

# Who will redislocate his/her shoulder? Predicting recurrent instability following a first traumatic anterior shoulder dislocation

Margie K Olds,<sup>1</sup> Richard Ellis,<sup>2</sup> Priya Parmar,<sup>3</sup> Paula Kersten<sup>4</sup>

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<sup>1</sup>Flawless Motion, Auckland, New Zealand

<sup>2</sup>Health and Rehabilitation Research Institute, Auckland University of Technology, Auckland, New Zealand

<sup>3</sup>Department of Biostatistics and Epidemiology, Auckland University of Technology, Auckland, New Zealand

<sup>4</sup>School of Health Sciences, University of Brighton, Brighton, UK

## Correspondence to

Margie K Olds;  
[margie@flawlessmotion.com](mailto:margie@flawlessmotion.com)

## ABSTRACT

**Objective** To develop a multivariate tool that would predict recurrent instability after a first-time traumatic anterior shoulder dislocation.

**Methods** Participants (aged 16–40 years) were recruited across New Zealand into a prospective cohort study. Baseline data were collected during a telephone interview and through examination of radiology records. Variables associated with recurrent instability were selected for the multivariate logistic regression model using backwards selection ( $p < 0.10$ ). Coefficients for those variables retained in the model were used to develop the predictive tool.

**Results** Among the 128 participants, 36% had redislocated at least once in the first 12 months. Univariate analysis showed an increased likelihood of recurrent dislocation with bony Bankart lesions (OR=3.65, 95% CI 1.05 to 12.70,  $p=0.04$ ) and participants who had: not been immobilised in a sling (OR = 0.38, 95% CI 0.15 to 0.98,  $p=0.05$ ), higher levels of shoulder activity (OR=1.13, 95% CI 1.01 to 1.27,  $p=0.03$ ), higher levels of pain and disability (OR=1.03, 95% CI 1.01 to 1.06,  $p=0.02$ ), higher levels of fear of reinjury (OR=1.12, 95% CI 1.01 to 1.26,  $p=0.04$ ) and decreased quality of life (OR=1.01, 95% CI 1.00 to 1.02,  $p=0.05$ ). There was no significant difference in those with non-dominant compared with dominant shoulder dislocations ( $p=0.10$ ) or in those aged 16–25 years compared with 26–40 years ( $p=0.07$ ).

**Conclusion** Six of seven physical and psychosocial factors can be used to predict recurrent shoulder instability following a first-time traumatic anterior shoulder dislocation.

## INTRODUCTION

The incidence of first-time traumatic anterior shoulder dislocation (FTASD) is around 23 per 100 000 person-years<sup>1</sup> with increased dislocation rate in contact athletes.<sup>2</sup> Recurrent instability following such injuries ranges from 26%<sup>3</sup> to 92%.<sup>4</sup> This wide variation may be explained by the heterogeneous populations in these studies.<sup>5</sup> Risk factors for recurrent instability following an FTASD have been described in recent systematic reviews and meta-analyses.<sup>6–8</sup> These risk factors may be categorised as either modifiable or non-modifiable. Modifiable risk factors include manual occupations,<sup>9</sup>

occupations where the upper limb is used above shoulder height,<sup>10</sup> immobilisation following the dislocation,<sup>11</sup> involvement in collision sport<sup>12</sup> and time to return to sport.<sup>12</sup> Psychosocial factors such as higher levels of pain<sup>13</sup> and fear of reinjury<sup>14 15</sup> may also be modifiable risk factors. Non-modifiable risk factors include greater tuberosity fractures,<sup>3 9 11 12 16</sup> Hill-Sachs lesions,<sup>11 16 17</sup> bony Bankart lesions,<sup>9 11 17 18</sup> axillary nerve palsy,<sup>12 18</sup> age,<sup>3 9 11 16–18</sup> gender<sup>3 9 11 12</sup> and hypermobility.<sup>12 17</sup>

While knowledge of individual risk factors is important in clinical practice, prognostic models use multiple predictive factors to calculate risk of recurrent instability in individual patients.<sup>19</sup> Personal, customised care is a goal of clinical practice.<sup>20</sup> Customising healthcare carries the costs of additional communication, cognition, coordination and capability.<sup>20 21</sup> However, these costs can be minimised through the use of decision-making aids which enable patients and clinicians to make informed treatment choices.

Decision-making tools and algorithms have been developed to assist clinicians and to enable patients with shoulder instability to make informed choices about their healthcare.<sup>22–30</sup> Of these, only two<sup>5 27</sup> tools have been developed to predict outcomes or management for people with an FTASD. These tools<sup>5 27</sup> primarily use age and gender to predict recurrent instability. Incorporation of other known significant risk factors into a prognostic model would improve the accuracy of identifying those more likely to have recurrent instability and enhance clinical decision-making for people following an FTASD.

There are very few high-quality prospective studies examining risk factors for recurrent instability following an FTASD.<sup>6 7</sup> We aimed to develop a multivariate prognostic tool which can be used to predict recurrent instability, based on known risk factors. We hypothesised

that key variables, other than the established variables age and gender,<sup>12</sup> would predict recurrent instability following an FTASD.

## METHODS

### Design and setting

This prospective cohort study was approved by the university and Accident Compensation Corporation (ACC) ethics committees. Consultation with two orthopaedic surgeons, two sports physicians and two physiotherapists, who had a special interest in shoulder pathology, was undertaken to examine previously reported risk factors<sup>6</sup> and determine whether additional variables of perceived clinical importance could be identified. Following this consultation, the variables identified from the meta-analysis<sup>6</sup> and the clinical team were combined to form the beta version of the clinical prediction tool.

### Participants

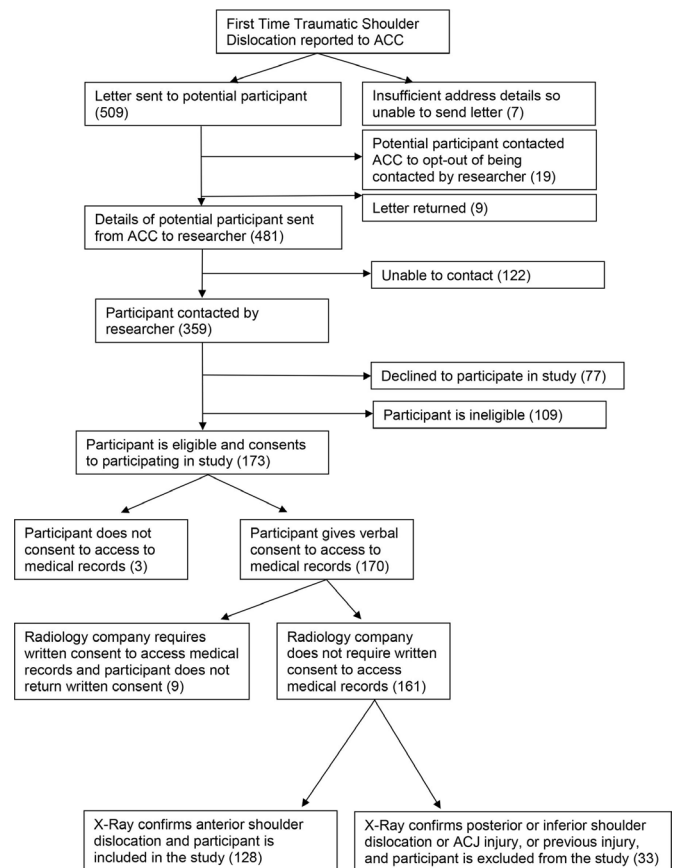
We completed this prospective study with people who had suffered an FTASD to examine the risk factors which predisposed them to recurrent shoulder instability or protected them from further instability. Participants were eligible for inclusion if they:

- ▶ Were aged between 16 and 40 years.
- ▶ Sustained an FTASD in New Zealand (NZ).
- ▶ Had a shoulder radiograph.
- ▶ Had an NZ contact address.
- ▶ Had registered their shoulder dislocation with Accident Compensation Corporation (ACC) between the dates of May 2015 and April 2016.
- ▶ Provided verbal informed consent to take part in the study.

Participants were excluded (n=81) if they had undergone surgical intervention for their current shoulder injury within 12 weeks of the injury as they were no longer able to demonstrate the natural history of an FTASD (n=3). Participants were also excluded if they reported a previous shoulder instability episode or other shoulder pathology such as impingement/acromioclavicular joint (ACJ) disruption at initial interview (n=43) or showed radiological evidence of a previous shoulder instability episode in subsequent radiological report (n=15). Radiological evidence excluded those who demonstrated pathology other than an anterior dislocation (n=18) and people who did not speak conversational English (n=2) were excluded (as they would be unable to participate in the telephone interview).

### Recruitment procedure

New Zealanders who have a traumatic accident present to health professionals who record their injury details with ACC, a government-owned corporation responsible for administering the country's universal no-fault injury scheme. People who had an FTASD were identified through the use of an injury coding system (READ codes) (see online supplementary file S1).



**Figure 1** Flow of participants. ACC, Accident Compensation Corporation; ACJ, acromioclavicular joint.

Eligible people with an FTASD were contacted by letter within 12 weeks of their dislocation by ACC with study information and a consent form (figure 1). They were given 2 weeks to opt out of the study. For those people who did not choose to opt out, contact details were forwarded to the primary researcher (MKO). Those people were then contacted by telephone. They were informed again about the study, had an opportunity to ask any questions and details of the shoulder injury were discussed to confirm a shoulder dislocation. Those who were eligible, who wished to take part in the study and permitted access to radiology records were consented into the study.

### Participant involvement

People who have had a shoulder dislocation often ask health professionals for information regarding the likelihood of further instability events. People with FTASD were not involved in setting the research question or study design. They were included in the development of the tool to be tested. Dissemination to participants will take the form of an email summarising the main results.

### Data collection

#### Baseline data

Following consent and inclusion in the study, participants could complete the beta version of the tool verbally over the phone, online via an internet hosted version

**Table 1** Variables obtained from initial contact with participants

Demographic	Clinical	Sport	Secondary variables
Age	Radiograph	Level of sport	Quality of life (WOSI)
Gender	Bony Bankart	Position played sport	Pain and function (SPADI)
Patient's estimated height	Greater tuberosity fracture	Hours per week	Fear of reinjury (TSK-11)
Patient's estimated weight	Hill-Sachs	Time to return to sport	Shoulder Activity Scale (SAS)
Hand dominance	US—rotator cuff tear	Type of sport (collision vs overhead)	
Side affected	US—bursitis		
Occupation	US—haemarthrosis		
Ethnicity	Apprehension		
Family history			
Hypermobility			
Period of immobilisation			
Physiotherapy sessions			

SPADI, Shoulder Pain and Disability Index; TSK-11, Tampa Scale of Kinesiophobia; US, ultrasonography; WOSI, Western Ontario Stability Index.

(URL link provided by email) or a using a paper version that was posted. The beta version of the tool recorded participant's primary predictive variables including age, gender, height, weight, ethnicity, hand dominance, side of dislocation, occupation, family history of instability, self-reported hypermobility, period of immobilisation and number of physiotherapy sessions attended after their injury (table 1). Operational definitions of these variables are provided in the online supplementary file. Ethnicity was categorised as per NZ Statistics<sup>31</sup> with up to six ethnic categories recorded and the minority ethnicity coded if the alternate was NZ European. Mechanism of injury was categorised as sports injuries, motor vehicle accidents (MVA), assault, fall or other.<sup>12</sup> Falls that occurred during sporting activities were classified as sports injuries.

Secondary variables such as quality of life, level of shoulder activity, shoulder function and fear of reinjury were measured with the Western Ontario Stability Index (WOSI),<sup>32</sup> Shoulder Activity Scale (SAS),<sup>33</sup> Shoulder Pain and Disability Index (SPADI)<sup>34</sup> and Tampa Scale of Kinesiophobia (TSK-11),<sup>35</sup> respectively (table 1). Radiology

records were reviewed to confirm an anteriorly directed shoulder dislocation and to confirm the presence of associated bony pathology. Radiology records that confirmed a dislocation in a direction that was not anterior or confirmed ACJ disruption or clavicle fracture resulted in participant exclusion. Those participants whose shoulder was reduced prior to radiograph and showed no evidence of another shoulder pathology or posterior/inferior dislocation were included in the study.

#### Follow-up data

Follow-up phone calls were made at 3, 6, 9 and 12 months following the date of injury, by research assistants blinded to baseline variables to limit recall and experimenter bias. When the participants preferred to be contacted by email, they were emailed with a link to the online version of the tool.

The primary outcome was recurrent instability of the previously dislocated shoulder. Recurrent instability was defined as a repeated event of instability of either a subluxation or dislocation.<sup>6</sup> A dislocation was defined as complete separation of the humeral head from the articular surface of the glenoid and required external force to relocate the shoulder.<sup>36 37</sup> A subluxation was defined as spontaneous reduction of the humeral head following complete separation of the humeral head from the glenoid without the requirement of external force.<sup>36 37</sup> Research assistants with a health background were trained to identify recurrent instability events (see online supplementary file S2), and discussions of individual cases were undertaken at regular meetings to reach a consensus when there was uncertainty regarding the instability event.

Follow-up was limited to 1 year to examine the immediate impact of an FTASD. Some studies<sup>38 39</sup> have advocated primary surgical intervention in this population of people following an FTASD, which would occur within the 12 months' time frame. One-year follow-up was used to study the shorter term impact of an FTASD as approximately 70% of all dislocations that occur take place within 12 months.<sup>12</sup> Additionally, this study was designed to elucidate variables which can be used to predict recurrent instability for the development of a multivariate prediction tool. It was not envisaged that these variables would alter beyond the first year of follow-up.

#### Sample size

The study was powered at 90% with a sample size of 84 participants and alpha at 0.05 to observe a recurrence rate as found by Robinson *et al*<sup>12</sup>; 50% from ages 15 to 20, and 21–25, and a 25% recurrence rate for age groups 26–30, 31–35 and 36–40 years (online supplementary file S3). It was anticipated that 50% of patients would drop out of the study as the population is young and mobile. Therefore, a minimum of 127 participants were required for recruitment.

**Table 2** Descriptive data of continuous variables

	n	Minimum	Maximum	Mean	SD
Age (years)	128	16	40	24.63	7.10
Height (cm)	127	154	198	179.00	8.71
Weight (kg)	128	50	128	82.95	16.31
Body mass index	127	18	41	25.72	4.41
SPADI-Total	128	0	89	18.41	17.30
SPADI-Pain	128	0	76	15.77	15.38
SPADI-Function	128	0	93	15.33	17.68
TSK-11	128	16	37	26.74	3.88
WOSI-Total	128	0	166	78.16	46.31
WOSI-Physical	128	0	80	33.44	20.84
WOSI-Life	128	0	39	16.46	10.73
WOSI-Recreation	128	0	35	13.27	10.46
WOSI-Emotion	128	0	30	14.95	8.28

SPADI, Shoulder Pain and Disability Index; TSK-11, Tampa Scale of Kinesiophobia; WOSI, Western Ontario Stability Index.

### Data and statistical analysis

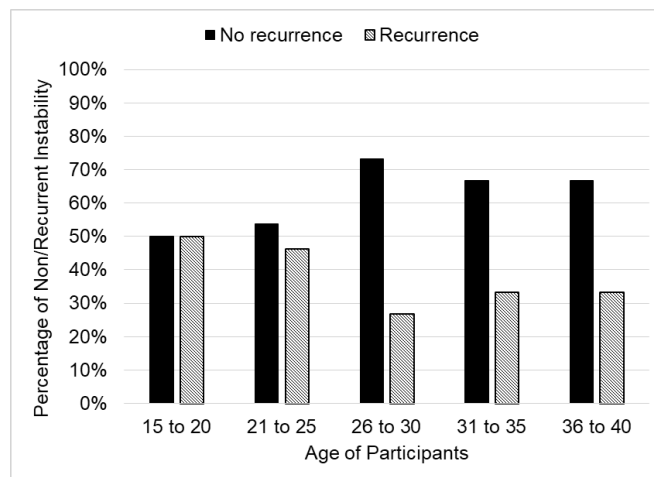
Data were analysed using Statistical Package for the Social Sciences software (SPSS V.24.0, IBM). Univariate logistic regression models were used to identify the risk factors predictive of recurrent shoulder instability ( $p < 0.05$ ). Multivariate logistic regression models used to identify the combined effect of variables for recurrent instability which were selected for using backwards selection ( $p < 0.10$ ). This lower cut-off is the statistical threshold used to identify when variables should be retained in a multivariate model (when other variables are being adjusted for).<sup>40</sup> Coefficients for those variables retained in the multivariate model were used to develop the predictive tool.<sup>41 42</sup>

## RESULTS

### Recruitment and participant demographics

One hundred and twenty-eight participants (110 males) were recruited from May 2015 to February 2016 (figure 1). Forty-nine (38.3%) participants were aged between 16 and 20 years, 30 (23.4%) between 21 and 25 years, 18 (14.1%) between 26 and 30 years, 17 (13.3%) between 31 and 35 years and 14 (10.9%) between 36 and 40 years. Baseline outcomes for demographic variables and secondary outcome measures are displayed in table 2. The rate of recurrent instability was 35.9% (46/128) at 1 year follow-up with the greatest recurrence in those aged 16–25 (figure 2). Fourteen per cent (18/128) of participants were lost to follow-up and 50% (64/128) of participants did not have recurrent instability.

There were 110 (85.9%) right-hand dominant participants, and the right shoulder was affected in 72 (56.3%) participants. The dominant limb was affected in 63 (49.2%) participants. The predominant ethnicity of the participants was NZ European (70; 54.6%), followed by



**Figure 2** Rate of recurrent shoulder instability.

NZ Māori (19; 14.8%), Pasifika (15; 11.7%) and European Other (13; 10.2%) (online supplementary file S4). This is similar to the distribution of ethnicity in NZ.<sup>43</sup>

There were 51 (39.8%) manual workers and 77 (60.2%) sedentary workers. There were 35 (27.3%) participants who participated in occupations above shoulder height, while 93 (72.7%) participants were involved in occupations at shoulder height or below. There were 22 (17.2%) participants with a family history of shoulder dislocation and 105 (82.2%) participants who did not have a family history of shoulder dislocation (one data set missing). Thirty-one (24.2%) participants self-reported generalised hypermobility. The majority of participants (103; 80.5%) were immobilised following the dislocation, 24 (18.8%) were not immobilised and one participant did not recall their immobilisation status. Most participants (92; 71.9%) had received physiotherapy treatment while 35 (27.3%) had not, and one did not recall.

The most common mechanism of the first anterior shoulder dislocation was a sports injury (95; 74.2%), followed by a fall (13; 10.1%), other mechanism (12; 9.3%), MVA (4; 3.1%) and assault (4; 3.1%). Because of the small number of MVAs and large variance, they were grouped with 'other' for univariate analysis. There were 33 (25.8%) participants whose injury was not sport related. Of the 95 (74.2%) participants whose injury was sports related, 87 (91.6%) were recreational athletes and 8 (8.4%) were semiprofessional or professional. Of the 95 participants who identified a sports injury, 52 (54.7%) were involved in contact sport, 25 (26.3%) were involved in limited contact sports and 18 (18.9%) were involved in non-contact sports, as classified by Rice.<sup>44</sup> At the time of injury, 38 of the 52 (73.1%) participants reporting contact injury were involved in collision sports. Rugby union, football, towed water sports and skateboarding all had a rate of recurrent instability of 50% or above. With regard to pathological injuries, there were 2 (1.6%) greater tuberosity fractures, 13 (10.2%) bony Bankart lesions and 36 (28.1%) Hill-Sachs lesions.

## Recurrent instability

At 12 months following their injury, 46 (35.9%) participants had an episode of recurrent instability, 64 (50.0%) participants had no episode of instability and 18 (14.1%) participants were lost to follow-up.

## Univariate analysis

The relationship between the variables and recurrent instability is displayed in [table 3](#). Significant univariate baseline predictors ( $p \leq 0.05$ ) of recurrence at 12 months were: bony Bankart lesion; not being immobilised; total scores for SPADI, SAS, TSK-11, and WOSI total score; ethnicity of not European Other; two subsections of the WOSI (Physical and Emotion) and the SPADI-Function score.

## Multivariate analysis

Results of the multivariate analysis using backwards stepwise regression are tabled ([table 4](#)). Variables shown were retained in the model if  $p < 0.10$ , even after adjusting for other significant risk factors of recurrent instability. Risk of recurrence at 12 months was predicted using both physical and psychosocial factors in the following equation:

$$\text{Risk of recurrence} = -4.73 + 1.06 \times (\text{ages 16–25 years}) + 1.80 \times (\text{bony Bankart lesions}) + 0.80 \times (\text{dominant side affected}) - 1.27 \times (\text{immobilised}) + 0.03 \times (\text{SPADI-Total}) + 0.13 \times (\text{TSK-11-Total}).$$

## DISCUSSION

We present the first prospective cohort study to report an association between fear of injury and self-reported pain and function with recurrent shoulder instability. We report a positive relationship between psychosocial factors and self-reported pain and function near the time of injury, with recurrent shoulder instability following an FTASD. Psychosocial variables are common sequelae of an FTASD.<sup>45</sup> However, in this population, fear of reinjury and self-reported pain and disability also identified those most at risk of further instability events at 12-month follow-up.

### Variables associated with recurrent instability

We extend previous findings<sup>12 46</sup> to highlight that being aged between 16 and 25 years was associated with increased rates of recurrent instability. While not statistically significant as a stand-alone variable in univariate analysis ( $p = 0.07$ ), age was a statistically significant risk factor ( $p = 0.03$ ) after adjusting for other variables.

Our study examined demographic risk factors of sex and limb dominance. While one author<sup>12</sup> found male sex to be related to recurrent instability, our current study agreed with others,<sup>10 47</sup> in that sex was not associated with recurrent instability following multivariate analysis. We believe that playing contact sport and the age of the participant may have confounded the influence of sex in that young males are more involved in contact sport in NZ than young females.<sup>48</sup> Additionally,

use of the dominant limb in both daily and high-risk activities may explain why participants who injured their non-dominant shoulder were less likely to have recurrent instability ( $p = 0.10$ ). In the presence of other variables, dislocation to the non-dominant limb trended towards significance ( $p = 0.07$ ). This may be related to the amount of use of the affected limb. However, this study was not sufficiently powered to examine the influence of shoulder activity on limb dominance on recurrent instability.

This study found that the presence of a bony Bankart lesion was associated with recurrent shoulder instability. In contrast, Salomonsson *et al*<sup>17</sup> found bony Bankart lesions to be a prognostic indicator for shoulder stability. Salomonsson *et al*<sup>17</sup> excluded participants with large bony Bankart lesions, thus biasing their sample. This study shows that patients with any sized bony Bankart lesion are more likely to have recurrent instability. The large variance in this study could result from dichotomising the size of bony Bankart lesions to present or absent.

The presence of a Hill-Sachs lesion was not significantly associated with recurrent instability, in line with other authors' findings.<sup>11 17</sup> This is in contrast to findings of a previous study<sup>16</sup> and may be because of heterogeneity of pathological Hill-Sachs lesions. In our study, radiological examination was undertaken by a number of radiologists who were not consistent in the way they reported the size, shape, location or interaction of bony lesions. Further analysis of Hill-Sachs and bony Bankart lesions was not possible because of variations in the way these lesions were reported. While our study was not sufficiently powered to examine the relationship between greater tuberosity fractures and recurrent instability, others have reported that these decrease the risk.<sup>9 11 12 16 47</sup>

Immobilisation of the limb following a shoulder dislocation was found to decrease the risk of recurrent instability at 1 year follow-up. The number of days patients were immobilised ranged from 1 to 70 days and was not associated with recurrent shoulder instability. Itoi *et al*<sup>49</sup> reported decreased recurrence when the shoulder was immobilised in external rotation. However, more recent systematic reviews<sup>50 51</sup> have failed to support the finding of Itoi and colleagues, and may be due to the effect of regional culture and healthcare systems. All participants in the current study who were immobilised were in a sling across the body and there was a significant association with decreased rates of recurrent instability.

This is one of the first studies to examine the ability of shoulder outcome measures to predict recurrent instability. All the questionnaires used (SAS, SPADI, TSK-11 and WOSI) were associated with recurrent instability. This finding illustrates the multifactorial nature of recurrent shoulder instability and the influence of patient beliefs, level of activity, fear of reinjury and self-reported pain and function as predictors of recurrent instability. Shoulder pain, function and quality of life are common

**Table 3** Univariate analysis of variables which predict recurrent instability

	Regression coefficient	SE	P value	OR	95% CI
Bony Bankart†	1.29	0.64	0.04	3.65	1.05 to 12.70
Hill-Sachs lesion	0.37	0.43	0.38	1.45	0.63 to 3.35
Age	-0.05	0.03	1.07	0.96	0.90 to 1.10
16–20 versus other	-0.54	0.40	0.17	0.58	0.27 to 1.27
21–26 versus other	-0.23	0.45	0.61	0.79	0.33 to 1.92
26–30 versus other	0.78	0.62	0.21	2.18	0.65 to 7.34
31–35 versus other	0.42	0.59	0.48	1.52	0.48 to 4.79
36–40 versus other	0.41	0.65	0.53	1.50	0.42 to 5.32
16–25 versus other†	0.74	0.41	0.07	2.10	0.94 to 4.72
Gender	-0.16	0.61	0.79	0.85	0.36 to 3.84
Height	-0.00	0.02	0.87	1.00	0.95 to 1.04
Weight	0.01	0.01	0.40	1.01	0.99 to 1.04
BMI	0.04	0.05	0.36	1.04	0.95 to 1.14
Ethnicity					
Asian	-0.05	0.79	0.95	0.96	0.20 to 4.50
European Other†	-1.63	0.79	0.04	5.08	1.08 to 23.92
NZ European	-0.38	0.39	0.33	0.68	0.32 to 1.48
NZ Māori	0.71	0.58	0.22	2.04	0.65 to 6.33
Other	0.34	1.43	0.81	1.40	0.09 to 22.98
Pasifika	0.41	0.65	0.53	1.50	0.42 to 5.32
Ethnic group: Other versus NZ Euro/NZ Māori/Pasifika*	-0.88	0.52	0.09	0.415	0.149 to 1.152
Limb side					
Dominance	-0.98	0.69	0.16	0.38	0.10 to 1.46
Side affected	-0.47	0.40	0.23	0.62	0.29 to 1.35
Dominant affected*	0.63	0.39	0.10	1.877	0.87 to 4.06
Occupation					
Manual sedentary	0.30	0.40	0.46	1.34	0.62 to 2.94
Overhead below shoulder	0.55	0.44	0.21	0.58	0.25 to 1.36
Family history	0.07	0.51	0.90	1.07	0.40 to 2.87
Hypermobility	0.49	0.45	0.27	0.61	0.25 to 1.47
Mechanism					
Sports	0.06	0.44	0.90	1.06	0.45 to 2.52
Assault	-0.34	1.02	0.74	0.71	0.10 to 5.23
Other/MVA	0.67	0.63	0.29	0.54	0.15 to 1.76
Falls	-0.81	0.68	0.23	0.44	0.12 to 1.68
Immobilised†	-0.97	0.48	0.05	0.38	0.15 to 0.98
Physiotherapy	0.25	0.43	0.56	0.78	0.33 to 1.81
Sport					
Contact versus other	-0.74	0.47	0.11	0.48	0.19 to 1.19
Collision versus other	-0.69	0.46	0.13	0.50	0.20 to 1.23
Limited contact versus other*	-0.97	0.58	0.09	0.38	0.12 to 1.17
Non-contact versus other	0.07	0.58	0.90	1.08	0.34 to 3.37
Sports professional/recreation	-0.40	1.03	0.70	0.67	0.09 to 5.04
SAS contact Y/N*	0.72	0.40	0.07	2.05	0.94 to 4.46

Continued

**Table 3** Continued

	Regression coefficient	SE	P value	OR	95% CI
OH versus non-OH	-0.33	0.50	0.51	0.72	0.27 to 1.90
Global rate of change	-0.02	0.01	0.18	0.98	0.96 to 1.01
SAS†	0.13	0.06	0.03	1.13	1.01 to 1.27
Pain-Initial	0.03	0.07	0.71	1.03	0.90 to 1.17
Pain-Now	0.15	0.11	0.15	1.16	0.95 to 1.43
SPADI-Total†	0.03	0.01	0.02	1.03	1.01 to 1.06
SPADI-Pain*	0.03	0.01	0.06	1.03	1.00 to 1.05
SPADI-Function†	0.04	0.02	0.01	1.04	1.01 to 1.07
TSK-11†	0.12	0.06	0.04	1.12	1.01 to 1.26
WOSI-Total†	0.01	0.01	0.05	1.01	1.00 to 1.02
WOSI-Physical†	0.02	0.01	0.03	1.02	1.00 to 1.04
WOSI-Life*	0.03	0.02	0.10	1.03	0.99 to 1.08
WOSI-Recreation	0.01	0.02	0.69	1.01	0.97 to 1.05
WOSI-Emotion†	0.07	0.03	0.01	1.07	1.02 to 1.13

\*Significant at  $p \leq 0.10$ .

†Significant at  $p \leq 0.05$ .

BMI, body mass index; MVA, motor vehicle accident; NZ, New Zealand; non-OH, non-overhead sport; OH, overhead sport; SAS, Shoulder Activity Scale; SPADI, Shoulder Pain and Disability Index; TSK-11, Tampa Scale of Kinesiophobia; WOSI, Western Ontario Stability Index.

sequelae of an FTASD. This study found that these variables are consequences of an FTASD, and predict future recurrent instability events.

Current non-surgical management appeared to be effective for over 60% of those who report with an FTASD at 12-month follow-up. Addressing factors such as patient education, psychosocial factors such as fear of injury and developing criteria for return to sport/work after a dislocation could further improve non-surgical management.

### Limitations

We note several limitations. The outcome of recurrent instability was self-reported and was not validated with a follow-up radiograph. The requirement for radiograph to confirm a dislocation would have excluded subluxation events from the outcome of recurrent instability. However, categorising recurrent instability

based on participants' self-report may have influenced the results, particularly in the context of the ability of self-reported questionnaires to predict self-reported instability.

### CONCLUSIONS

This prospective cohort study reports the rate of recurrent instability in NZ within 1 year of an FTASD. It is the first prospective cohort study to report an association between fear of injury and self-reported pain and function with recurrent shoulder instability. The findings that a bony Bankart lesion, ages between 16 and 25, dislocation of the dominant shoulder, not being immobilised and higher SPADI and TSK-11 scores can be used to predict recurrent instability will now be tested in a separate population to examine its predictive validity and reliability.

**Table 4** Multivariate analysis of variables which predict recurrent instability

	Regression coefficient	SE	P value	OR	95% CI
Bony Bankart*	1.798	0.746	0.016	6.040	1.40 to 26.062
Ages 16–25 versus other†	1.062	0.482	0.028	2.892	1.124 to 7.439
Dominant affected*	0.801	0.454	0.077	2.227	0.916 to 5.418
Immobilised†	-1.270	0.571	0.026	0.281	0.092 to 0.859
SPADI-Total†	0.033	0.015	0.031	1.034	1.003 to 1.066
TSK-11†	0.133	0.071	0.061	1.142	0.994 to 1.313
Constant	0.061	1.142	0.016	0.009	

\*Significance at  $p \geq 0.05$ .

†Significance at  $p \geq 0.10$ .

SPADI, Shoulder Pain and Disability Index; TSK-11, Tampa Scale of Kinesiophobia.

## What are the findings?

- ▶ A multivariate tool of age, bony Bankart lesion, immobilisation status, dominance of affected shoulder, fear of reinjury and pain and disability can be used to predict recurrent shoulder instability at 1 year.

## How might it impact on clinical practice in the future?

- ▶ Clinical tools can improve clinical decision-making.
- ▶ Clinical tool such as this can be used for shared decision-making with patients regarding the likelihood of further episodes of recurrent instability given their patient-specific factors.

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## REFERENCES

- Leroux T, Wasserstein D, Veillette C, *et al*. Epidemiology of primary anterior shoulder dislocation requiring closed reduction in Ontario, Canada. *Am J Sports Med* 2014;42:442–50.
- Owens BD, Agel J, Mountcastle SB, *et al*. Incidence of glenohumeral instability in collegiate athletics. *Am J Sports Med* 2009;37:1750–4.
- te Slaa RL, Wijnffels MPJM, Brand R, *et al*. The prognosis following acute primary glenohumeral dislocation. *J Bone Joint Surg Br* 2004;86:58–64.
- Postacchini F, Gumina S, Cinotti G. Anterior shoulder dislocation in adolescents. *J Shoulder Elbow Surg* 2000;9:470–4.
- Murray IR, Ahmed I, White NJ, *et al*. Traumatic anterior shoulder instability in the athlete. *Scand J Med Sci Sports* 2013;23:387–405.
- Olds M, Ellis R, Donaldson K, *et al*. Risk factors which predispose first-time traumatic anterior shoulder dislocations to recurrent instability in adults: a systematic review and meta-analysis. *Br J Sports Med* 2015;49:913–22.
- Olds M, Donaldson K, Ellis R, *et al*. In children 18 years and under, what promotes recurrent shoulder instability after traumatic anterior shoulder dislocation? A systematic review and meta-analysis of risk factors. *Br J Sports Med* 2016;50:1135–41.
- Wasserstein DN, Sheth U, Colbenson K, *et al*. The true recurrence rate and factors predicting recurrent instability after nonsurgical management of traumatic primary anterior shoulder dislocation: a systematic review. *Arthroscopy* 2016;32:2616–25.
- Vermeiren J, Handelberg F, Casteleyn PP, *et al*. The rate of recurrence of traumatic anterior dislocation of the shoulder. A study of 154 cases and a review of the literature. *Int Orthop* 1993;17:337–41.
- Sachs RA, Lou SM, Paxton E, *et al*. Can the Need for Future Surgery for Acute Traumatic Anterior Shoulder Dislocation Be Predicted? Can the Need for Future Surgery for Acute Traumatic Anterior Shoulder Dislocation Be Predicted? *J Bone Jt Surg Am* 2007;89:1665–74.
- Hoelen MA, Burgers AM, Rozing PM, *et al*. Prognosis of primary anterior shoulder dislocation in young adults. *Arch Orthop Trauma Surg* 1990;110:51–4.
- Robinson CM, Howes J, Murdoch H, *et al*. Functional outcome and risk of recurrent instability after primary traumatic anterior shoulder dislocation in young patients. *J Bone Joint Surg Am* 2006;88:2326–36.
- Parr J, Borsa P, Fillingim R, *et al*. Psychological influences predict recovery following exercise induced shoulder pain. *Int J Sports Med* 2014;35:232–7.
- Bot SDM, van der Waal JM, Terwee CB, *et al*. Predictors of outcome in neck and shoulder symptoms: a cohort study in general practice. *Spine* 2005;30:E459–70.
- Lentz TA, Barabas JA, Day T, *et al*. The relationship of pain intensity, physical impairment, and pain-related fear to function in patients with shoulder pathology. *J Orthop Sports Phys Ther* 2009;39:270–7.
- Kralinger FS, Golser K, Wischatta R, *et al*. Predicting recurrence after primary anterior shoulder dislocation. *Am J Sports Med* 2002;30:116–20.
- Salomonsson B, von Heine A, Dahlborn M, *et al*. Bony Bankart is a positive predictive factor after primary shoulder dislocation. *Knee Surg Sports Traumatol Arthrosc* 2010;18:1425–31.
- Pevny T, Hunter RE, Freeman JR. Primary traumatic anterior shoulder dislocation in patients 40 years of age and older. *Arthroscopy* 1998;14:289–94.
- Steyerberg EW, Moons KGM, van der Windt DA, *et al*. Prognosis research strategy (prognosis) 3: prognostic model research. *PLoS Med* 2013;10:e1001381.
- Federer AE, Taylor DC, Mather RC. Using evidence-based algorithms to improve clinical decision making: the case of a first-time anterior shoulder dislocation. *Sports Med Arthrosc Rev* 2013;21:155–65.
- Benning TM, Kimman ML, Dirksen CD, *et al*. Combining individual-level discrete choice experiment estimates and costs to inform health care management decisions about customized care: the case of follow-up strategies after breast cancer treatment. *Value Health* 2012;15:680–9.
- Balg F, Boileau P. The instability Severity Index score. A simple pre-operative score to select patients for arthroscopic or open shoulder stabilisation. *J Bone Joint Surg Br* 2007;89:1470–7.
- Piasecki DP, Verma NN, Romeo AA, *et al*. Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management. *J Am Acad Orthop Surg* 2009;17:482–93.
- Emond M, Le Sage N, Lavoie A, *et al*. Clinical factors predicting fractures associated with an anterior shoulder dislocation. *Acad Emerg Med* 2004;11:853–8.
- Bishop JA, Crall TS, Kocher MS. Operative versus nonoperative treatment after primary traumatic anterior glenohumeral dislocation: expected-value decision analysis. *J Shoulder Elbow Surg* 2011;20:1087–94.
- Crall TS, Bishop JA, Guttman D, *et al*. Cost-effectiveness analysis of primary arthroscopic stabilization versus nonoperative treatment for first-time anterior glenohumeral dislocations. *Arthroscopy* 2012;28:1755–65.
- Mather RC, Orlando LA, Henderson RA, *et al*. A predictive model of shoulder instability after a first-time anterior shoulder dislocation. *J Shoulder Elbow Surg* 2011;20:259–66.
- Ahmed I, Ashton F, ChB M, *et al*. Arthroscopic Bankart repair and capsular shift for recurrent anterior shoulder instability functional outcomes and identification of risk factors for recurrence.
- Calvo E, Granizo JJ, Fernández-Yruegas D. Criteria for arthroscopic treatment of anterior instability of the shoulder: a prospective study. *J Bone Joint Surg Br* 2005;87:677–83.
- van Kampen DA, van den Berg T, van der Woude HJ, *et al*. Diagnostic value of patient characteristics, history, and six clinical tests for traumatic anterior shoulder instability. *J Shoulder Elbow Surg* 2013;22:1310–9.
- Ministry of Health. *Ethnicity data protocols for the health and disability sector*, 2004.
- Kirkley A, Griffin S, McLintock H, *et al*. The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. *Am J Sports Med* 1998;26:764–72.
- Brophy RH, Beauvais RL, Jones EC, *et al*. Measurement of shoulder activity level. *Clin Orthop Relat Res* 2005;439:101–8.



34. Roach KE, Budiman-Mak E, Songsirdej N, *et al.* Development of a shoulder pain and disability Index. *Arthritis Care Res* 1991;4:143–9.
35. Woby SR, Roach NK, Urmston M, *et al.* Psychometric properties of the TSK-11: a shortened version of the Tampa scale for Kinesiophobia. *Pain* 2005;117:137–44.
36. Owens LCBD, Nelson BJ, Duffey ML, *et al.* Pathoanatomy of first-time, traumatic, anterior glenohumeral subluxation events. *J Bone Jt Surg Am Vol* 2010;92:1605–11.
37. Rockwood CA, Matsen FA, Wirth CJ. *The Shoulder*. 2nd ed. Philadelphia: Saunders, 1998.
38. Marshall T, Vega J, Siqueira M, *et al.* Outcomes after arthroscopic bankart repair: patients with first-time versus recurrent dislocations. *Am J Sports Med* 2017;45:1776–82.
39. Polyzois I, Dattani R, Gupta R, *et al.* Traumatic first time shoulder dislocation: surgery vs non-operative treatment. *Arch Bone Jt Surg* 2016;4:104–8.
40. Bursac Z, Gauss CH, Williams DK, *et al.* Purposeful selection of variables in logistic regression. *Source Code Biol Med* 2008;3.
41. Courville T, Thompson B. Use of structure coefficients in published multiple regression articles:  $\beta$  is not enough. *Educ Psychol Meas* 2001;61:229–48.
42. Kraha A, Turner H, Nimon K, *et al.* Tools to support interpreting multiple regression in the face of multicollinearity. *Front Psychol* 2012;3:1–16.
43. Statistics New Zealand. 2013 Census - Major ethnic groups in New Zealand. infographic, 2015. Available: <http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/infographic-culture-identity.aspx> [Accessed 8 Nov 2017].
44. Rice SG. Medical conditions affecting sports participation and the Council on sports medicine and fitness. *Paediatrics* 2008;121:841–8.
45. Dickens JF, Owens BD, Cameron KL, *et al.* Return to play and recurrent instability after In-Season anterior shoulder instability. *Am J Sports Med* 2014;42:2842–50.
46. Hovelius L, Augustini BG, Fredin H, *et al.* Primary anterior dislocation of the shoulder in young patients. a ten-year prospective study. *J Bone Joint Surg Am* 1996;78:1677–84.
47. te Slaa RL, Brand R, Marti RK, *et al.* A prospective arthroscopic study of acute first-time anterior shoulder dislocation in the young: a five-year follow-up study. *J Shoulder Elbow Surg* 2003;12:529–34.
48. Sport New Zealand. *Sport and active recreation in the lives of New Zealand adults. 2013/2014 active new Zealand survey results*, 2015.
49. Itoi E, Hatakeyama Y, Sato T, *et al.* Immobilization in external rotation after shoulder dislocation reduces the risk of recurrence. A randomized controlled trial. *J Bone Joint Surg Am* 2007;89:2124–31.
50. Paterson WH, Throckmorton TW, Koester M, *et al.* Position and duration of immobilization after primary anterior shoulder dislocation: a systematic review and meta-analysis of the literature. *J Bone Jt Surg - Am Vol* 2010;92:2924–33.
51. Liu A, Xue X, Chen Y, *et al.* The external rotation immobilisation does not reduce recurrence rates or improve quality of life after primary anterior shoulder dislocation: a systematic review and meta-analysis. *Injury* 2014;45:1842–7.