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Upper Extremity Pain Is Associated with Lower Back Pain among Young Basketball Players: A Cross-Sectional Study

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Basketball is a major sport worldwide among different age groups that leads to a high frequency of injuries at multiple body sites. Upper and lower extremities and lower back are common pain sites in basketball players; however, there is little information about the relationship between upper or lower extremity pain and lower back pain. This study elucidated the associations between upper extremity (shoulder and elbow) pain and lower back pain (LBP) among young basketball players. We conducted a cross-sectional study using self-reported questionnaires mailed to 25,669 young athletes; the final study population comprised 590 basketball players, and their median age was 13 years (range: 6-15 years). The point prevalence rates of lower back, shoulder, elbow, and upper extremity pain among young basketball players were 12.9% (76/590), 4.6% (27/590), 2.7% (16/590), and 7.1% (42/590), respectively. Multivariate logistic regression analyses revealed that upper extremity pain was significantly associated with LBP (adjusted odds ratio [OR]: 7.86; 95% confidential interval [CI], 3.93-15.72). Shoulder pain was significantly associated with training per week (> 4 days) (adjusted OR: 4.15; 95% CI: 1.29-13.40) and LBP (adjusted OR: 13.77; 95% CI: 5.70-33.24). This study indicates that upper extremity and shoulder pain is associated with LBP among young basketball players. Assessing for lower back pain, as well as elbow and/or shoulder pain, may help prevent severe injuries in young basketball players. In conclusion, parents and coaches should be properly re-educated to help improve lower back, upper extremity, and shoulder pain among young basketball players.

Keywords: basketball; elbow pain; lower back pain; school-aged athletes; shoulder pain
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Introduction

Basketball is a major sport worldwide that leads to a high frequency of injuries because of its fast and aggressive nature (Meeuwisse et al. 2003). For instance, among young athletes (182 players between 13 and 19 years of age) from the highest national basketball leagues in Germany, 2 out of 3 players suffered from joint pain (knee and leg pain, 40.3%; ankle and foot pain, 20.9%; shoulder pain, 21.4%; elbow pain, 6.1%; hand and finger pain, 11%; hip pain, 5.5%) (Schneider et al. 2019). Accumulating evidence indicates that the most affected sites are the ankle, knee, and head/face in young basketball players (Clifton et al. 2018a, b). Because the participants' age, levels of activity, and experiences were different in different studies, it is difficult to simply compare the findings in these studies. However, it is apparent that basketball players are at a higher risk of developing pain at multiple body sites.

Throwing and passing motions are popular actions in basketball. Over 90% of wheelchair (WC) women basketball athletes have shoulder and upper extremity pain (Curtis and Black 1999), and upper extremities are very common

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injury sites in adolescent athletes (Schneider et al. 2019). Lower back pain (LBP) is another major public health problem among both young and adult athletes (Hangai et al. 2010). Various sports are characterized by their specific motions that place excessive loads on the lumbar spine, and some sports correlate with a higher prevalence of LBP (Farahbakhsh et al. 2018). Studies have demonstrated that basketball players have the highest prevalence of LBP (Noormohammadpour et al. 2016; Farahbakhsh et al. 2018). Therefore, upper extremities and lower back are the most common pain sites in basketball players.

Because energy derived from the lower extremity passes through the trunk to the upper extremity in throwing motion, a break in such a kinetic chain could lead to upper extremity injuries. In fact, both lower back and knee pains are significantly associated with the elbow and/or shoulder pain in youth baseball players (Sekiguchi et al. 2018). These involved body parts in these pains are linked and work together during running, jumping, and throwing (Nadler et al. 1998). The disrupted kinematic chain caused by pain is thought to cause secondary injuries in other body parts (Jonasson et al. 2011). However, to the best of our knowledge, no study has evaluated the association between upper extremity pain and LBP among young basketball players. Accordingly, this study assessed whether upper extremity pain, including shoulder and elbow pain, correlates with LBP among young basketball players.

Methods

Participants

The study protocol was reviewed and approved by the Ethics Committee on Research of Human Subjects at the Tohoku University Graduate School of Medicine (approved number: 2013-1-564). This cross-sectional study included elementary and middle school-aged athletes (aged 6-15 years) who belonged to the Miyagi Amateur Sports Association in Japan. Various sports teams (baseball, football, basketball, karate, and tennis) are included in the association. A self-reported questionnaire and an informed consent form were mailed to all registered athletes at the Miyagi Amateur Sports Association (n = 25,469) in October 2014. Of those, 7,333 athletes consented to participate in this study and responded to the questionnaire by December 2014 (response rate, 28.8%). Generally, all the participants responded to the questionnaire by themselves; however, parents were allowed to respond to the questionnaire for younger children. Participants who did not play basketball (n = 6,644) or who played other sports and basketball (n = 9) were excluded. Respondents who had missing data were also excluded (n = 90). Finally, 590 young basketball players were included in this study (Fig. 1).

Pain assessment

Lower back and upper extremity pains such as shoulder and elbow pain were assessed using a self-reported questionnaire (Yabe et al. 2018; Sekiguchi et al. 2018). The question was “Do you have pain in any parts of your body?

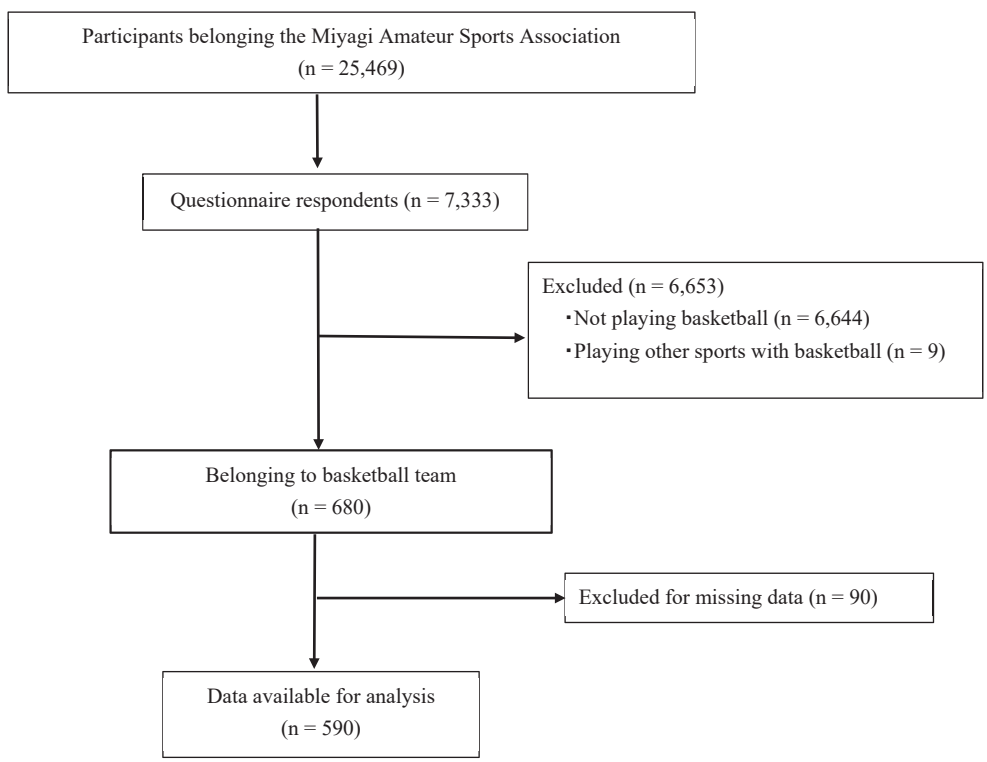

Fig. 1. Flow chart of this study.

If yes, please check the parts where you have pain (multiple answers were allowed)." The body parts include the head, different joints, and lower back. These anatomical areas and names were illustrated using a drawing. The participants who checked lower back, shoulder, or elbow were considered to have LBP, shoulder pain, or elbow pain, respectively. Upper extremity pain was defined as pain in the shoulder and/or elbow (Sekiguchi et al. 2018).

Assessment of covariates

The following potential confounding factors were assessed using self-reported questionnaires and were included in this analysis as covariates: sex, age, body mass index (BMI, calculated using self-reported height and weight values), team levels (recreation, local competition, prefectural competition, distinct competition, or national competition), number of days of training per week, number of hours of practice per day on weekdays and weekends, frequency of participation in games (never, seldom, sometimes, or often), and practice intensity (not hard or hard) (Sekiguchi et al. 2017). The following continuous variables were divided into different categories according to the number distribution: number of days of training per week (≤ 4 and > 4 days); number of hours of practice per day on weekdays (≤ 2 and > 2 hrs); and number of hours of practice per day on weekends (≤ 3 and > 3 hrs). The following categorical variables were divided into two groups according to the variable distribution: team levels (low: "recreation" or "local competition"; high: "prefectural competition" or higher) and frequency of participation in games (not frequently: "never," "seldom," or "sometimes"; frequently: "often").

Statistical analysis

Continuous variables were presented as medians with interquartile ranges (IQR), and categorical variables were presented as numbers and percentages (%). Univariate and multivariate logistic regression models were used to assess factors related to upper extremity pain, and odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated. The analysis included the following variables: sex (male or female), age (continuous variable), BMI (continuous variable), team levels (low or high), number of days of training per week (≤ 4 or > 4 days), number of hours of practice per day on weekdays (≤ 2 or > 2 hrs), number of hours of practice per day on weekends (≤ 3 or > 3 hrs), frequency of participation in games (not frequently or frequently), and practice intensity (not hard or hard). All statistical analyses were performed using SPSS 24.0 (SPSS Japan Inc., Tokyo, Japan). A P value of < 0.05 was considered statistically significant.

Results

Baseline characteristics of participants and point prevalence of each pain according to age are described in Tables 1 and 2, respectively. The median age of participants was 13 years (IQR: 12-14, age distribution: < 10 years, 11.2%; 11 to 13 years, 57.1%; > 14 years, 31.7%), and the median body mass index was 18.3 (IQR: 16.7-19.7). The point prevalence rates of the lower back, shoulder, and elbow pain among young basketball players were 12.9% (76/590), 4.6% (27/590), and 2.7% (16/590), respectively. The point prevalence of defined upper extremity pain was 7.1% (42/590), and the median age of young athletes with upper extremity pain was 13 (IQR: 12.6-14.0) years. Among those 42 athletes, 26 had only shoulder pain, 15 had only elbow pain, and 1 had both shoulder and elbow pain. Upper

Table 1. Basic characteristics of young basketball players (n = 590).

Variables	Categories	n (%)
Sex	Male	331 (56.1)
	Female	259 (43.9)
Team levels	Low	404 (68.5)
	High	186 (31.5)
Training per week (days)	≤ 4	266 (45.1)
	> 4	324 (54.9)
Practice per day weekdays (hours)	≤ 2	402 (68.1)
	> 2	188 (31.9)
Practice per day weekends (hours)	≤ 3	304 (51.5)
	> 3	286 (48.5)
Frequency of participation in games	Sometimes or seldom	262 (44.4)
	Frequently	328 (55.6)
Practice intensity	Not hard	203 (34.4)
	Hard	387 (65.6)
Lower back pain	Absence	514 (87.0)
	Presence	76 (12.9)

Table 2. The prevalence of each pain according to age (n = 590).

Age (years)	Point prevalence, n (%)				
	n	Upper extremity pain	Shoulder pain	Elbow pain	Lower back pain
6	3	0 (0)	0 (0)	0 (0)	0 (0)
7	5	0 (0)	0 (0)	0 (0)	0 (0)
8	9	1 (11.1)	1 (11.1)	0 (0)	0 (0)
9	16	0 (0)	0 (0)	0 (0)	0 (0)
10	33	1 (3.0)	1 (3.0)	0 (0)	0 (0)
11	51	2 (3.9)	0 (0)	2 (3.9)	6 (11.8)
12	117	6 (5.1)	2 (1.7)	4 (3.4)	14 (12.0)
13	169	19 (11.2)	14 (8.3)	6 (3.6)	31 (18.3)
14	166	11 (6.6)	8 (4.8)	3 (1.8)	24 (14.5)
15	21	2 (9.5)	1 (4.8)	1 (4.8)	1 (4.8)
Total	590	42 (7.1)	27 (4.6)	16 (2.7)	76 (12.9)

Table 3. Association of upper extremity and lower back pain among young basketball players (n = 590).

Variables	Categories		Upper extremity pain	Adjusted OR (95% CI)	P value
		n	Presence, n (%)		
Sex	Male	331	20 (6.0)	1.00	
	Female	259	22 (8.5)	1.25 (0.64-2.45)	0.511
Age (years)	Per 1.0 increase			1.03 (0.77-1.38)	0.825
Body mass index	Per 0.1 increase			1.05 (0.92-1.20)	0.459
Team levels	Low	404	26 (6.4)	1.00	
	High	186	16 (8.6)	1.48 (0.74-2.97)	0.266
Training per week (days)	≤ 4	266	12 (4.5)	1.00	
	> 4	324	30 (9.3)	1.93 (0.85-4.40)	0.117
Practice per day weekdays (hours)	≤ 2	402	28 (7.0)	1.00	
	> 2	188	14 (7.4)	0.92 (0.45-1.89)	0.829
Practice per day weekends (hours)	≤ 3	304	19 (6.3)	1.00	
	> 3	286	23 (8.0)	1.15 (0.57-2.31)	0.697
Frequency of participation in games	Sometimes or seldom	262	21 (8.0)	1.00	
	Frequently	328	21 (6.4)	0.69 (0.35-1.39)	0.3
Practice intensity	Not hard	203	13 (6.4)	1.00	
	Hard	387	29 (7.5)	0.78 (0.37-1.66)	0.522
Lower back pain	Absence	514	22 (4.3)	1.00	
	Presence	76	20 (26.3)	7.86 (3.93-15.72)	< 0.001

extremity pain was significantly associated with LBP in the adjusted analyses (adjusted OR [95% CI]: 7.86 [3.93-15.72]) (Table 3). Shoulder pain was significantly associated with training per week (> 4 days) (adjusted OR [95% CI]: 4.15 [1.29-13.40]) and LBP (adjusted OR [95% CI]: 13.77 [5.70-33.24]) (Table 4). However, no statistically significant association was observed between elbow pain and other factors (Table 5).

Discussion

This study investigated LBP and upper extremity injuries in young basketball players. Our findings indicate that upper extremity pain, especially in the shoulder, is associated with LBP among young basketball players.

Few studies have investigated the association between upper extremity pain and LBP among youth basketball athletes. Both LBP and knee pains are significantly associated with the elbow and/or shoulder pain in youth baseball players (Sekiguchi et al. 2018). Furthermore, decreased shoulder flexibility and age are risk factors for LBP in elite male divers (Narita et al. 2014). Higher levels of shoulder depression strength and shoulder flexion strength are significantly related to back injury in high performances of young bowlers of cricket (Foster et al. 1989). Competitive tennis players with rotational deficit less than 10° in the dominant shoulder joint than in non-dominant ones have a higher risk

Table 4. Association of shoulder and lower back pain among young basketball players (n = 590).

Variables	Categories		Shoulder pain	Adjusted OR (95% CI)	P value
		n	Presence, n (%)		
Sex	Male	331	13 (3.9)	1	
	Female	259	14 (5.4)	1.16 (0.50-2.69)	0.739
Age (years)				0.97 (0.65-1.44)	0.883
Body mass index				1.07 (0.91-1.25)	0.436
Team levels	Low	404	15 (3.7)	1	
	High	186	12 (6.5)	2.19 (0.92-5.19)	0.076
Training per week (days)	≤ 4	266	5 (1.9)	1	
	> 4	324	22 (6.8)	4.15 (1.29-13.40)	0.017
Practice per day during weekdays (hours)	≤ 2	402	17 (4.2)	1	
	> 2	188	10 (5.3)	1.04 (0.43-2.49)	0.937
Practice per day during weekends (hours)	≤ 3	304	11 (3.6)	1	
	> 3	286	16 (5.6)	1.27 (0.52-3.10)	0.596
Frequency of participation in games	Sometimes or seldom	262	14 (5.3)	1	
	Frequently	328	13 (4.0)	0.61 (0.25-1.48)	0.275
Practice intensity	Not hard	203	9 (4.4)	1	
	Hard	387	18 (4.7)	0.52 (0.20-1.36)	0.596
Lower back pain	Absence	514	11 (2.1)	1	
	Presence	76	16 (21.1)	13.77 (5.70-33.24)	< 0.001

Table 5. Association of elbow and lower back pain among young basketball players (n = 590).

Variables	Categories		Elbow pain	Adjusted OR (95% CI)	P value
		n	Presence, n (%)		
Sex	Male	331	7 (2.1)	1.00	
	Female	259	9 (3.5)	1.61 (0.58-4.46)	0.363
Age (years)				1.10 (0.73-1.66)	0.634
Body mass index				1.01 (0.82-1.23)	0.958
Team levels	Low	404	12 (3.0)	1.00	
	High	186	4 (2.2)	0.76 (0.24-2.43)	0.641
Training per week (days)	≤ 4	266	7 (2.6)	1.00	
	> 4	324	9 (2.8)	0.80 (0.25-2.52)	0.703
Practice per day weekdays (hours)	≤ 2	402	12 (3.0)	1.00	
	> 2	188	4 (2.1)	0.70 (0.22-2.28)	0.555
Practice per day weekends (hours)	≤ 3	304	8 (2.6)	1.00	
	> 3	286	8 (2.8)	1.12 (0.39-3.23)	0.828
Frequency of participation in games	Sometimes or seldom	262	8 (3.1)	1.00	
	Frequently	328	8 (2.4)	0.71 (0.25-1.99)	0.513
Practice intensity	Not hard	203	4 (2.0)	1.00	
	Hard	387	12 (3.1)	1.35 (0.41-4.42)	0.625
Lower back pain	Absence	514	11 (2.1)	1.00	
	Presence	76	5 (6.6)	2.96 (0.98-8.95)	0.055

for LBP (Hjelm et al. 2012). Upper extremity pain commonly exists together with LBP among athletes.

Basketball players have a high frequency of lower extremity injuries because of sudden motion in lower extremities (Meeuwisse et al. 2003; Pasanen et al. 2016). WC athletes have a higher prevalence of shoulder pain than nonathletic WC users (Fullerton et al. 2003), probably because of the overuse of muscles around the shoulder girdle. Repeated demand on a muscle may cause a shortening of the muscle with microtrauma damage (Vad et al. 2003); therefore, it is reasonable that there is an increased incidence of upper extremity pain in basketball players due to

repetitive shooting and passing motions.

A small number of studies have investigated the prevalence of LBP among basketball players (Noormohammadpour et al. 2016; Pasanen et al. 2016; Farahbakhsh et al. 2018). The point prevalence rates of LBP were 25% among 52 male elite basketball players (mean age 16 years) and 22.9% among 140 female university students, and the rates were higher than those among other sports players (Noormohammadpour et al. 2016; Farahbakhsh et al. 2018). Therefore, basketball players are at a higher risk of LBP. Basketball entails sudden turns, stops, and landings, all of which require sudden and repetitive lumbar flexion, rotation, and hyperextension (Noormohammadpour et al. 2016; Rossi et al. 2018). These motions impose excessive loads on the lumbar spine, probably leading to a higher prevalence of LBP among basketball players (Pasanen et al. 2016). The present study is the first to investigate the point prevalence of LBP among elementary and middle school-aged basketball players (12.9%), and the prevalence rate is lower than that in other studies (Noormohammadpour et al. 2016; Farahbakhsh et al. 2018). The discrepancy may be because of younger ages and differences in sex and competition levels. Because the point prevalence of LBP is 5.0%-8.0% among elementary and middle school-aged athletes (Muller et al. 2017; Yabe et al. 2018), LBP is more common in young basketball players, and effective prevention and treatment should be considered.

The latissimus dorsi is the large, flat, dorsi-lateral muscle on the trunk, posterior to the arm, and is partly covered by the trapezius on its median dorsal origin, which is involved in the motion of the shoulder as well as the lumbar spine (Bhatt et al. 2013). These anatomical features could account for comorbidity of both upper extremity pain and LBP in basketball players due to microtrauma damage on the muscle, which could explain the association between the shoulder pain and practice intensity in this study. Further study is needed to examine the underlying pathology in order to prevent sports injuries.

In addition, no association was observed between elbow pain and LBP in this study, although the adjusted OR (95% CI) in elbow pain was marginal (2.96 [0.96-8.95]). Dysfunction of the trunk and lower extremity is associated with elbow and shoulder pain in baseball players (Chaudhari et al. 2014). Both shoulder and elbow are close related to throwing motion. Repetitive shooting and passing motions in basketball could easily induce stress on the elbow. Skills, age, and the number of participants would affect the result in this study.

The present study has several limitations. First, the self-reported questionnaire and informed consent form were mailed to the participants, and the response rate was not high. The responders might have a higher awareness of their bodies than non-responders, possibly affecting the results. Second, lower back and upper extremity pains were assessed using a drawing, allowing respondents to choose multiple sites of pain. The reliability of this method was not confirmed in this study, possibly affecting the accuracy of the results. Third, we did not evaluate the exact portions and degrees of pain. Fourth, this study had a cross-sectional design. Further longitudinal studies are needed to investigate the relationship between upper extremity pain and LBP and evaluate the function of each body part.

In conclusion, this study indicates that upper extremity and shoulder pain is associated with LBP among elementary and middle school-aged basketball players. The findings would shed light on the development of therapeutic approaches for upper extremity pain, and parents and coaches should be properly retrained and reeducated to help improve lower back, upper extremity, and shoulder pain among young basketball players. Further studies are needed to examine the pathogenesis underlying the association between upper extremity pain and LBP.

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Conflict of Interest

The authors declare no conflict of interest.

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