Title: In children aged 18 years and under, what promotes recurrent shoulder instability after traumatic anterior shoulder dislocation? A systematic review and meta-analysis of risk factors.

Corresponding Author

Margie Olds, Auckland University of Technology, Private Bag 92006, Auckland, New Zealand. +64-9-9219999x7156

Margie.olds@aut.ac.nz

Olds, M., Auckland University of Technology, Private Bag 92006, Auckland, New Zealand

Donaldson, K., Auckland University of Technology, Private Bag 92006, Auckland, New Zealand

Ellis, R., Health and Rehabilitation Research Institute, Auckland University of Technology, Private Bag 92006, Auckland, New Zealand

Kersten, P. Centre for Person Centred Research, Auckland University of Technology, Private Bag 92006, Auckland, New Zealand

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Margie Olds designed the study, collected and extracted and appraised data, designed the statistical analysis, analysed the data and drafted and revised the paper. Kurt Donaldson collected, extracted and appraised the data, analysed the data and drafted and revised the paper. Richard Ellis monitored data extraction, assisted with methods development, helped draft and revise the manuscript. Paula Kersten monitored data extraction, assisted with methods development, helped draft and revise the manuscript and adjudicated when consensus was required regarding study inclusions and rating quality.

ABSTRACT

Background

Skeletal maturity and age-related changes in the composition of the glenoid labrum and joint capsule may influence rates of recurrent instability in children. We systematically review risk factors which predispose children to recurrent shoulder instability.

Methods

The systematic review concerned studies published before May 2015. Statistical analysis was undertaken to compare rates of recurrence for each extracted risk factor. Pooled odds ratios were analysed using random effects meta-analysis.

Results

Six retrospective cohort studies met the inclusion criteria. Eight risk factors were identified across the studies including age, sex, shoulder dominance and injury side, mechanism of injury, state of physis closure, and Hill-Sachs and Bankart lesions. The rate of recurrent instability was 73%. Children aged 14 to 18 years were 24 times more likely to experience recurrent instability than children aged 13 years and less (93% versus 40%) (OR)=24.14, 95%CI (3.71, 156.99) Z=3.33, p=0.001, I^2=6.83%). There was a non-significant trend indicating males were 3.4 times more likely to experience recurrent instability, (OR=3.44, 95%CI (0.98, 12.06), Z=1.93, p=0.053, I^2=0%). Analysis of one study found that children with a closed physis are 14 times more likely to experience recurrent instability compared to those with an open physis (OR=14.0, 95%CI (1.46, 134.25, Z=2.29, p=0.02, I^2=0%) .

Conclusion

Male children aged 14 years and over had the greatest risk of recurrent shoulder instability following a first time traumatic anterior shoulder dislocation. This meta-analysis summarises a mix of six acceptable and poor quality Level III retrospective cohort studies. Further examination of this population with blinded prospective

cohort studies will assist clinicians in the appropriate management of first time traumatic anterior shoulder dislocation.

INTRODUCTION

Many studies which examine recurrent shoulder instability following a first time anterior shoulder dislocation do not differentiate skeletally immature children from adult populations, despite the presence of unique pathoanatomical entities such as open physes[1] which can be present until 18 years of age.[2] Rates of recurrent shoulder instability following a first time traumatic anterior shoulder dislocation have been reported to be as high as 100% in the skeletally immature[3] and 96% in adolescents.[4] Further analysis of the specific risk factors which predispose this subgroup of the population to recurrent shoulder instability following a first time traumatic anterior shoulder dislocation is warranted.

Factors reported to influence the high rates of recurrent shoulder instability following a dislocation in children include anatomical age-related variances of the shoulder joint, such as a more lateral insertion of the joint capsule on the glenoid,[5] and a higher composition of type three collagen fibres.[6] Other proposed factors relating to recurrent shoulder instability in both adults and children include the severity of initial injury, presence of a Bankart lesion, lack of rehabilitation compliance and premature return to high-level activity.[7 8] While several systematic reviews have investigated the effects of surgical intervention on shoulder instability,[8-12] none have identified the risk factors of recurrent shoulder instability in a non-operative, skeletally immature population.

The aim of this systematic review was to identify the risk factors associated with recurrent shoulder instability following a first time traumatic anterior shoulder dislocation in children aged 18 years and under. For the purposes of this systematic review, a recurrent shoulder instability event was defined as either a subluxation or dislocation. We hope that strengthening the evidence will improve clinical decision making in regard to the management of shoulder instability in children

Methods

The development of this systematic review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol[13] and was registered with the PROSPERO database which can be accessed at http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42013005900#.U yj7BKiSySo. A systematic review and meta-analysis was conducted of the available literature in November 2014 using the following databases; MEDLINE, CINAHL, SPORTDiscus, Scopus, Web of Science, Biomedical Reference Collection, Health and Psychosocial Instruments, AMED, ERIC and Proquest Health and Medical. Five key concepts were used in determining the keywords used in the database search (Table 1). Where keywords returned greater than 100,000 titles, the keywords which referred to the shoulder (i.e. 'shoulder', 'glenohumeral' and 'GHJ') were contained to search within the 'title' field only. Screening of the literature was initially done by title and abstract followed by a screening of the full text. The reference lists from the included articles were then analysed to identify any additional articles (Figure 1). Literature not published in English was sent to an external source for translating. Two authors (KD & MO) reviewed potential articles and a consensus was reached regarding included and excluded articles. Inclusion and exclusion criteria for articles are listed in Table 2.

Concept	Keywords used in search strategy
Shoulder	Shoulder* OR glenohumeral* OR GHJ*
Dislocation and instability	Instabilit* OR unstable OR subluxat* OR stabil* OR stabl* OR luxat* OR disarticulat* OR detach* OR disassociat* disengage* OR sublux* OR dislocat*
Recurrent	Recurr* OR repeat* OR repetit* OR intermit* OR frequen*
Children (0-18 years old)	Child* OR adolescen* OR youth* OR juvenil* OR teen* OR student* OR pubescen* OR pubert*
Risk	Risk* OR factor* OR prevalen* OR predict* OR incidence* OR "odds ratio" OR "relative risk"

Table 1: Search strategy keywords

Inclusion criteria
1. Participants 18 years of age or less
2. Participants had a first time traumatic anterior shoulder dislocation or subluxation confirmed by radiographic or clinical testing[14-16]
3. Case control, prospective or retrospective cohorts study designs
4. Recurrence of glenohumeral instability was used as an outcome
5. Studies had a follow-up of one year or more - Studies have shown that the majority of anterior instability events following a first time traumatic dislocation occur within a year[2 17-19]
6. Studies were published before November, 2014
Exclusion criteria
1. Studies which reported multi-directional or posterior shoulder instability
2. Studies which reported participants with atraumatic shoulder instability
3. Studies available in abstract only
4. Chapters from a book
5. Grey literature
6. Studies investigating risk factors of instability following surgical intervention or when comparing alternative surgical interventions

Table 2: Inclusion and Exclusion Criteria

The methodological quality of the articles was evaluated using the Scottish Intercollegiate Guidelines Network (SIGN) checklist.[20] While other tools are available for assessing the methodological quality of observational studies, the SIGN checklist is reported to be the most appropriate and valid tool.[21] This assessment tool for cohort study designs covers areas of subject selection, assessment, confounding factors, statistical analysis and overall assessment of the study. The overall methodological quality of each article was graded as being either high quality (++) (addressed 7 or more of the nine SIGN quality appraisal questions), acceptable (+) (addressed 5-6 of the nine SIGN quality appraisal questions) or low quality (-) (addressed 4 or less of the nine SIGN quality appraisal questions).[20] Methodological quality appraisal was carried out independently by two authors (MO and KD). If a consensus on methodological quality could not be made, a separate independent author (PK) was used to arbitrate to reach an agreement on the methodological quality results as recommended by the SIGN50 handbook.[20]

Data pertaining to the recurrence rates of shoulder instability was extracted from the included references. These data were pooled to provide an overall instability recurrence rate specific to each risk factor/exposure. Where there was sufficient data to calculate an odds ratio, statistical analyses were performed using the Comprehensive Meta-Analysis programme (Version 2.2.064).[22] Statistical significance was set at 0.05. Statistical heterogeneity between studies was assessed using I^2. I^2 is a measure of the heterogeneity of the data, where a value of 0% represents no heterogeneity while values above 75% indicate that high heterogeneity exists.[23]

RESULTS

General study characteristics/demographics

A total of 2,385 abstracts were identified following an initial database search, of which 122 articles were potentially suitable after title and abstract screening (Figure 1). Six articles met the criteria for inclusion and exclusion following a full text screen (Table 3). There were a total of 137 participants included in the review whose age

ranged from 4 to 18 years (Table 3). The mean follow-up period was 8.8 years (SD 4.86). The minimum follow up period was 1 year.

Author	Number of participants	Participants age range (years)	Follow-up period (years)	Risk factors/exposure	Outcome measures	SIGN ratings
Cordischi et al., 2009	14	10.9-13.1	2-4	Age, Gender, Shoulder dominance, Open physis Greater tuberosity fracture, HAGL*** lesion	Recurrence rate, WOSI****	+
Deitch et al., 2003	32	11-18	1-14	Age, Gender, Mechanism of injury, Open/close physis	Recurrence rate	+
Lampert et al., 2003	40*	4-18	1	Age; <14 years and ≥14 years	Recurrence rate	+
Marans et al., 1992	20*	4-16	2-13.8	Age, Gender, Mechanism of injury, Shoulder dominance, Open/Closed physis, Immobilization/No immobilization	Recurrence rate	-
Postacchini et al., 2000	21*	12-17	5.5-8.9	Age, Gender, Hill-Sach lesion, Bankart lesion	Recurrence rate	+
Wagner & Lyne, 1983	10**	12-16	2.2-11.3	Age, Gender, Mechanism of injury, Open physis	Recurrence rate	-

*Note. Numbers relate to participants of the study that were applicable to this systematic review.
**Note. 9 participants in study, 10 shoulders dislocated
*** Humeral Avulsion of Glenohumeral Ligament
****Western Ontario Shoulder Instability Index

Table 3: Article Summaries

The methodological quality of four articles was rated as acceptable (+) and two articles were low quality (-) (Table 3). All articles followed a retrospective cohort study design which prevented completion of analysis related to selection or attrition bias. Furthermore, all articles failed to mention or attempted blinding of the assessment of recurrent instability from the exposure status. Finally, the two papers deemed low quality,[3 24] either poorly addressed or did not address the definition of the primary outcome measure of recurrent instability (SIGN Q1.7).

Eight common risk factors for recurrent shoulder instability following a first time traumatic anterior shoulder dislocation in children 18 years old or younger were identified in the six included articles. These included: age, sex, mechanism of initial injury, state of physis closure, shoulder dominance and side of the affected shoulder, Hill-Sachs lesion and Bankart lesion.

Age	Cordischi et al., 2009		Deitch et al., 2003		Lampert et al., 2003		Marans et al., 1992		Postachinni et al., 2000		Wagner & Lyne, 1983		Total	
	Rec*	Non*	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Recurrence	Non-recurrence
<14 years	3/14	11/14	2/ 6	4/6	0/12	12/12	10/10	0/ 10	1/ 3	2/ 3	5/ 7	2/ 7	40.4% (21/52)	59.6% (31/52)
≥14 years			22/26	4/26	27/28	1/28	10/10	0/ 10	17/ 18	1/ 18	3/ 3	0/ 3	92.9% (79/85)	7.1% (6/85)
Total	3/14	11/14	24/32	8/ 32	27/40	13/40	20/20	0/ 20	18/21	3/ 21	8/ 10	2/ 10	73.0% (100/137)	27% (37/137)

*Note. Rec = recurrent shoulder instability; Non = no shoulder instability.
Results indicate number of people with recurrent instability of a total number of people in the study

Table 4: Recurrent shoulder instability in people aged under 14 years, compared with 14 years and older

All six studies reported an association between age and recurrent instability (Table 4).[1-4 24 25] Pooled data revealed that 92.9% (79/85) of children aged 14 years and older experienced an instability event following a first time traumatic anterior shoulder dislocation and 40.4% (21/52) of children aged 13 years and younger experienced recurrent instability (Table 4). A meta-analysis revealed that children aged 14 to 18 years are 24.14 times more likely to experience recurrent instability compared with those aged 13 years and under (OR=24.14, 95%CI (3.71, 156.99) Z=3.33, p=0.001, I^2=6.83%) (Figure 2). This odds ratio is heavily influenced by the one study of Lampert et al.[[25] which reported a large number of recurrent episodes in children aged over 14 years (27/28) compared with no episodes of recurrence in children aged under 14 years (0/12). The large confidence interval is due to small numbers in the study by Wagner et al. (Figure 2).

Sex

Five articles reported the association between sex and recurrent instability.[1-4 24] Pooled data revealed that 83.4% (57/66) of males had at least one recurrent episode of shoulder instability while 51.6% (16/31) of females experienced a recurrent instability event following a FTASD (Table 5). Analysis showed that male children were 3.44 times more likely to experience recurrent instability when compared to female children. While this result was not statistically significant, it was homogenous (i.e. all studies reported a similar result)[23] (OR=3.44, 95%CI (0.98, 12.06), Z=1.93, p=0.053, I^2=0%) (Figure 3).

Gender	Cordischi et al., 2009		Deitch et al., 2003		Marans et al., 1992		Postachinni et al., 2000		Wagner & Lyne, 1983		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Male	1/2	1/2	20/25	5/25	14/14	0/14	16/18	2/18	6/7	1/7	57/66	9/66	83.4%	13.6%
Female	2/12	10/12	4/7	3/7	6/6	0/6	2/3	1/3	2/3	1/3	16/31	15/31	51.6%	48.4%
Total	3/14	11/14	24/32	8/32	20/20	0/20	18/21	3/21	8/10	2/10	73/97	24/97		

Results indicate the number of recurrent instability events in the total population

Table 5: Gender and recurrent shoulder instability

Mechanism of Primary Shoulder Dislocation

The mechanism of injury for first time traumatic anterior shoulder dislocation was typically divided into two groups; sporting and non-sporting related. Three articles provided results on instability recurrence rates with regards to sporting and non-sporting injuries as an initial mechanism of injury.[3 4 24] Pooled data showed that 89.2% (33/37) of participants whose primary mechanism of injury was sporting related had a recurrent instability event while 76% (19/25) of the non-sporting related group experienced recurrent instability (Table 6). In cases where the mechanism of injury was sporting activity, children were 2.85 times more likely to experience recurrence, compared to when the mechanism of injury was not during sporting activity. This result was not statistically significant but was homogeneous[23] (OR=2.85, 95%CI (0.64, 12.62) Z=1.38, p=0.17, I^2=0%).

	Deitch et al., 2003		Marans et al., 1992		Wagner & Lyne, 1983		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Sporting	14/17	3/17	12/12	0/12	7/8	1/8	33/37	4/37	89.2%	10.8%
Non-sport	10/15	5/15	8/8	0/8	1/2	1/2	19/25	6/25	76%	24%
Total	24/32	8/32	20/20	20/20	8/10	2/10	52/62	10/62	83.9%	16.1%

Results indicate the number of recurrent instability events in the total number of participants

Table 6: Sporting vs. non-sporting mechanism of injury and recurrent shoulder instability

Open/Closed Proximal Humeral Physis

Four articles provided information on the state (open or closed) of the proximal humeral physis of the affected shoulder at the time of primary anterior shoulder dislocation.[1 3 4 24] Pooled data revealed that 61.1% (39/59) of subjects with an open proximal humeral physis at the time of the initial dislocation had a recurrent

episode of shoulder instability compared with 94.1% (16/17) of participants with a radiographically confirmed closed proximal humeral physis (Table 7). Only one study[4] of the four identified, compared open and closed physis. Further analysis of this study indicated children with a closed physis are 14 times more likely to experience recurrent instability compared to those with an open physis (OR=14.0, 95%CI (1.46, 134.25, Z=2.29, p=0.02, I^2=0%) . Again the large variation in confidence intervals reflects the small subject numbers in these studies.

	Cordischi et al.,, 2009		Deitch et al., 2003		Marans et al., 1992		Wagner & Lyne, 1983		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Open	3/14	11/14	8/15	7/15	20/20	0/20	8/10	2/10	39/59	20/59	66.1%	33.9%
Closed			16/17	1/17					16/17	1/17	94.1%	5.9%
Total	3/14	11/14	24/32	8/32	20/20	0/20	8/10	2/10	55/76	21/76	72.4%	27.6%

Results indicate the number of recurrent instability events in the total number of participants

Table 7: open/closed physis at time of injury and recurrent instability

Shoulder Dominance

Two of the six eligible articles presented information regarding the side-dominance of the shoulder that was initially dislocated.[1 3] Pooled data illustrated that 83.3% (15/18) of participants whose initial dislocation was on their dominant shoulder experienced recurrent instability. Of those participants who initially dislocated their non-dominant side, 50% (8/16) experienced a recurrent episode of instability (Table 8). Calculation of an odds ratio was possible in one study[1] indicating people who have a first time traumatic anterior shoulder dislocation in their dominant shoulder are 65% less likely to experience recurrence (OR=0.35, 95%CI (0.01, 8.63), Z=-065, p=0.52, I^2=0%).

	Cordischi et al., 2009		Marans et al., 1992		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Dominant	0/3	3/3	15/15	0/15	15/18	3/18	83.3%	16.7%
Non-dominant	3/11	8/11	5/5	0/5	8/16	8/16	50%	50%
Total	3/14	11/14	20/20	0/20	23/34	11/34	67.6%	32.4%

Results indicate the number of recurrent instability events in the total number of participants

Table 8: Dominance of dislocated shoulder and recurrent shoulder instability

Side of Shoulder that was Initially Dislocated

Three of the six included articles did not report arm dominance but presented information on the side of the shoulder that was initially dislocated.[1 2 24] Pooled data showed that 66.7% (14/21) of participants with right shoulder dislocations and 62.5% (15/24) of participants with left shoulder dislocations experienced recurrent instability (Table 9). The data show that people who experience a first time traumatic anterior shoulder dislocation on the right side were 61% less likely to experience recurrent instability. The result was not statistically significant but was homogeneous[23] (OR=0.39 95%CI (0.065, 2.42, Z=-1.00, p=0.31, I^2=0%).

	Cordischi et al., 2009		Postachinni et al., 2000		Wagner & Lyne, 1983		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Right	0/3	3/3	10/13	3/13	4/5	1/5	14/21	7/21	66.7%	33.3%
Left	3/11	8/11	8/8	0/8	4/5	1/5	15/24	9/24	62.5%	37.5%
Total	3/14	11/14	18/21	3/21	8/10	2/10	29/45	16/45	64.4%	35.6%

Results indicate the number of recurrent instability events in the total number of participants

Table 9: Side of shoulder initially dislocation and recurrent shoulder instability

Hill-Sachs Lesion

Radiographic evidence (X-Rays and magnetic resonance imaging (MRI)) of the presence of a Hill-Sachs lesion was reported by two studies.[2 24] Combined data from the two articles illustrated that 100% (13/13) of participants who had radiographic evidence of a Hill-Sachs lesion on their affected shoulder experienced a recurrent instability event. For participants who had no evidence of a Hill-Sachs lesion, 72% (13/18) had a recurrent instability episode (Table 10). Odds ratio calculations were possible using the data of Postacchini et al.[2] indicating that people aged under 18 years with Hill Sachs lesions were 17.18 times more likely to

experience recurrent instability compared to those without a Hill Sachs lesion (OR=17.18, 95%CI (0.76, 390.92, Z=1.78, p= 0.07, I^2=0%).

	Postachinni et al., 2000		Wagner & Lyne, 1983		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Hill-Sach	13/13	0/13			13/13	0/13	100%	0%
No HSL	5/8	3/8	8/10	2/10	13/18	5/18	72.2%	27.8%
Total	18/21	3/21	8/10	2/10	26/31	5/31	83.9%	16.1%

Results indicate the number of recurrent instability events in the total number of participants

Table 10: Hill Sachs lesion and recurrent shoulder instability

Bankart Lesion

Two studies reported the presence of a Bankart lesion[1 2]. Cordischi et al.[1] reported that no participants (0/14) had evidence of a discrete labral tear as determined by either magnetic resonance imaging (MRI) of magnetic resonance athrogram (MRA) evaluation. Postacchini et al.[2] evaluated 12 of the 18 people who had experienced recurrent shoulder instability for the presence of a Bankart lesion. All twelve participants had evidence of a Bankart lesion (Table 11). Odds ratio calculations were not possible with this data as neither paper made comparisons between children with and without a Bankart lesion.

	Cordischi et al., 2009		Postachinni et al., 2000		Total		Percentage	
	Rec	Non	Rec	Non	Rec	Non	Rec	Non
Bankart			12/12	0/12	12/12	0/12	100%	0%
No lesion	3/14	11/14			3/14	11/14	21.4%	78.6%

Results indicate the number of recurrent instability events in the total number of participants

Table 11: Bankart lesions and recurrent shoulder instability

DISCUSSION

Across the included studies, age has been identified as the primary prognostic factor for recurrent shoulder instability.[26-30] The majority of studies appeared to group the paediatric populations as one cohort thus making it difficult to distinguish those who were skeletally immature. Some studies[2 4] have suggested that the 13 and under age group have lower rates of instability following a first time traumatic anterior shoulder dislocation than children 14 years and older. This review supported these findings and found the 14 to 18 year age group were 24.14 times more likely to experience recurrent instability than the 13 and under year age group. There are

many reasons why this may occur including a more lateral glenohumeral joint capsule insertion at a younger age,[5] greater joint capsule elasticity in children younger than 13 years,[6] healing potential, capsular vs labral lesions[31] and level of activity[32]. It is beyond the scope of this review to hypothesise further regarding the presence of increased recurrence in the younger age group.

The state of closure of the proximal humeral physis may relate to the lower recurrence rates found in younger children. Some authors have shown rates of recurrent instability to be as high as 100% in children with an open proximal humeral physis.[3 32 33] In contrast, the results of this systematic review revealed a 66.1% recurrence rate in children with an open physis and 91.4% rate in the closed humeral physis group. However, data presented in this systematic review must be interpreted carefully as there were significantly more subjects within the closed physis group (n=59) compared to the open physis group (n=17). In addition, rates of recurrence in people aged between 15 and 40 have been reported to be 44%[34] and therefore the presence of variables other than a closed physis must be considered.

Sex has also been proposed to be an important recurrent instability; however, there is discrepancy in the literature. Robinson et al.[35] used a Cox regression model to predict sex-specific risk factors for recurrent shoulder instability and found males to be at higher risk in all reported ages (15-35 years). Data from Owens et al.[36] supported these results and found significantly higher shoulder instability rates in males. However, some studies have suggested that sex has no significant effect on recurrent shoulder instability.[4 26 30 37 38] This meta-analysis showed an association between sex and risk of glenohumeral instability with males 3.44 times more likely to experience recurrent instability and were near statistical significance (p-value: 0.053).

There is controversy in the literature regarding sporting related dislocations and recurrence rates. Simonet et al.[26] found that 82% of people of all ages who

initially dislocated their shoulder during athletic activity experienced recurrent instability, which was significantly higher than the non-athletic dislocation cohort (30%) (p-value: 0.001). Sachs et al.[39] reported that people of all ages with sporting related dislocations were more prone to recurrent instability; however this trend did not reach a level of significance. In contrast, Kralinger et al.[27] and Hovelius et al.[37] concluded that sporting related dislocations in people of all ages were not associated with recurrent instability. This systematic review found an 89.2% recurrence rate in sporting related dislocations and 76% recurrence rate in the non-sporting group. However, these results were not significantly different (p-value: 0.17).

While the relationship between shoulder dominance and instability recurrence has been mentioned in several studies, there appears to be no relationship.[1 3 28 30] Te Slaa et al.[28] and Hoelen et al.[30] found no differences in recurrence rates for people of all ages following a first time traumatic anterior shoulder dislocation between dominant and non-dominant shoulders. Cordischi et al.[1], Postachinni et al.[2] and Wagner & Lyne[24] also compared recurrence rates between left and right shoulders in children under 18 years of age and found no significant difference. These results support the findings of this systematic review. Recurrence rates were similar between left and right shoulders, 62.5% and 66.7% respectively. The rates between dominant and non-dominant shoulders were 83.3% and 50% respectively, however, only two articles assessed the relationship between shoulder dominance and recurrent shoulder instability[1 3].

Our study was limited by the number of studies which reported pathological lesions. Only two studies[2] [22] reported the presence of a Hill Sachs lesions following a FTASD. Postacchini et al.[2] reported that all children had a Hill Sachs lesion and 100% rate of recurrence in these children, Wagner and Lyne[24] found no Hill Sachs lesions in the nine children who underwent radiological investigations. Adults with

Hill Sachs lesions were 1.55 times more likely to have recurrent instability following a first time traumatic anterior shoulder dislocation, although this finding was non-significant (p>0.05) with moderate heterogeneity[34]. Further investigations are required into the presence of Hill Sachs lesions and rates of recurrent instability in children following a first time traumatic anterior shoulder dislocation. With regards to a Bankart lesion this systematic review found a 100% rate of recurrent instability in children with a Bankart lesion based on one study[2] of acceptable quality which reported Bankart lesions in all participants. Conversely, Cordischi et al.[1] reported no Bankart lesions were evident on MRI or MRA. Further evidence from prospective studies which use investigations which have high rates of sensitivity and specificity for detecting Bankart lesions (such as MRA[40]) is required to establish the association between Bankart lesions and risk of recurrent instability in children aged under 18 years.

There are some limitations to the findings of this systematic review. The methodological quality of the eligible studies was limited as all were Level III evidence (retrospective cohort studies). There was no mention in any of the six studies on whether the assessment of the outcome was made blind to the exposure status. Consequently, all articles[1-4 24 25] received 'low quality' ratings due to increased risk of bias. A noticeable strength of this systematic review was the homogeneity of participants in the six included studies. All the participants were recruited from hospitals, under eighteen years of age, had radiographic evidence of anterior shoulder dislocation, and were followed for a minimum of one year. Furthermore, the risk factors/exposures described in the studies were similar throughout, meaning that common risk factors could be clearly identified. However, the effect sizes of the identified risk factors in this systematic review may have been influenced by confounding variables (such as sample size and participant recruitment) reported across the included studies.

Conclusion

This systematic review was carried out in order to determine the risk factors associated with recurrent shoulder instability in children aged 18 years and under with a diagnosis of first time traumatic anterior shoulder dislocation. The common risk factors identified in the six included articles were age at time of initial dislocation, sex, mechanism of initial injury, side and dominance of injured shoulder, state of the proximal humeral physis, and the presence of Bankart and/or Hill-Sachs lesions. As with other studies, age and sex appeared to be the most significant predictors of recurrent shoulder instability. Male children aged 14 years and older appeared to be at the greatest risk of recurrent shoulder instability. This evidence is based on studies deemed acceptable and poor Level III evidence, and the strength of evidence in this paper is poor quality Level II evidence. Recommendations for future research include carrying out blinded, prospective cohort studies with larger sample sizes in people aged under 18 years in order to provide higher quality research, thus strengthening the evidence base for predicting recurrent instability.

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