



Original Article

Shoulder and elbow pain in elementary school baseball players: The results from a nation-wide survey in Japan



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ABSTRACT

Background: Despite recommendations on how to prevent baseball injuries in youths by the Japanese Society of Clinical Sports Medicine, shoulder and elbow pain still frequently occurs in young baseball players. We conducted a questionnaire survey among baseball players at elementary schools across the country to understand the practice conditions of players, examining the risk factors of shoulder and elbow pain in baseball players.

Methods: The questionnaire survey was conducted among elementary school baseball players as members of the Baseball Federation of Japan in September 2015.

Results: A total of 8354 players belonging to 412 teams (average age: 8.9) responded to the survey. Among 7894 players who did not have any shoulder and/or elbow pain in September 2014, elbow pain was experienced in 12.3% of them, shoulder pain in 8.0% and shoulder and/or elbow pain in 17.4% during the previous one year. A total of 2835 (39.9% of the total) practiced four days or more per week and 97.6% practiced 3 h or more per day on Saturdays and Sundays. The risk factors associated shoulder and elbow pain included a male sex, older age, pitchers and catchers, and players throwing more than 50 balls per day.

Conclusions: It has been revealed that Japanese elementary school baseball players train too much. Coaches should pay attention to older players, male players, pitchers and catchers in order to prevent shoulder and elbow pain. Furthermore, elementary school baseball players should not be allowed to throw more than 50 balls per day.

Study design: Retrospective cohort study.

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1. Introduction

Baseball is one of the most popular sports in Japan and it is enjoyed by many children. More than 13,000 elementary school baseball teams officially belong to several baseball associations, with approximately 270,000 elementary school students playing baseball [1]. Baseball is believed to be one of the safest sports; however, many have reported that the occurrence of disorders associated with the shoulders/elbows is still common in young players [2–7]. It is believed that such injuries occur due to the accumulation of small injuries from their earlier years [8].

In 1995, the Japanese Society of Clinical Sports Medicine (JSCSM) made a proposal regarding how to prevent baseball injuries in youths, in order to prevent disorders associated with the shoulders and elbows [9]. The proposal indicates a limited number of pitches per day and week. Symposiums regarding upper limb disorders in young baseball players due to baseball have been conducted at many medical conferences including the Japanese Orthopaedic Association, concluding that young baseball players should not engage in excessive training. Despite these recommendations and medical attention, young baseball players with shoulder and elbow injuries often visit our orthopedic surgery on an outpatient basis. Some have reported many pitchers come in to pitch in successive games at the national baseball tournament for short periods.

In this study, we conducted a questionnaire survey among baseball players at elementary schools across the country to understand the practice conditions of players. We hypothesized that factors such as the number of pitches per day or week, the number of practices, and positions are associated with a risk of shoulder and elbow pain in young baseball players.

2. Subjects and methods

We conducted a retrospective cohort study among elementary school baseball players in Japan.

Members of Bone and Joint Decade Japan, the “Committee for the prevention and education of sports injuries during the growth period” and the sports committee of the Japanese Orthopaedic Association conducted this as a joint study to investigate and analyze the results. The questionnaire survey was created by revising previous surveys [5] which had investigated the risk factors of shoulder and elbow pain among elementary school baseball players. The questions are regarding the basic information and daily practices of players. We asked players whether or not they had any pain in their shoulder or elbow in September 2014, or if they have suffered from shoulder or elbow pain between October 2014 and September 2015 over the past year. The phenomenon of “shoulder or elbow pain” is defined as any condition resulting in the subject experiencing pain for ≥ 1 week. Any injury that occurred via another mechanism, such as trauma including abrasion, bruise, dislocation, and fractures, was excluded.

Other questions included their names, age, height, weight, grade, baseball experience, baseball teams, prefectures where they live, main position in the most recent one year, whether they use a hard ball or rubber ball, practice days per week, weekend and weekday training times, pitch counts with 100% of their energy per day or week, and the number of days per week when they deliver a pitch with 100% of their energy. We asked coaches about the number of games in one year and the off-season period. The Rohrer index is calculated from weight and height to investigate the growth status [10]. This study has been approved by the IRB of the Japanese Orthopaedic Association. An official of The Bone and Joint Decade Japan first met members of each youth baseball organization to discuss the contents of this study. Questionnaires were sent to the respective regional organizations in September 2015 through

the offices of the Japan Rubber Baseball Association, Japan Little League Baseball Association, Japan Boys League, Pony Baseball Association of Japan, Young Baseball League, and Fresh Baseball League of Kyushu District. Collection was complete in December. All parents and coaches gave their consent.

The subjects were divided into 2 groups according to absence or presence of shoulder and elbow pain for the past year. A comparative examination was conducted between groups, including those with and without shoulder and elbow pain, to clarify the characteristics of subjects with shoulder and elbow pain by Mann–Whitney U test for continuous variables and Pearson's chi-square test for categorical data. In addition, we investigated the risk factors of shoulder and elbow pain for the past year. The data were analyzed using a multivariate logistic regression analysis and shown as an odds ratio (OR) and profile likelihood with 95% confidence interval (CI) values. All statistical analyses were conducted using the SAS 9.4 software program (SAS Institute Inc., Cary, NC, USA), and the critical value for significance was set at $P < 0.05$.

3. Results

A total of 8354 players belonging to 412 teams (average age: 8.9) responded to the survey. The teams of the participants included 380 teams (7794 players) across the country belonging to the Japan Rubber Baseball Association and 32 teams (560 players) belonging to the associations where players use a hard ball (Table 1). We analyzed 7894 players excluding one junior high school student and 460 players who suffered from shoulder and elbow pain in September 2014 (mean age 9.9 ± 1.39 , males 7589 and females 305). This year, the main positions included pitchers: 911, catchers: 666, and position players: 6317. Among players who had no shoulder or elbow pain one year ago, 971 (12.3%) experienced elbow pain over the past one year, 631 (8.0%) experienced shoulder pain, and 1364 (17.4%) experienced shoulder or elbow pain. The relationship between the items and shoulder and elbow pain is shown in Table 2.

3.1. Prevalence of risk-prone pitching activities

JSCSM has created a proposal to prevent baseball shoulder and elbow injuries [9], listing the following items. 1) The practice days and practice hours of elementary school baseball players shall not surpass three days a week and 2 h per day. 2) Pitch counts in which players give 100% of their energy shall be 50 per day and 200 per week in the exercise and games. 3) Coaches shall try to have players stay away from baseball and play other sports in the off-season.

A total of 2835 players practiced more than four days per week. 39.9% of all players did not follow these rules. Regarding practice time on Saturday and Sunday, 172 players practiced 2 h or less on average, while 7052 players (97.6%) did not follow the proposal, practicing for 3 h or more. 2747 players (38.4%) were undecided

Table 1
Participant Baseball associations and players.

Baseball association	No of teams (collection rate)	Number of players
Japan Rubber Baseball Association	380 (79.7%)	7794
Japan Little League	16 (84.2%)	314
Japan Boys League	8 (61.5%)	147
Pony Baseball Association of Japan	1 (50.0%)	8
Young Baseball League	1 (33.3%)	15
Fresh Baseball League of Kyushu District	6 (60.0%)	76
Total	412 (78.6%)	8354

Table 2
Characteristics of players.

		Absence of shoulder and elbow pain (n = 6530)	Presence of shoulder and elbow pain (n = 1364)	P value
Gender ^a	Boys	5981 (82.3%)	1290 (17.7%)	P < 0.001
	Girls	278 (91.1%)	27 (8.9%)	
Rohrer index ^a		124.4 ± 16.5 (n = 6206)	123.5 ± 17.0 (n = 1317)	P = 0.06
Grade ^a		4.5 ± 1.3 (n = 6519)	5.1 ± 1.0 (n = 1363)	P < 0.001
Age ^a		9.7 ± 1.4 (n = 6525)	10.4 ± 1.1 (n = 1363)	P < 0.001
Years of experience ^a		2.1 ± 1.5 (n = 6520)	2.7 ± 1.3 (n = 1363)	P < 0.001
Games per year ^a	Less than 100	5086 (82.9%)	1052 (17.1%)	P = 0.16
	100 or more	795 (81.0%)	187 (19.0%)	
Duration of Off-season ^a	3 months or less	5420 (82.6%)	1143 (17.4%)	P = 0.99
	4 months	488 (82.7%)	102 (17.3%)	
Days of practice per week ^a	3 days or less	3515 (82.5%)	747 (17.5%)	P = 0.73
	4 days or more	2348 (82.8%)	487 (17.2%)	
Average practice hours on weekdays ^a	Less than 3 h	5401 (82.3%)	1162 (17.7%)	P < 0.05
	3 h or more	537 (85.5%)	91 (14.5%)	
Average practice hours per day in weekend ^a	Less than 3 h	152 (88.4%)	20 (11.6%)	P = 0.05
	3 h or more	5808 (82.4%)	1244 (17.6%)	
Total amount of practice per week (Hours) ^a		14.1 ± 3.7 (n = 5856)	14.1 ± 3.7 (n = 1229)	P = 1
Main position	Pitcher	661 (72.6%)	250 (27.4%)	P < 0.001
	Catcher	494 (74.2%)	172 (25.8%)	
	Fielder	5375 (85.1%)	942 (14.9%)	
Forced pitches a day ^a	Less than 50	3974 (85.2%)	688 (14.8%)	P < 0.001
	More than 50	1969 (76.4%)	608 (23.6%)	
Days with a forced pitches a week ^a	Less than 3 days	5141 (82.4%)	1096 (17.6%)	P < 0.04
	More than 4 days	803 (79.7%)	205 (20.3%)	
Total forced pitches a week ^a	Less than 100	4761 (83.5%)	938 (16.5%)	P < 0.001
	More than 100	1151 (76.1%)	361 (23.9%)	
Ball used	Rubber ball	6103 (82.7%)	1279 (17.3%)	P = 0.72
	Hard ball	427 (83.4%)	85 (16.6%)	

Continuous variables were presented as a mean with standard deviation; categorical variables were presented as numbers and percentage (%). Mann–Whitney U test was used for a continuous variables and Pearson's chi-square test for a categorical variable.

^a Because each item has a limited number of respondents, the actual number is not necessarily in accordance with the total number.

regarding their off-season. Only 590 players (8.2%) took four or more months off from baseball.

3.2. Risk factors of shoulder and elbow pain

A total of 1290 males (17.7%) and 27 females (8.9%) had shoulder and elbow pain over the past year (Table 2). More males suffered from shoulder and elbow pain than females. Players experiencing shoulder and elbow pain were older and in higher grades with longer baseball careers. There was no difference in the occurrence of shoulder and elbow pain between the players who played 100 games or more a year and those playing less than 100. The players taking four or more months off from baseball per a year had the same incidence of shoulder and elbow pain, compared with those taking three or less months off.

There was no difference between players with practice days of three days or less and those with four days or more. No significant differences in the total training hours per week were shown between the group experiencing shoulder and elbow pain and that without experiencing such pain. Regarding positions, 250 pitchers among 911 (27.8%) and 172 catchers (25.8%) suffered shoulder or elbow pain, with more pitchers and catchers having experienced pain than position players. Regarding pitch counts giving 100% of their energy per day, those with less than 50 per day had less frequent occurrence of shoulder or elbow pain than those with 50 or more. Regarding the number of days per week when they deliver a pitch giving 100% of their energy, those with three days or less had less frequent occurrence of shoulder or elbow pain than those with four days or more. Regarding pitch counts giving 100% of their energy per week, those with less than 100 per week had less frequent occurrence of shoulder or elbow pain than those with 100 or more. There was no difference in the occurrence of shoulder and elbow pain between rubber and hard ball usage.

According to a multivariate logistic regression analysis, the occurrence frequency of shoulder and elbow pain in males was found to be 1.69-fold in females (Table 3). As the age increases by one year, the frequency of shoulder and elbow pain increased 1.287-fold. The occurrence frequency in pitchers and catchers is 1.434-fold and 1.404-fold that of others. The occurrence frequency in players who throw over 50 balls per day is 1.282-fold higher than those who do not.

4. Discussion

A survey conducted by sports organizations in cooperation with the Japanese Orthopaedic Association has never before been conducted on a national scale in Japan. This study was conducted by orthopedists in cooperation with all amateur baseball organizations, regarding the daily practice conditions and the occurrence of shoulder and elbow pain over the last one year among more than 8000 elementary school baseball players across the country.

Many previous reports have focused on pitchers, specifically investigating individual pitchers. However, few have reported on studies regarding the situation of practices and games of the whole team including other positions [5,7,11]. This survey revealed that many Japanese teams practice excessively despite the proposal by JSCSM in 1995. Specifically, approximately 40% of players practice for four days or more per week, with only 2% following the proposal which calls for regulating the average weekend practice time to 2 h per day. Moreover, approximately 38% of players play on teams with no definite off-season.

In addition, 12.2% of players experienced elbow pain over the past one year, 7.7%, experienced shoulder pain, and 17.3% experienced shoulder or elbow pain. According to a report by Lyman [12], with a similar target age group as our study, approximately 30% of pitchers aged 9–12 experienced shoulder and elbow pain

Table 3

A multivariate logistic regression analysis of the risk factor for shoulder and elbow pain.

	Odds ratio (95% Confidence Interval)	P value
Gender: boys vs girls	1.690 (1.089–2.623)	P < 0.02
Rohrer index	1.001 (0.997–1.005)	P < 0.74
Grade	1.122 (0.953–1.320)	P < 0.17
Age	1.287 (1.115–1.484)	P < 0.001
Years of experience	1.002 (0.942–1.065)	P < 0.96
Games per year: 100 or more vs. less than 100	1.055 (0.865–1.286)	P < 0.60
Duration of off-season: 3 months or less vs. 4 months	1.003 (0.776–1.297)	P < 0.98
Days of practice per week: 4 days or more vs. 3 days or less	0.998 (0.835–1.193)	P < 0.99
Average hours of practice on weekdays: 3 h or more vs. 2 h or less	0.786 (0.605–1.023)	P < 0.08
Average hours of practice a day at weekend: 3 h or more vs. 2 h or less	1.418 (0.801–2.509)	P < 0.24
Total amount of practice per week	1.006 (0.982–1.030)	P < 0.66
Position: pitchers vs. fielders	1.434 (1.178–1.745)	P < 0.001
Position catcher vs. fielders	1.404 (1.123–1.755)	P = 0.003
Pitch counts with 100% of their energy per day: 50 or more vs. less than 50	1.282 (1.082–1.520)	P = 0.004
Days of throw with 100% of their energy a week: 4 or more vs. 3 or less	1.095 (0.891–1.346)	P < 0.40
Pitch counts with 100% of their energy per week : 100 or more vs. less than 100	1.132 (0.934–1.372)	P < 0.21
Ball: hard ball vs. rubber ball	0.883 (0.662–1.177)	P < 0.40

throughout the season. Matsuura reported that 30.5% of 7 to 11-year-old baseball players complained of elbow pain over the course of a single season [5]. The frequency of shoulder and elbow pain was lower than their reports probably due to differences in age distribution, positions and the practice environment of targeted subjects.

In this survey, the age of subjects was 6–12. The older their age, the higher the occurrence frequency of shoulder and elbow pain. This can be confirmed in the report by Lyman [12]. All physes are exhibited in the proximal end of the humerus and around the elbow joint among 11 to 12-year-old players without adhesion until reaching the age of 19 [13]. Thus, the frequency of elbow and shoulder injuries is higher during that period. It can be assumed that the strength of players increases as they age, thereby placing more pressure on their elbows and shoulders.

According to the proposal made by the JSCSM, the practice days and practice hours of elementary school baseball players should not surpass three days a week and 2 h per day, with a maximum of six practice hours per week. However, the average practice days and total practice time respectively surpass three days and 14 h in both groups with and without shoulder and elbow pain. It has been revealed that many players do not follow the limit of 6 h per week stated in the recommendations. In the survey we conducted in 2014, the occurrence frequency of shoulder and elbow pain in the past was higher in elementary school players who practiced six or more days per week than those who practiced five days or less [1]. It can be assumed that few rest days allows fatigue to accumulate and causes shoulder and elbow injuries. It is vital for baseball players to take sufficient rest.

Pitchers and catchers experienced a higher frequency of shoulder and elbow pain than position players. From previous reports [2,6,12,14,15], it is well known that pitchers have a higher frequency of shoulder and elbow pain and injuries. It has widely

been reported in international studies that throwing breaking balls such as sliders may cause elbow pain due to the biomechanical stress placed on the elbow [16]. However, throwing breaking balls is not allowed in baseball games among Japanese elementary school students, with rules in place to punish players for throwing breaking balls, a point which has played a significant role in the prevention of shoulder and elbow injuries among pitchers.

This study revealed that both catchers and pitchers are positions with higher frequency of shoulder and elbow pain. Many articles regarding elbow injuries due to pitching have investigated pitchers [2,6,8,12,14,17], without focusing on catchers. According to Yang [14], catchers are not at risk of elbow pain in young baseball players. On the other hand, according to Hang et al. [18], 58% of pitchers had elbow pain compared to 63% of catchers and 47% of position players. Compared to pitchers or position players, the frequency of fragmentation was higher in catchers. Moreover, Matsuura et al. reported that the frequency of elbow pain in catchers is similar to pitchers [5]. Catchers are required to throw as many balls as pitchers. It is important to follow the recommendation of JSCSM to educate multiple pitchers and catchers [9].

According to the proposal [9], pitch counts giving 100% of their energy per day shall be limited to 50 per day. In this survey, the occurrence frequency in players who throw over 50 balls per day was higher than those who do not. This suggests that larger pitch counts lead to the onset of shoulder and elbow pain. In the pitch smart guidelines of the U.S. [19], described in detail are the limits in pitch counts per day according to age as well as the pitch counts per day and following rest days. The limit per day is 85 for 11 to 12-year-old players, with three rest days recommended following days with pitch counts of 51 or more. In this survey, there was no significant difference in the pitch count per week between those with 100 or more and those with less than 100.

Gender differences have been reported regarding knee injuries associated with basketball as a youth sport [20]. To date, few articles have reported on gender differences regarding the occurrence frequency of shoulder and elbow pain in elementary school baseball players. This survey revealed that the frequency of shoulder and elbow pain is higher in male baseball players than females. The cause is not clear. The shorter distance that elementary school girls can throw a ball may place less stress on their shoulders and elbows [21].

This study is associated with some limitations. The first is the bias in terms of player selection. The teams participating in the questionnaire were determined by the local branch belonging to each baseball organization without our involvement. However, elementary school baseball players living in every prefecture across the country participated, with no bias in terms of climate or region. The second limitation is the fact that this was a retrospective cohort study reported by the players themselves. They ranged from six to 12 years old. The events over the past one year were documented according to their memory with the help of their parents. Thus, the pitch counts are not exact. In order to reduce this limitation, we asked their parents to help them with the documentation. The third limitation is the obscurity of the causes of shoulder and elbow pain and the severity as the questionnaire survey was conducted without diagnoses of players. However, many diseases associated with shoulder and elbow are known to occur due to shoulder and elbow pain. Last but not least, the coaches may have indicated a longer off-season than the actual case in the questionnaire. However, despite this fact, the off-season period was still short.

Given these limitations, this study was conducted by the Japanese Orthopaedic Association in cooperation with Baseball Federation of Japan, revealing that many Japanese baseball teams train too much. Moreover, the risk factors of shoulder and elbow pain turned out to be a male sex, catchers and pitchers, and players who throw more than 50 balls per day. From this study, we expect

amateur baseball world to recognize that excessive training can expose elementary school baseball players to risk of shoulder and elbow pain. It is expected that the baseball world will revise the practice environment of elementary school baseball players by regulating off-seasons and limiting pitch counts to prevent shoulder and elbow pain in elementary school baseball players.

Going forward, we need to conduct a prospective study in more detail including direct medical examinations, in order to clarify the risk factors of shoulder and elbow injuries in young baseball players and enable them to continue enjoying baseball without these injuries.

Conflict of interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jos.2017.03.016>.

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