Risk factors for shoulder and elbow pain in youth baseball players

Tetsuya Matsuura[1], Toshiyuki Iwame[1], Naoto Suzue[2], Kokichi Arisawa[3], Koichi Sairyo[1]

[1]Department of Orthopedics, Institute of Biomedical Sciences, Tokushima University Graduate School, 3-18-15 Kuramoto, Tokushima 770-8503, Japan
[2]Department of Orthopaedic Surgery, Tokushima Red Cross Hospital, 103 Irinokuchi, Komatsushima-cho, Komatsushima, Tokushima 773-8502, Japan
[3]Department of Preventive Medicine, Institute of Biomedical Sciences, Tokushima University Graduate School, 3-18-15 Kuramoto, Tokushima 770-8503, Japan

Corresponding author: Tetsuya Matsuura, MD
Department of Orthopedics, Institute of Biomedical Sciences, Tokushima University Graduate School, 3-18-15 Kuramoto, Tokushima, Tokushima 770-8503, Japan
Tel.: +81 88 633 7240
Fax: +81 88 633 0178
E-mail: tmatsu@tokushima-u.ac.jp

Abstract

Objectives: This study sought to quantify the 1-year cumulative incidence of shoulder and elbow pain among youth baseball players and identify risk factors associated with the occurrence of shoulder and elbow pain.

Methods: In total, 900 youth baseball players (aged 7–11 years) were enrolled in a 1-year prospective follow-up study. One year later, subjects were asked whether they had experienced episodes of shoulder or elbow pain and the following risk factors for such pain were investigated: age, position, length of baseball experience, training hours per week, and history of shoulder or elbow pain. Data for the groups with and without shoulder or elbow pain were analyzed using multivariate logistic regression models.

Results: Episodes of shoulder pain were reported by 18.3% of players and episodes of elbow pain were reported by 35.2% of players. Multivariate analysis showed that shoulder pain was associated with playing pitcher, catcher, increasing training hours per week, and history of shoulder and elbow pain, and that elbow pain was associated with increasing age, playing pitcher, catcher, increasing training hours per week, and history of elbow pain. Length of baseball experience was not associated with shoulder or elbow pain.

Conclusion: History of elbow pain, playing pitcher, catcher and increasing training hours per week were associated with both types of pain. History of shoulder pain was associated with shoulder pain but not elbow pain. Increasing age was associated with elbow pain but not shoulder pain.

Keywords: Youth sports, Joint pain, Athletic injuries, Risk assessment

1. Introduction

Youth baseball players are at risk of shoulder and elbow problems. Further, reports suggest there has been a rapid increase in shoulder and elbow injury rates among players in this age group since the first decade of the 21st century (1, 2, 3, 4). It is thought that at higher competition levels, shoulder and elbow injuries requiring medical attention are likely the result of cumulative microtrauma starting at the youth level. Serious throwing injuries are most commonly due to the accumulation of microtrauma from repetitive throwing motions (5). Although epidemiological research has increasingly focused on throwing-related risk factors for injuries among youth and adolescent players (2, 6, 7, 8, 9, 10, 11), the factors associated with these problems are not well understood.

Lyman et al. followed 298 youth baseball pitchers (aged 9–12 years) for 2 consecutive spring seasons (7). They found that the frequency of shoulder pain and elbow pain was 32% and 26%, respectively, and that the factors associated with each type of pain were different. Shoulder pain was associated with pitches thrown per season and pitches thrown per game (7); elbow pain was associated with increasing age, arm fatigue during the game, and pitches thrown per season (7). The risk of shoulder and elbow pain from playing catcher, infield, or outfield without pitching was not examined in that study. Matsuura et al. investigated 1563 players aged 7–12 years including pitchers and nonpitchers, and found that 15.9% and 29.2% of the players reported episodes of shoulder pain and elbow pain, respectively (9). Again, the associated risk factors were different for each type of pain. There was a significant association between shoulder pain and increasing age; elbow pain was associated with increasing age, increasing length of baseball experience, and playing catcher (9).

48 However, that study did not clarified risk factors because study design was
49 cross-sectional study. To our knowledge, no study has assessed the risk factors for
50 shoulder and/or elbow pain in youth baseball players, either in pitchers or in position
51 players.

52 The aim of this study was to determine the cumulative incidence of shoulder and
53 elbow pain in youth baseball players within a 1-year period. We hypothesized that the
54 risk factors for shoulder pain would be different from those for elbow pain in youth
55 baseball players.

56

57 2. **Materials and Methods**

58 This study was approved by the institutional review board at our institution, and all
59 parents and coaches provided informed consent. All team players gave their assent to
60 participate.

61 Baseline data were collected by questionnaire from 1020 players who participated in
62 a regional summer championship for youth baseball teams in July 2012. The
63 questionnaire was distributed to team coaches, and the players completed them with the
64 assistance of their coaches and/or parents. Players were asked whether they had
65 experienced episodes of shoulder or elbow pain that resulted in restriction of
66 participation for ≥ 1 day. The questionnaire was also used to gather data on age, playing
67 position, length of baseball experience, and training hours per week. Players reported
68 their most often played position. Training hours per week included hours spent in
69 practice, the bullpen, and games.

70 The same subjects were re-investigated for shoulder and/or elbow pain 1 year later
71 using a follow-up questionnaire sent out by mail. The subjects were not contacted by the

study investigators during the intervening year. Of the 1020 players, 900 (88.2%; mean age 9.5 [range 7–11] years) completed the survey. Of these 900 players, 122 had reported prior shoulder pain and 187 had reported prior elbow pain on the initial baseline questionnaire completed at the beginning of the study. No completed questionnaires were excluded. Subjects were asked at follow-up whether they had experienced episodes of shoulder or elbow pain that resulted in restriction of participation for ≥ 1 day. The first author reviewed the questionnaire returned by mail with each subject to confirm their understanding of the questions and to check the accuracy of the information provided.

We investigated the following potential risk factors for shoulder and elbow pain: age (four categories), position (four categories), length of baseball experience (five categories), training hours per week (four categories), and history of shoulder or elbow pain (binary). The data were analyzed by multiple logistic regression analysis. First, the potential risk factors were analyzed one by one, followed by multivariate analysis that included all potential risk factors in the models. Dummy variables were created and those except for reference categories were included in the models. Odds ratios (ORs) with profile likelihood 95% confidence intervals (CIs) are presented relative to the reference categories. A two-tailed *P*-value < 0.05 (Wald test) was considered statistically significant. The statistical analysis was performed using PROC LOGISTIC PC SAS version 8.2 software (SAS Institute Inc., Cary, NC).

3. Results

Of the 900 subjects, 165 (18.3%) reported episodes of pain in the throwing shoulder during the 1-year study period. Potential risk factors associated with shoulder pain are

summarized in Tables 1 and 2. Univariate analysis showed that shoulder pain was significantly associated with age 10 years ($P < 0.01$), age 11 years ($P < 0.01$). There was no statistically significant association between 9 years and shoulder pain. There was a statistically significant association between shoulder pain and playing pitcher ($P < 0.0001$) or catcher ($P < 0.001$). Infielder position was not significantly associated with shoulder pain. There was a statistically significant association between shoulder pain and lengths of baseball experience of > 4.5 but ≤ 6 years ($P < 0.05$). Training hours per week were not significantly associated with shoulder pain. There was a statistically significant association between shoulder pain and history of shoulder and elbow pain ($P < 0.0001$; Table 1). Multivariate analysis of these variables showed that the risk factors significantly associated with shoulder pain were playing pitcher (OR 2.99; 95% CI 1.65–5.43), catcher (OR 2.02; 95% CI 1.07–3.76), training hours per week of > 16 but ≤ 36 h (OR 2.00; 95% CI 1.07–3.92), history of shoulder pain (OR 3.34; 95% CI 2.16–5.17), and history of elbow pain (OR 1.53; 95% CI 1.00–2.31; Table 2). Age 10 years (OR 1.31; 95% CI 0.69–2.57), 11 years (OR 1.26; 95% CI 0.60–2.71) and lengths of baseball experience of > 4.5 but ≤ 6 years (OR 1.60; 95% CI 0.43–7.90) were not significantly associated with shoulder pain..

Of the 900 subjects, 317 (35.2%) reported episodes of pain in the throwing elbow during the season. Potential risk factors associated with elbow pain are summarized in Tables 3 and 4. Univariate analysis showed that elbow pain had a significant association with age 9 ($P < 0.0001$), age 10 ($P < 0.0001$), or age 11 ($P < 0.0001$) years. Playing pitcher ($P < 0.0001$), catcher ($P < 0.0001$), or infielder ($P < 0.01$) was significantly associated with elbow pain. Lengths of baseball experience of > 2.5 but ≤ 3.5 years ($P < 0.01$), > 3.5 but ≤ 4.5 years ($P < 0.001$), and 4.5 but ≤ 6 years ($P < 0.001$) were

120 significantly associated with elbow pain. Training hours per week of > 16 but ≤ 36 h (*P*
121 < 0.01) was significantly associated with elbow pain. There was a significant
122 association between elbow pain and history of shoulder and elbow pain (*P* < 0.001;
123 Table 3). Multivariate analysis of these variables showed that the following risk factors
124 were significantly associated with elbow pain: age 9 (OR 3.19; 95% CI 1.76–6.02), age
125 10 (OR 3.18; 95% CI 1.76–6.00), or 11 (OR 3.93; 95% CI 2.01–7.95) years; playing
126 pitcher (OR 2.62; 95% CI 1.53–4.50), and catcher (OR 2.29; 95% CI 1.33–3.96);
127 training hours per week of > 16 but ≤ 36 h (OR 2.33; 95% CI 1.34–4.15; Table 4);
128 history of elbow pain (OR 5.70; 95% CI 3.91–8.41) . Infielder (OR 1.41; 95% CI 0.96–
129 2.06), length of baseball experience of > 2.5 but ≤ 3.5 years (OR 1.65; 95% CI 0.59–
130 5.91), > 3.5 but ≤ 4.5 years (OR 1.64; 95% CI 0.56–6.03) and > 4.5 but ≤ 6 years (OR
131 2.39; 95% CI 0.73–9.48) of baseball experience and episodes of shoulder pain (OR
132 1.20; 95% CI 0.77–1.88) were not significantly associated with elbow pain.
133
134 **4. Discussion**
135 This study investigated the risk factors for shoulder and/or elbow pain in youth
136 baseball players. Unique aspects of this study were the inclusion of pitchers and
137 position players and a Japanese study population. Baseball is the most popular sport in
138 Japan, and many problematic throwing injuries in young players are recognized (6, 9,
139 10).
140 This is the first study to report the cumulative incidence of shoulder and elbow pain
141 in entire teams of youth baseball players aged 7–11 years within a 1-year period. The
142 1-year cumulative incidence of shoulder and elbow pain at either site was 18.3% and
143 35.2%, respectively. History of shoulder or elbow pain was the strongest risk factors for

pain at each site. Picher was also strong risk factors for both shoulder and elbow pain. Some factors associated with pain at these sites appeared to be different, suggesting diverse etiologies. Increasing age was strong risk factor for elbow pain but not for shoulder pain.

History of shoulder or elbow pain was the strongest risk factors for pain at each site. These results suggest that players with a previous history of shoulder or elbow pain were required attention. Interestingly, in our study, a history of elbow pain was associated with a higher incidence of shoulder pain. However, a history of shoulder pain was not associated with a higher incidence of elbow pain. Taken together with the fact that the frequency of elbow pain was higher than that of shoulder pain, elbow injury in youth baseball players might often precede a shoulder injury. It may be that, in players who develop an elbow injury, throwing mechanics are altered to alleviate the stress on the elbow and lead to decreased performance, thereby increasing the stress on the shoulder, although there is no direct evidence that this occurs (12).

Multivariate logistic regression revealed that pitching was associated with shoulder pain and elbow pain. The risk factor with the association with injury was pitching, suggesting that pitching is a strong risk factor for developing pain at the shoulder and elbow. In a cross-sectional study of risk factors for elbow injuries in baseball players aged 9–12 years, Harada et al. showed that pitching was a strong risk factor for elbow injury (6). In our study, catcher was also risk factor for shoulder and elbow pain. Previous studies have demonstrated comparatively high rates of arm pain in young catchers, which might be explained by the fact that the number of throws made by catchers is comparable to that of pitchers and more than that of position players (10, 13).

Increasing age, but not length of baseball experience, had a strong association with elbow pain. The relationship between age and risk of arm problems and/or injuries has frequently been reported in earlier studies, where increasing age was shown to be associated with a higher incidence of arm pain (7, 9, 14, 15, 16). Because this increase was found for 2–3 years between the ages of 8 and 11 years, it might have important implications. It is possible that older players are more skillful and thus may make more throws per game (2, 8, 11). Older players are also likely to be stronger and capable of generating a greater load on the joint/soft tissue structures. A further hypothesis focuses on the secondary ossification centers (8), which start to ossify between the ages of 2 and 11 years and do not fuse to the long bones until as late as 17 years of age. There may be up to six secondary ossification centers present in the elbow of an 11-year-old boy. These centers are the most vulnerable points in the young elbow and can become inflamed and irritated by the throwing motion (8). However, increasing age was not associated with shoulder pain in this study. Lyman et al. reported similar results, that is, a relationship between increasing age and elbow pain but not with shoulder pain (7).

Training hours per week of > 16 but ≤ 36 h was also associated with both shoulder and elbow pain. Harada et al. showed that ≥ 14 h of training per week tended to be an associated risk factor (6). The results of our longitudinal study confirm that increasing training hours per week are risk factors for arm pain.

It is expected that increasing length of baseball experience would be associated with arm pain because throwing injuries result in the accumulation of microtrauma from repetitive throwing motion (5). However, in this study, length of baseball experience was not associated with the incidence of shoulder pain or elbow pain. A possible explanation for this lack of a significant finding is that most (72.3%) of the participants

in our study had < 3.5 years of baseball experience. Combined with the fact that increasing training hours per week was associated with shoulder and elbow pain, it might be that increasing length of baseball experience is associated with shoulder and/or elbow pain in players who are older than those in the present study.

This prospective study identified multiple risk factors for “throwing injuries” in youth baseball players and adds new information to the available data. However, the study has several limitations. One major limitation is that our data are based on self-reporting by young participants. There might have been some recall bias when the players were asked about their history of shoulder and/or elbow pain. Moreover, it would have been ideal for someone who was not involved in the study or was blinded to the study hypothesis to have reviewed the questionnaires with each player. The study would also have yielded more robust information if the questionnaire had included information on factors such as additional or secondary positions, the characteristics, intensity, and duration of pain and treatment, time to return to baseball, and prior surgical treatment. A further limitation was that no physical examination was undertaken to rule out conditions such as glenohumeral internal rotation deficit, loss of total range of motion at the shoulder, rotator cuff weakness, scapular dysfunction, muscle tightness in the lower extremities, and deficits in single-leg standing balance. The final limitation was that all the players were from the same geographic region in Japan. It is unclear whether the risk factors identified in this study are different from those for players in other regions or countries. Future multicenter studies are needed to draw firm conclusions regarding the causes of pain and the risk of injury to the shoulder and elbow in youth baseball players.

5. Conclusion

History of shoulder or elbow pain, and pitcher are strong risk factors for arm pain. Increasing age is strong risk factor for elbow pain not for shoulder pain. Training hours per week should be restricted less than 16 hours. Players with history of elbow pain were paid attention to occurrence of shoulder pain.

References

1. Fleisig GS, Andrews JA. Prevention of elbow injuries in youth baseball pitchers. Sports Health. 2012;4:419–24.
2. Fleisig GS, Andrews JA, Cutter GR, et al. Risk of serious injury for young baseball pitcher: a 10-year prospective study. Am J Sports Med. 2011;39:253–7.
3. Hodgins JL, Vitale M, Arons RR, Ahmad CS. Epidemiology of medial ulnar collateral ligament reconstruction. Am J Sports Med. 2016;44:729–34.
4. Petty DH, Andrews JR, Fleisig GS, Cain EL. Ulnar collateral ligament reconstruction in high school baseball players: clinical results and injury risk factors. Am J Sports Med. 2004;32:1158–64.
5. Oberlander MA, Chisar MA, Campbell B. Epidemiology of shoulder injuries in throwing and overhead athletes. Sports Med Arthrosc Rev. 2000;8:115–23.
6. Harada M, Takahara M, Mura N, Sasaki J, Ito T, Ogino T. Risk factors for elbow injuries among young baseball players. J Shoulder Elbow Surg. 2010;19:502–7. doi: 10.1016/j.jse.2009.10.022.
7. Lyman S, Fleisig GS, Andrews JR, Osinski ED. Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers. Am J Sports Med. 2002;30:463–8.
8. Lyman S, Fleisig GS, Waterbor JW, et al. Longitudinal study of elbow and shoulder pain in youth baseball pitchers. Med Sci Sports Exerc. 2001;33(11):1803–10.
9. Matsuura T, Suzue N, Iwame T, Arisawa K. Fukuta S, Sairyo K. Epidemiology of shoulder and elbow pain in youth baseball players. Phys Sportsmed. 2016;44:97–100.
10. Matsuura T, Suze N, Kashiwaguchi S, Arisawa K, Yasui N. Elbow injuries in youth

245 baseball players without prior elbow pain. A 1-year prospective study. Orthop J
246 Sports Med. 2013;1(5):2325967113509948. doi:10.1177/2325967113509948.
247 11. Olsen SJ II, Fleisig GS, Dun S, Loftice J, Andrews JR. Risk factors for shoulder and
248 elbow injuries in adolescent baseball pitchers. Am J Sports Med. 2006;34:905–12.
249 12. Fleisig GS, Leddon CE, Laughlin WA, et al. Biomechanical performance of
250 baseball pitchers with a history of ulnar collateral ligament reconstruction. Am J
251 Sports Med. 2015;43:1045–50.
252 13. Hang DW, Chao CM, Hang YS. A clinical and roentgenographic study of Little
253 League elbow. Am J Sports Med. 2004;32:79–84.
254 14. Sabick MB, Kim YK, Torry MR, Keims MA, Hawkins RJ. Biomechanics of the
255 shoulder in youth baseball pitchers: implications for the development proximal
256 humeral epiphysis and humeral retrotorsion. Am J Sports Med. 2005;33:1716–22.
257 15. Walton J, Paxinos A, Tzannes A, et al. The unstable shoulder in the adolescent
258 athlete. Am J Sports Med. 2002;30:758–67.
259 16. Zaremski JL, Krabak BJ. Shoulder injuries in the skeletally immature baseball
260 pitcher and recommendations for the prevention of injury. PM R. 2012;4:509–16.
261

Table 1 Univariate analysis of risk factors for shoulder pain

	n (%)	OR	95% CI	*P*-value
Age (years)				
≤ 8	153 (19.7)	1		
9	200 (25.7)	1.55	0.79−3.15	0.21
10	**310 (39.8)**	**2.24**	**1.24−4.31**	**0.01**
11	115 (14.8)	1.61	0.75−3.48	0.22
Position				
Pitcher	**80 (10.3)**	**2.82**	**1.49−5.29**	**< 0.01**
Catcher	**75 (9.6)**	**2.12**	**1.05−4.13**	**0.03**
Infielder	339 (43.6)	1.43	0.89−2.34	0.15
Outfielder	284 (36.5)	1		
Length of baseball experience (years)				
≤ 1.5	30 (3.9)	1		
> 1.5 but ≤ 2.5	270 (34.7)	1.95	0.55−12.41	0.38
> 2.5 but ≤ 3.5	279 (35.9)	2.07	0.59−13.18	0.33
> 3.5 but ≤ 4.5	150 (19.3)	3.80	1.06−24.28	0.08
> 4.5 but ≤ 6	49 (6.2)	4.05	0.99−27.54	0.08
Training hours per week (h)				
≤ 10.5	87 (11.2)	1		
> 10.5 but ≤ 13	197 (25.3)	2.24	0.95−6.17	0.09
> 13 but ≤ 16	249 (32.0)	2.06	0.89−5.63	0.12
> 16 but ≤ 36	**245 (31.5)**	**3.20**	**1.42−8.62**	**0.01**
History of elbow pain				
Negative	637 (81.9)	1		
Positive	**141 (18.1)**	**1.99**	**1.25−3.12**	**0.01**

Potential risk factors were examined one by one. Statistically significant values (Wald test) are shown in bold. Abbreviations: CI, confidence interval, OR, odds ratio

Table 2 Multivariate analysis of risk factors for shoulder pain

Variable	OR	95% CI	*P*-value
Age (years)			
≤ 8	1		
9	1.22	0.61−2.56	0.58
10	1.42	0.71−2.96	0.34
11	0.94	0.40−2.25	0.90
Position			
Pitcher	**2.12**	**1.05−4.23**	**0.03**
Catcher	1.61	0.77−3.28	0.19
Infielder	1.26	0.76−2.10	0.38
Outfielder	1		
Length of baseball experience (years)			
≤ 1.5	1		
> 1.5 but ≤ 2.5	1.59	0.44−10.25	0.54
> 2.5 but ≤ 3.5	1.40	0.38−9.13	0.66
> 3.5 but ≤ 4.5	2.03	0.52−13.53	0.37
> 4.5 but ≤ 6	2.40	0.53−17.28	0.30
Training hours per week (h)			
≤ 10.5	1		
> 10.5 but ≤ 13	2.05	0.86−5.71	0.13
> 13 but ≤ 16	1.87	0.80−5.16	0.18
> 16 but ≤ 36	**2.98**	**1.30−8.09**	**0.02**
History of elbow pain			
Negative	1		
Positive	**1.60**	**0.98−2.59**	**0.06**

All five potential risk factors were included in the model. Statistically significant values (Wald test) are shown in bold. Abbreviations: CI, confidence interval, OR, odds ratio

Table 3 Univariate analysis of risk factors for elbow pain

	n (%)	OR	95% CI	*P*-value
Age (years)				
≤ 8	152 (21.3)	1		
9	**194 (27.2)**	**3.42**	**1.86−6.69**	**< 0.001**
10	**265 (37.2)**	**4.34**	**2.43−8.28**	**< 0.0001**
11	**102 (14.3)**	**6.10**	**3.16−12.39**	**< 0.0001**
Position				
Pitcher	**74 (10.4)**	**4.59**	**2.62−8.10**	**< 0.0001**
Catcher	**64 (9.0)**	**4.48**	**2.48−8.12**	**< 0.0001**
Infielder	**306 (42.9)**	**1.88**	**1.25−2.87**	**< 0.01**
Outfielder	269 (37.7)	1		
Length of baseball experience (years)				
≤ 1.5	32 (4.5)	1		
> 1.5 but ≤ 2.5	264 (37.0)	1.76	0.65−6.13	0.31
> 2.5 but ≤ 3.5	250 (35.1)	2.56	0.96−8.89	0.09
> 3.5 but ≤ 4.5	**120 (16.8)**	**3.63**	**1.31−12.88**	**0.02**
> 4.5 but ≤ 6	**51 (6.6)**	**4.75**	**1.55−18.00**	**0.01**
Training hours per week (h)				
≤ 10.5	89 (12.4)	1		
> 10.5 but ≤ 13	180 (25.3)	0.95	0.51−1.83	0.88
> 13 but ≤ 16	224 (31.4)	1.13	0.63−2.12	0.69
> 16 but ≤ 36	**220 (30.9)**	**2.30**	**1.30−4.22**	**< 0.01**
History of shoulder pain				
Negative	637 (89.3)	1		
Positive	**76 (10.7)**	**1.80**	**1.08−2.95**	**0.02**

Each potential risk factor was examined one by one. Statistically significant values (Wald test) are shown in bold. Abbreviations: CI, confidence interval, OR, odds ratio

Table 4 Multivariate analysis of risk factors for elbow pain

Variable	OR	95% CI	*P*-value
Age (years)			
≤ 8	1		
9	**2.87**	**1.50−5.79**	**< 0.01**
10	**3.03**	**1.58−6.13**	**< 0.01**
11	**4.17**	**1.97−9.16**	**< 0.001**
Position			
Pitcher	**3.30**	**1.78−6.13**	**< 0.001**
Catcher	**3.35**	**1.78−6.33**	**< 0.001**
Infielder	**1.68**	**1.09−2.62**	**0.02**
Outfielder	1		
Length of baseball experience			
≤ 1.5	1		
> 1.5 but ≤ 2.5	1.48	0.52−5.32	0.50
> 2.5 but ≤ 3.5	1.35	0.47−4.90	0.60
> 3.5 but ≤ 4.5	1.39	0.46−5.22	0.58
> 4.5 but ≤ 6	1.49	0.44−6.12	0.55
Training hours per week			
≤ 10.5	1		
> 10.5 but ≤ 13	0.98	0.51−1.96	0.96
> 13 but ≤ 16	1.17	0.62−2.25	0.64
> 16 but ≤ 36	**2.44**	**1.33−4.66**	**< 0.01**
History of shoulder pain			
Negative	1		
Positive	1.40	0.81−2.38	0.22

All five potential risk factors were included in the model. Statistically significant values (Wald test) are shown in bold. Abbreviations: CI, confidence interval, OR, odds ratio