using a self-reported questionnaire. Multiple logistic regression models were used to assess the factors related to LBP along with the odds ratio (OR) and 95% confidence interval (95% CI). Variables included in the analysis were sex, age, body mass index, team level, number of days and hours of training, frequency of participation in games, practice intensity, and lower extremity pain. The prevalence of LBP was 6.9% in judo, 4.7% in kendo, and 2.9% in karate. Older age was significantly associated with LBP in judo (adjusted OR, 2.12 [95% CI, 1.24-3.61]), kendo (1.77 [1.27-2.47]), and karate (2.22 [1.14-4.33]). Lower extremity pain was significantly associated with LBP in judo (6.56 [1.57-27.34]) and kendo (21.66 [6.96-67.41]). Coaches should understand the characteristics of LBP in each martial art to develop strategies to prevent LBP among school-aged martial arts athletes.

Keywords: Japan; low back pain; lower extremity pain; martial arts; school-aged athletes
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Introduction

Low back pain (LBP) is a common symptom not only in adults but also in children and adolescents (Hangai et al. 2010). LBP is a significant problem in sports, and some related factors, such as age (Shah et al. 2014), sex (Fett et al. 2017), body mass index (BMI) (Noormohammadpour et al. 2016), competition level (Fett et al. 2017), and frequency of training (Newlands et al. 2015), have been reported in adult athletes. However, LBP in school-aged athletes has been scarcely studied. Further, lower extremity pain is also associated with LBP in athletes, which is thought to be due to a disrupted kinematic chain (Yabe et al. 2019). Furthermore, the prevalence of LBP can differ according to the sport because each sport has its own body movements (Noormohammadpour et al. 2016, Farahbakhsh et al. 2018). Muller et al. (2017) reported that the point prevalence of LBP among young athletes ranged from 3% in soccer to 14% in canoeing surveying across 17 different sport disciplines.

Martial arts, such as judo, kendo, and karate, are popular in Japan and are widely practiced worldwide (Destombe et al. 2006; Pocecco et al. 2013; Schultzel et al. 2016). According to a cross-sectional report on sports activities among schoolchildren in Japan, the rates of athletes in martial arts were 1.9% in judo, 3.3% in kendo, and 3.0% in

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karate (Sato et al. 2011). Some studies have reported that LBP is common among these martial arts athletes (Okada et al. 2007; Kishi and Morikita 2009; Noormohammadpour et al. 2016). Therefore, understanding the characteristics of LBP in each martial art is important to prevent and treat LBP among athletes. The purpose of this study was to elucidate the point prevalence of and factors related to LBP among Japanese school-aged athletes in martial arts, such as judo, kendo, and karate.

Methods

Participants

A cross-sectional study was conducted in school-aged athletes (age: 6-15 years) who were members of an amateur sports association in Miyagi prefecture (Yabe et al. 2018), which has various sports teams, including football, volleyball, basketball, tennis, judo, kendo, and karate. A self-reported questionnaire and informed consent form were mailed to 25,469 athletes who were registered in the association, and 7,333 athletes consented to the study and answered the questionnaire (response rate, 28.8%). Among these, 1,019 athletes played martial arts, such as judo, kendo, and karate, without participating in other sports. Responders with missing data (n = 123) were excluded and 896 school-aged martial arts athletes were ultimately included in this study (Fig. 1). The study protocol was reviewed and approved by the Ethics Committee on Research of Human Subjects at Tohoku University Graduate School of Medicine (Approved number: 2013-564).

Outcome variables

The point prevalence of LBP was assessed using a self-reported questionnaire. The question was "Do you have pain in any parts of your body now? If yes, please check the parts you have pain (they can choose multiple sites)." Examples of the body parts were neck, lower back, and each joint. The body parts and names were illustrated using a drawing, and participants who checked lower back were considered to have LBP (Yabe et al. 2018).

Variables

The following variables were assessed using a self-reported questionnaire and included in the analysis as covariates according to previous reports: sex, age, BMI (calculated using self-reported height and weight), team level (recreation, local competition, prefectural competition, district competition, or national competition), number of days for training per week, number of hours for training per day on weekdays and weekends, frequency of participation in games (never, seldom, sometimes, or often), practice intensity (not hard or hard), and lower extremity pain (absence or presence) (Sogi et al. 2018; Yabe et al. 2019). Lower extremity pain was defined as pain in the knee and/or ankle, which was assessed in the same manner as LBP (Sogi et al. 2018). The following categorical variables were divided into two groups according to the distribution: team level (low: "recreation" or "local competition"; high: "prefectural competition" or higher), frequency of participation in games (not frequently: "never," "seldom" or "sometimes"; frequently: "often"). Further, continuous variables, such as training days and hours, were divided into categories according to their distribution (Yabe et al. 2019).

Statistical analysis

Continuous variables are presented as median and interquartile range (IQR), while categorical variables are presented as number and percentage. Multiple logistic regression analyses were performed to assess the factors related to LBP along with the odds ratio (OR) and 95%

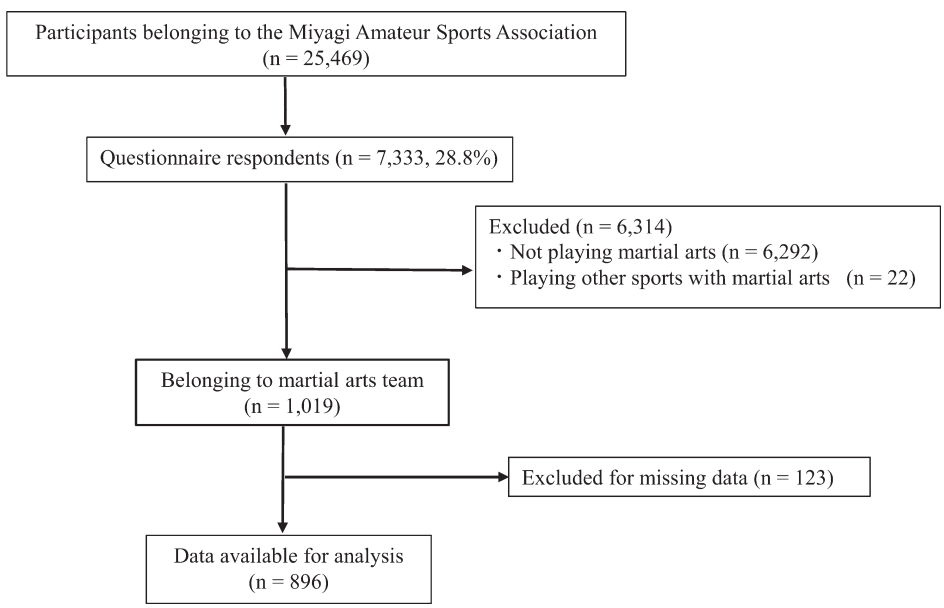

Fig. 1. Flow diagram of the study participants.

confidence interval (95% CI). Variables included in the analysis were sex (male vs. female), age (continuous variable), BMI (continuous variable), team level (low vs. high), number of days for training per week (< 3 vs. ≥ 3), number of hours for training per day on weekdays (< 2 vs. ≥ 2) and weekends (< 2 vs. ≥ 2), frequency of participation in games (not frequently vs. frequently), practice intensity (not hard vs. hard), and lower extremity pain (absence vs. presence). All statistical analyses were performed using SPSS version 24.0 (SPSS Japan Inc, Tokyo, Japan), and a P value < 0.05 was considered statistically significant.

Results

Baseline characteristics of the participants are listed in Table 1. The median age was 11 years (IQR, 9-13 years). The overall point prevalence of LBP among school-aged martial arts athletes was 4.8% (43 of 896); the point prevalence was 6.9% (15 of 218) in judo, 4.7% (22 of 469) in kendo, and 2.9% (6 of 209) in karate. Further, the point prevalence of LBP was categorised by age and shown in Fig. 2. The rate of LBP increased with age and reached its peak at 14 years old. Tables 2, 3, and 4 show the association between each variable and LBP in judo, kendo, and karate, respectively. Older age was significantly associated with LBP in judo, kendo, and karate; the adjusted OR (95% CI) was 2.12 (1.24-3.61) in judo, 1.77 (1.27-2.47) in kendo, and 2.22 (1.14-4.33) in karate. Lower extremity pain was also significantly associated with LBP in judo and kendo. Using "absence" as a reference, the adjusted OR (95% CI) was 6.56 (1.57-27.34) and 21.66 (6.96-67.41) for "presence" in judo and kendo, respectively. The association between lower extremity pain and LBP in karate was not significant. There were no significant associations between the other variables and LBP in judo, kendo, and karate.

Discussion

The present study revealed that older age was significantly associated with LBP among school-aged judo, kendo, and karate athletes. Furthermore, lower extremity pain was also significantly associated with LBP among school-aged judo and kendo athletes.

In a comparison between athletes and general population, a higher rate of LBP was reported in adult athletes when compared to non-athletes (Brynhildsen et al. 1997). Other studies found no difference between adult athletes and non-athletes (Tunås et al. 2015). The prevalence of LBP among athletes differs greatly due to sports disciplines with some sports having a lower rate of LBP compared to non-athletes (Fett et al. 2017). Although there have been only a few reports of LBP among school-aged athletes (Sato et al. 2011, Muller et al. 2017, Yabe et al. 2018), judo, kendo, and karate players have been reported to have higher rate of LBP compared to non-athletes (Sato et al. 2011). A previous study reported that the point prevalence of LBP among school-aged athletes (age, 11-17 years) was 8.0% and ranged from 3% to 14 % (Muller et al. 2017). Although these results are slightly higher compared to our result of the point prevalence of LBP among school-aged martial arts athletes (4.8%), there was a difference in the age distribution which might affect the results. Sato et al. (2011) com-

Table 1. Baseline characteristics of the participants.

Variables	Categories	n (%)			
		All (n = 896)	Judo (n = 218)	Kendo (n = 469)	Karate (209)
Sex	Male	607 (67.7)	159 (72.9)	297 (63.3)	151 (72.2)
	Female	289 (32.3)	59 (27.1)	172 (36.7)	58 (27.8)
Age (years)	Median (IQR)	11.0 (9.0, 13.0)	11.0 (10.0, 13.0)	11.0 (9.0, 13.0)	10.0 (8.0, 12.0)
Body mass index	Median (IQR)	17.9 (16.3, 20.5)	19.8 (17.3, 22.9)	17.9 (16.2, 19.9)	17.3 (15.7, 19.3)
Team level	Low	366 (40.8)	71 (32.6)	231 (49.3)	64 (30.6)
	High	530 (59.2)	147 (67.4)	238 (50.7)	145 (69.4)
Training per week (days)	< 3	350 (39.1)	72 (33.0)	148 (31.6)	130 (62.2)
	≥ 3	546 (60.9)	146 (67.0)	321 (68.4)	79 (37.8)
Practice per day weekdays (hours)	< 2	218 (24.3)	38 (17.4)	121 (25.8)	59 (28.2)
	≥ 2	678 (75.7)	180 (82.6)	348 (74.2)	150 (71.8)
Practice per day weekends (hours)	< 2	398 (44.4)	106 (48.6)	194 (41.4)	98 (46.9)
	≥ 2	498 (55.6)	112 (51.4)	275 (58.6)	111 (53.1)
Frequency of participation in games	Not frequently	337 (37.6)	75 (34.4)	184 (39.2)	78 (37.3)
	Frequently	559 (62.4)	143 (65.6)	285 (60.8)	131 (62.7)
Practice intensity	Not hard	415 (46.3)	84 (38.5)	219 (46.7)	112 (53.6)
	Hard	481 (53.7)	134 (61.5)	250 (53.3)	97 (46.4)
Lower extremity pain	Absence	753 (84.0)	186 (85.3)	378 (80.6)	189 (90.4)
	Presence	143 (16.0)	32 (14.7)	91 (19.4)	20 (9.6)

IQR, interquartile range.

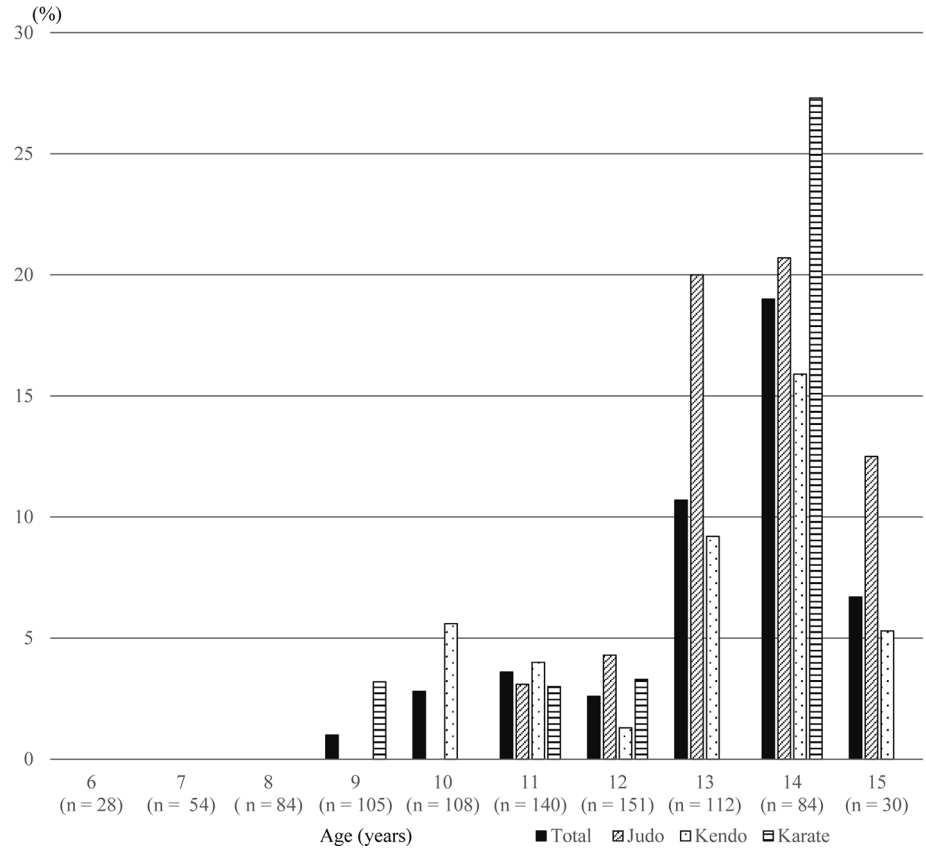

Fig. 2. Point prevalence (%) of low back pain among school-aged martial arts athletes (1-year categories).

pared the lifetime prevalence of LBP in school-aged athletes, which ranged from 27.5% in swimming to 51.4% in rugby. This study also found that judo had high prevalence of LBP with 51.1%, which was followed by kendo (35.5%) and karate (31.9%) (Sato et al. 2011). Although there have been no reports of the point prevalence of LBP among school-aged martial arts athletes, our results showed that it was high with 6.9% in judo, which was followed by 4.7% in kendo, and 2.9% in karate. This order is same with the previous report (Sato et al. 2011). In judo, players need to throw heavy opponents with repetitive trunk hyperextension and rotation, which induces high stress on the lower back (Okada et al. 2007, Pocecco et al. 2013). Lumber intervertebral disc degeneration is common among judo players and the rate of it is higher in heavyweight class compared to lightweight class (Okada et al. 2007). During forward-stepping motion in kendo, the lumbar spine extends and lower part of lumbar spine rotates and bends against upper part. These motions are repeated during kendo practice and shear stress provides excessive load on the lower back (Kishi et al. 2009). Although there have been few reports to examine the mechanism of LBP in karate athletes, karate is considered a combat sport and direct trauma is one of the causes of LBP (Noormohammadpour et al. 2016). In this study, LBP was most frequent in judo athletes, and the load on the lower back is thought to be highest in judo among these martial arts.

The median age of the participants was slightly lower in karate, which may have affected the results. Some authors have reported the association between age and LBP among children and adolescents (Balague et al. 1999, Sato et al. 2008). Sato et al. reported that the prevalence of LBP increased with age in elementary and middle school students (Sato et al. 2008), which was demonstrated to be similar in school-aged athletes (Sato et al. 2011). It has been considered that the risk of LBP increases with age due to increased physical activity (Sato et al. 2008). Our study showed that older age was significantly associated with LBP in all martial arts, which supports these previous reports. The prevalence of LBP among young martial arts athletes has been shown to reach the highest percentage of 19% at around 14 years old. This is the same pattern seen in other sports athletes. Muller et al. (2017) showed that the prevalence of LBP among school-aged athletes increased with age and became constant after 14 years old.

Lower extremity pain was significantly associated with LBP in judo and kendo, but not in karate. Previous reports have shown an association between lower extremity pain and LBP in young baseball, football, and volleyball players (Sogi et al. 2018, Yabe et al. 2019, 2020) and is considered to be due to a disrupted kinematic chain (Sekiguchi et al. 2018). The lower extremities work to absorb impact from the ground (Nadler et al. 1998) and lower extremity pain

Table 2. Multiple logistic regression analysis for the factors related to low back pain among school-aged judo players.

Variables	Categories		Low back pain	Adjusted OR (95% CI)	P value
		n	Presence, n (%)		
Total		218	15 (6.9)		
Sex	Male	159	13 (8.2)	1.00	
	Female	59	2 (3.4)	0.26 (0.03-2.36)	n.s.
Age (years)	Per 1.0 increase			2.12 (1.24-3.61)	0.006
Body mass index	Per 0.1 increase			1.12 (0.98-1.29)	n.s.
Team level	Low	71	1 (1.4)	1.00	
	High	147	14 (9.5)	8.18 (0.85-78.91)	n.s.
Training per week (days)	< 3	72	6 (8.3)	1.00	
	≥ 3	146	9 (6.2)	0.19 (0.04-0.91)	n.s.
Practice per day weekdays (hours)	< 2	38	4 (10.5)	1.00	
	≥ 2	180	11 (6.1)	0.62 (0.14-2.71)	n.s.
Practice per day weekends (hours)	< 2	106	9 (8.5)	1.00	
	≥ 2	112	6 (5.4)	0.44 (0.11-1.78)	n.s.
Frequency of participation in games	Not frequently	75	4 (5.3)	1.00	
	Frequently	143	11 (7.7)	0.56 (0.13-2.52)	n.s.
Practice intensity	Not hard	84	6 (7.1)	1.00	
	Hard	134	9 (6.7)	0.53 (0.14-2.05)	n.s.
Lower extremity pain	Absence	186	8 (4.3)	1.00	
	Presence	32	7 (21.9)	6.56 (1.57-27.34)	0.010

n.s., not significant.

Table 3. Multiple logistic regression analysis for the factors related to low back pain among school-aged kendo players.

Variables	Categories		Low back pain	Adjusted OR (95% CI)	P value
		n	Presence, n (%)		
Total		469	22 (4.7)		
Sex	Male	297	13 (4.4)	1.00	
	Female	172	9 (5.2)	1.19 (0.42-3.33)	n.s.
Age (years)	Per 1.0 increase			1.77 (1.27-2.47)	0.001
Body mass index	Per 0.1 increase			1.07 (0.92-1.25)	n.s.
Team level	Low	231	10 (4.3)	1.00	
	High	238	12 (5.0)	1.02 (0.33-3.17)	n.s.
Training per week (days)	< 3	148	6 (4.1)	1.00	
	≥ 3	321	16 (5.0)	1.50 (0.41-5.43)	n.s.
Practice per day weekdays (hours)	< 2	121	4 (3.3)	1.00	
	≥ 2	348	18 (5.2)	0.98 (0.27-3.50)	n.s.
Practice per day weekends (hours)	< 2	194	9 (4.6)	1.00	
	≥ 2	275	13 (4.7)	0.86 (0.30-2.43)	n.s.
Frequency of participation in games	Not frequently	184	10 (5.4)	1.00	
	Frequently	285	12 (4.2)	0.27 (0.09-0.80)	n.s.
Practice intensity	Not hard	219	9 (4.1)	1.00	
	Hard	250	13 (5.2)	1.05 (0.38-2.93)	n.s.
Lower extremity pain	Absence	378	5 (1.3)	1.00	
	Presence	91	17 (18.7)	21.66 (6.96-67.41)	< 0.001

n.s., not significant.

Table 4. Multiple logistic regression analysis for the factors related to low back pain among school-aged karate players.

Variables	Categories		Low back pain	Adjusted OR (95% CI)	P value
		n	Presence, n (%)		
Total		209	6 (2.9)		
Sex	Male	151	4 (2.6)	1.00	
	Female	58	2 (3.4)	1.09 (0.15-7.92)	n.s.
Age (years)	Per 1.0 increase			2.22 (1.14-4.33)	0.019
Body mass index	Per 0.1 increase			0.89 (0.60-1.33)	n.s.
Team level	Low	64	1 (1.6)	1.00	
	High	145	5 (3.4)	0.98 (0.08-12.20)	n.s.
Training per week (days)	< 3	130	2 (1.5)	1.00	
	≥ 3	79	4 (5.1)	4.97 (0.46-54.19)	n.s.
Practice per day weekdays (hours)	< 2	59	1 (1.7)	1.00	
	≥ 2	150	5 (3.3)	1.65 (0.12-23.48)	n.s.
Practice per day weekends (hours)	< 2	98	2 (2.0)	1.00	
	≥ 2	111	4 (3.6)	1.00 (0.14-7.03)	n.s.
Frequency of participation in games	Not frequently	78	2 (2.6)	1.00	
	Frequently	131	4 (3.1)	0.51 (0.07-3.82)	n.s.
Practice intensity	Not hard	112	3 (2.7)	1.00	
	Hard	97	3 (3.1)	1.02 (0.18-5.78)	n.s.
Lower extremity pain	Absence	189	5 (2.6)	1.00	
	Presence	20	1 (5.0)	0.79 (0.60-1.33)	n.s.

n.s., not significant.

can interfere with this role and transfer excessive load to the lower back. In addition, lower extremity dysfunction can cause unstable postural balance (Sarto et al. 2019), increasing the load on the lower back. Thus, lower extremity pain induces these conditions and provides repetitive stress on the lower back, which can result in LBP. On the other hand, in this study, the association between lower extremity pain and LBP in karate was not significant. It has been reported that the lower extremities are the most common injury sites in judo and kendo (Pocecco et al. 2013; Kisi and Yoshida 2017). In this study, the prevalence of lower extremity pain was highest in kendo (19.4%), followed by judo (14.7%) and karate (9.6%). The lower extremities need to work hard in judo and kendo, which can lead to a high prevalence of lower extremity pain, especially in kendo. The role of the lower extremities differs among these martial arts, which is considered to relate to the strong association between lower extremity pain and LBP in kendo and judo. Compared with judo and kendo, the association between lower extremity pain and LBP was weaker in karate and resulted in no significance.

Considering the other variables, sex, BMI, team level, number of days and hours for training, frequency of participation in games, and practice intensity were not significantly associated with LBP. Some authors have shown that sex and BMI were associated with LBP (Noormohammadpour et al. 2016; Fett et al. 2017), whereas another report indicated that the associations were not significant (Fritz and Clifford 2010). The findings are considered to be controversial and the difference in study methodology may be related to the inconsistent results. High competition level and frequent or intense training are generally reported to be associated with LBP among athletes (Newlands et al. 2015; Fett et al. 2017). However, the younger age distribution and milder intensity or lower frequency of training compared with other reports may have affected the results of this study. The prevalence of and factors related to LBP are different among judo, kendo, and karate, which is considered to be due to different body motions in each martial art. Coaches should understand how to identify and prevent LBP in their martial arts athletes. The results of this study suggested that lower extremity symptoms can lead to LBP among school-aged judo and kendo athletes. A longitudinal study should be done to clarify this association to develop strategies to prevent LBP among young judo and kendo athletes.

This study had some limitations. First, a self-reported questionnaire and informed consent form were mailed to participants, and the response rate was not high. Responders might have a higher consciousness compared with non-responders, which could affect the prevalence of pain reported in this study. Second, pain was assessed using a drawing, and the reliability and validity of this method were not confirmed. Further, intensity, duration, or past history of LBP, or missed competitions due to pain were not assessed in this study. Finally, this study had a cross-sectional design and, as such, reverse causality cannot be ruled out.

In conclusion, LBP among school-aged athletes participating in martial arts, such as judo, kendo, and karate, was assessed in this study. The prevalence of LBP was highest in judo, followed by kendo and karate. Older age was associated with LBP in judo, kendo, and karate, while lower extremity pain was associated with LBP in judo and kendo. Coaches should understand the characteristics of LBP in each martial art to develop strategies to prevent LBP among school-aged martial arts athletes.

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Conflict of Interest

The authors declare no conflict of interest.

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