

# Characterization of Shoulder Instability in Rhode Island: Incidence, Surgical Stabilization, and Recurrence

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## ABSTRACT

**PURPOSE:** To characterize shoulder instability within the state of Rhode Island from 2011 to 2019.

**METHODS:** The Rhode Island All-Payer Claims Database (APCD) was used to identify all patients that make an insurance claim related to a shoulder instability event. All patients in the APCD with an ICD-9 code of 718.31, 718.32, or 831.00 through 831.19 or an ICD-10 code of S43.001 through S43.086 or M24.41 through M25.319 between January 1, 2011 and December 31, 2019 were selected. Chi-square analysis was used to compare age- and sex-delimited subgroups; multivariate logistic regression was used to assess for factors influencing rates of surgical intervention and recurrent instability; and Kaplan-Meier failure and log-rank analyses was used to analyze variation in the time to surgery and recurrence between age-delimited subgroups.

**RESULTS:** The incidence of overall shoulder instability (subluxations and dislocations) in Rhode Island was 62.20 instability events (95% CI, 60.61–63.78) per 100,000 person-years. The incidence of dislocations and subluxations were 49.46 injuries (95% CI, 48.05–50.88) and 12.73 injuries (95% CI, 12.02–13.45) per 100,000 person-years, respectively. Bivariate analysis demonstrated that male patients had significantly increased rates of surgical stabilization (6.36% vs. 2.80%) and recurrent instability (16.30% vs. 9.85%) compared to their female counterparts. However, after controlling for age at the primary instability event and the type and directionality of the instability, the difference in recurrence rates between males and females is no longer statistically significant ( $p = 0.326$ ). Contrary to sex, age maintained its significance with those patients aged 20 and younger and 21–40 years at significantly increased odds of surgical stabilization (3.12 and 1.99, respectively) and experiencing a recurrent instability event (3.96 and 2.77, respectively).

**CONCLUSION:** These data characterize the epidemiology of shoulder instability within the state of Rhode Island and demonstrate how increasing age at a primary instability event decreases the likelihood of both surgical stabilization and rates of recurrence.

**KEYWORDS:** shoulder instability, glenohumeral instability, epidemiology, recurrent instability, surgical stabilization

## INTRODUCTION

Due to the wide functional range of motion and lack of bony restraint, glenohumeral joint instability is common in the general U.S. population and reaches near endemic levels in young athletes.<sup>1–3</sup> Reported rates of the general population have ranged from 12 to 56 dislocations per 100,000 person-years, with rates reaching as high as 169 dislocations per 100,000 person-years among the United States Military.<sup>1,3,4</sup> Active individuals who experience a primary shoulder instability event are at significantly increased risk of subsequent instability due to the associated soft tissue and/or osseous injuries that occur at the time of the instability event and therefore, often require surgical stabilization to decrease the risk of recurrent instability.<sup>5–7</sup> In younger patients, these injuries often result in significant time loss from participation in athletics, while in older patients, they may limit their ability to exercise and complete their activities of daily living.<sup>8</sup> The long-term complications of glenohumeral instability are also significant as these patients are at increased risk for cumulative damage to the glenohumeral joint increasing the risk for future osteoarthritis.<sup>9–11</sup>

Rhode Island's All-Payer Claims Database (APCD) is part of the Rhode Island Department of Health's effort to identify healthcare quality and health outcome improvement opportunities. These data are gathered from health insurance payments made throughout the state, capturing health data for approximately 1.06 million patients.<sup>12</sup> The purpose of this study was to determine and characterize the incidence of shoulder instability and its management in the state of Rhode Island to help inform healthcare providers in the state to limit both short- and long-term complications of shoulder instability.

## METHODS

### Data Source

The Rhode Island All-Payer Claims Database (APCD) was used in this study. This database includes all healthcare insurance payment information for all people with health insurance living in Rhode Island. This information includes demographics and health status, medical services, emergency department visits, pharmacy claims, associated International Classification of Disease, Ninth and Tenth Revisions (ICD-9, ICD-10) and Current Procedural Terminology (CPT)

codes, as well as general demographic information on the rendering providers. This database does not include information on patients without health insurance and claims by small insurance companies with less than 3000 members. According to the Kaiser Family Foundation, 4.8% of Rhode Islanders were uninsured in 2018.<sup>13</sup> In aggregate, this database includes data on about 95% of Rhode Islanders that make a medical claim within the state of Rhode Island.

### Patient Selection

All patients in the APCD with an ICD-9 code of 718.31, 718.32 or 831.00 through 831.19 or an ICD-10 code of S43.001 through S43.086 or M24.41 through M25.319 were selected. These diagnosis codes represent all codes for shoulder dislocation or subluxation and recurrent instability events of the shoulder. Patients that presented between January 1, 2011 and December 31, 2019 were included in the study. All claims made with traditional Medicare Fee-For-Service (FFS) were excluded (14% of the state population) from the study as per the state's directive, but all Medicare Advantage recipients (40% of the Rhode Island Medicare beneficiaries) were included in the analysis.<sup>13</sup> Following all exclusions, this study included over 80% of Rhode Islanders that made a medical claim between January 1, 2011 and December 31, 2019.

### Statistical Analysis

Multivariate logistic regression was used to calculate odds ratios and 95% confidence intervals for all variables of interest and linear regression was used to assess trends in the incidence of shoulder instability. U.S. Census data was used to calculate at-risk person-years for both the greater Rhode Island population and the age and sex delimited subgroups. Kaplan-Meier failure and log-rank analyses were used to assess for significant differences between the rate of recurrence and surgical stabilization between subgroups. Thirteen patients underwent multiple surgical procedures over the study period and were treated as a single data point for surgical stabilization analysis.

## RESULTS

The query of the APCD yielded 5,930 patients who experienced a shoulder instability, event in Rhode Island between January 1, 2011 and December 31, 2019 and an associated 30,979 medical claims. This includes primary subluxation and dislocation, as well as recurrent instability. Of the 5,930 patients, 1,160 presented with recurrent instability following a primary dislocation or subluxation from before the study period, while the remaining 4,770 patients presented with primary shoulder instability (Table 1). Over 80% of these cases were dislocations (4,714) and just under 30% presented with anterior instability (64.8% had direction not specified in the database). The overall incidence rate of shoulder instability within Rhode Island during the study period was 62.20

**Table 1.** Characteristics of initial documented instability events within the state of Rhode Island from January 1, 2011 to December 31, 2011.

	Number of Cases	Proportion (95% CI)
<b>Type of Instability</b>		
Subluxation	1,214	20.47 (19.46–21.52)
Dislocation	4,716	79.53 (78.48–80.54)
<b>Directionality</b>		
Anterior	1,399	29.93 (28.64–31.26)
Posterior	147	3.15 (2.68–3.69)
Inferior	100	2.14 (1.76–2.60)
Not Specified	3,028	64.78 (63.40–66.14)
<b>Primary or Recurrent</b>		
Primary*	4,770	80.44 (79.41–81.43)
Recurrent	1,160	19.56 (18.57–20.59)
<b>Surgical Stabilization</b>		
Surgery	287	4.84 (4.32–5.42)
No Surgery	5,643	95.16 (94.58–95.68)

\*646 Patients experienced a recurrent instability event during the study period.

**Table 2.** Multivariate logistic regression analysis of independent factors that influence the likelihood of surgical stabilization and recurrent instability.

Variable	Surgery		Recurrent Instability	
	OR (95% CI)	p-value	OR (95% CI)	p-value
<b>Type of Instability</b>				
Subluxation	Reference	N/A	Reference	N/A
Dislocation	1.29 (0.74–2.25)	0.362	1.56 (1.15–2.10)	0.004
<b>Directionality</b>				
Anterior	3.67 (0.48–28.20)	0.211	0.98 (0.50–1.92)	0.959
Posterior	4.19 (0.50–35.32)	0.187	0.63 (0.28–1.42)	0.271
Inferior	Reference	N/A	Reference	N/A
Not Specified	1.90 (0.25–14.58)	0.537	0.62 (0.32–1.21)	0.165
<b>Primary or Recurrent</b>				
Primary	Reference	N/A	N/A	N/A
Recurrent*	6.61 (4.74–9.21)	< 0.001	N/A	N/A
<b>Sex</b>				
Male	1.49 (0.99–2.23)	0.055	1.11 (0.91–1.35)	0.326
Female	Reference	N/A	Reference	N/A
<b>Age</b>				
Under 21	3.12 (1.84–5.28)	< 0.001	3.96 (2.98–5.25)	< 0.001
21 to 40	1.99 (1.16–3.42)	0.012	2.77 (2.08–3.67)	< 0.001
41 to 60	Reference	N/A	Reference	N/A

\*Recurrent includes both patients who initially presented with a recurrent instability event and those who experienced a recurrent instability event following a primary instability event.

injuries (95% CI, 60.61–63.78) per 100,000 person-years. The incidence rates of dislocations and subluxations were 49.46 injuries (95% CI, 48.05–50.88) and 12.73 injuries (95% CI, 12.02–13.45) per 100,000 person-years, respectively (Table 2). Excluding all recurrent instability events, the incidence rate of primary instability (including subluxations and dislocation) was 50.03 injuries (95% CI, 48.61–51.45) per 100,000 person-years.

Male sex predominated with 3,394 (57.2%) of the total number of cases and the mean age was 44.16 ±23.9 years and ranged from 1 to 90 years. The incidence rate of shoulder instability in males was 73.13 (95% CI, 70.67–75.69) injuries per 100,000 person-years, compared to 51.83 (95% CI, 49.81–53.84) injuries per 100,000 person-years in females, yielding an incidence rate ratio of 1.41 (95% CI, 1.34–1.49). The peak incidence rate occurred in 2016 (75.9, 95% CI, 70.6–81.1), while the lowest incidence rate during the study period came in 2013 (51.3, 95% CI, 46.9–51.3). There was no significant change in the overall incidence of shoulder instability in Rhode Island during the study period (p = 0.058). The incidence of shoulder instability in males was also unchanged (p = 0.767), but the incidence of shoulder instability in females has significantly increased linearly (at a rate of 3.5 injuries per 100,000 person-years) across the study period (p = 0.012).

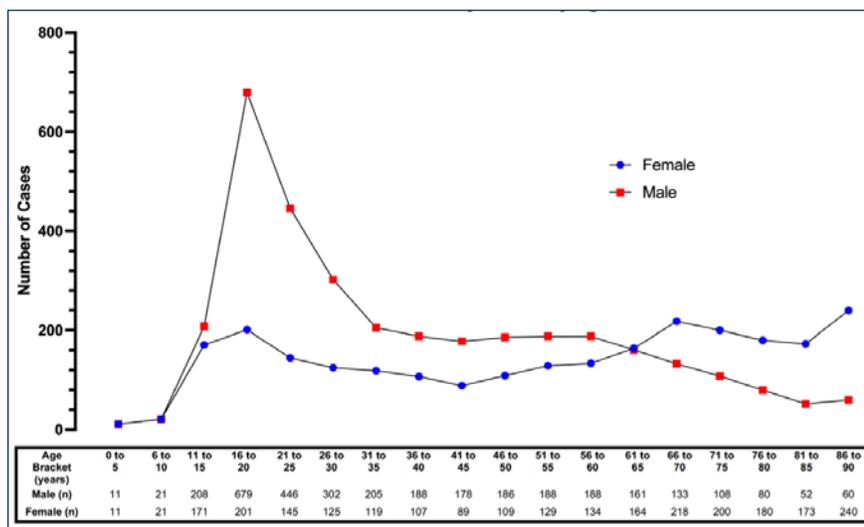
Just over 43% of the cases of shoulder instability occurred in patients aged 11 to 30 years. In males, 54.2% of the cases fell within this age bracket, compared to 30.0% in females (p < 0.001). The cases of shoulder instability gradually declined after the age of 60 in males, whereas in females, a second peak of cases occurred between the ages of 66 and 90 (Figure 1). The incidence of shoulder instability also differed significantly between age groups. The incidence rates within the

20 and younger, 21–40, and 41–60 age groups was 57.54 (95% CI, 54.44–60.64), 63.74 (95% CI, 60.65–66.83), and 48.81 (95% CI, 46.05–51.57), respectively (Table 2). Of note, the specific incidence rates for the 61–80 and 81 and older age group are not reported as their values likely underrepresent the true incidence as Medicare FFS recipients were excluded from the study.

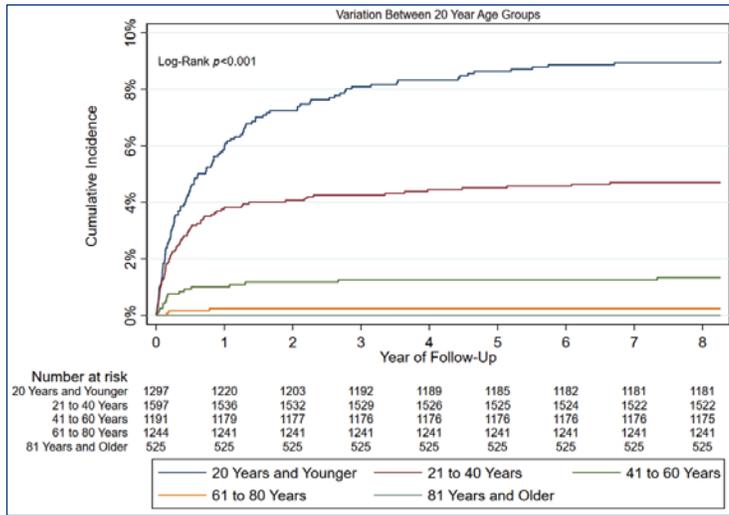
Of the 5,930 patients who experienced shoulder instability during the study period, 287 received surgical stabilization (4.84%, 95% CI, 4.32–5.42%). This percentage differed significantly depending on the sex of the patient. Males received surgical intervention at a rate of 6.36% (95% CI, 5.54–7.19%), compared to 2.80% in females (95% CI, 2.16–3.44) (p < 0.001). Of the 4,770 patients who presented with a primary instability event during the study period, 13.54% (95% CI, 12.60–14.54%) experienced recurrent instability. This rate also significantly differed depending on the sex of the patient. In males, 16.30% (95% CI, 14.91–17.69%) experienced recurrent instability, compared to 9.85% in females (95% CI, 8.56–11.15%) (p < 0.001). However, after using a multivariate logistic regression model to control for age, type of instability, and directionality of instability, the difference in likelihood of experiencing recurrent shoulder instability between males and females was no longer statistically significant (p=0.326). Recurrent instability was 6.61 times more likely to receive surgical stabilization compared to primary instability (p < 0.001) (Table 2). Patients in the 20 and younger and 21–40 years age groups were 3.12 (95% CI, 1.84–5.28) and 1.99 (95% CI, 1.16–3.42) times more likely to receive surgery than those aged 41–60 (p < 0.001 and p = 0.012, respectively). As for rates of recurrent instability, recurrence in those 20 years and younger or 21–40 years old were 3.96 (95% CI, 2.98–5.25) and 2.77 (95% CI, 2.08–3.67) times more likely compared to those aged 41–60 (p < 0.001 for both).

Kaplan-Meier failure analysis and log-rank testing further corroborated this finding with the youngest age group experiencing the highest percentage of both surgical stabilization (p < 0.001) and recurrent instability (p < 0.001) (Figures 2a and 2b). Table 3 shows the cumulative rates of surgical stabilization and recurrent instability at 30 days, 6 months, and 1 through 5 years after the initial presentation during the study period. At 1-year post-primary dislocation or subluxation, 5.9% of patients 20 years or younger received surgical stabilization to address their glenohumeral instability, compared to just 1.0% in patients aged 41 to 60 years. Similarly, 15.0% of patients 20 years or younger experienced

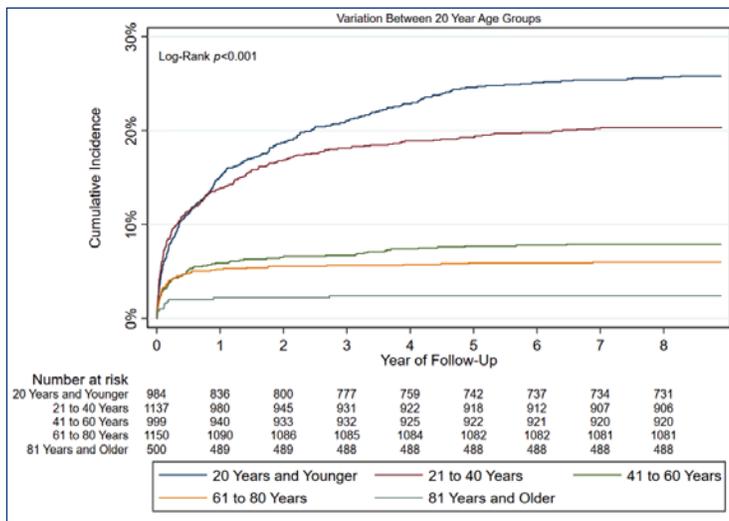
**Figure 1.** Age distribution of shoulder instability cases over five-year age brackets stratified by sex. This figure demonstrates the predominance of cases occurs in young adult males. After the age of 60, the number of cases in males begins to decrease, while the number of cases in females begins to peak for a second time.



**Figure 2a.** Kaplan-Meier Failure Analysis with log-rank analysis overlaid. The figure is depicting the cumulative percentage of surgical stabilization over time for each age-delimited subgroup.



**Figure 2b.** Kaplan-Meier Failure Analysis with log-rank analysis overlaid. The figure is depicting the cumulative percentage of recurrent dislocations following a primary instability event over time for each age-delimited subgroup.



recurrent instability within a year, compared to 5.9% of patients aged 41 to 60 years. Of note, those patients whose first claim within the APCD was either for surgical stabilization (76 patients) or recurrent instability (1,160 patients) were excluded from the Kaplan-Meier and log-rank analyses since their time to event was zero days.

**DISCUSSION**

Using the Rhode Island All-Payer Claims Database, we determined the incidence rate of shoulder instability within the state of Rhode Island to be 62.20 injuries (95% CI, 60.61–63.78) per 100,000 person-years, with the incidence of

**Table 3.** Cumulative surgical stabilization and recurrent instability rates using the Kaplan-Meier method over 20-year age groups.

Surgical Stabilization					
Time to Event	20 and Younger (%)	21 to 40 Years (%)	41 to 60 Years (%)	61 to 80 Years (%)	81 Years and Older (%)
30 days	1.3	1.2	0.3	0.0	0.0
6 months	4.5	3.1	0.9	0.2	0.0
1 year	5.9	3.8	1.0	0.2	0.0
2 years	7.2	4.1	1.2	0.2	0.0
3 years	8.1	4.3	1.3	0.2	0.0
4 years	8.3	4.4	1.3	0.2	0.0
5 years	8.6	4.5	1.3	0.2	0.0
Recurrent Instability					
Time to Event	20 and Younger (%)	21 to 40 Years (%)	41 to 60 Years (%)	61 to 80 Years (%)	81 Years and Older (%)
30 days	5.0	6.1	2.8	3.1	1.0
6 months	11.2	11.4	5.2	4.8	2.0
1 year	15.0	13.8	5.9	5.2	2.2
2 years	18.7	16.9	6.6	5.6	2.4
3 years	21.0	18.1	6.7	5.7	2.4
4 years	22.9	18.9	7.4	5.7	2.4
5 years	24.6	19.3	8.1	5.9	2.4

dislocations and subluxations at 49.46 injuries (95% CI, 48.05–50.88) and 12.73 injuries (95% CI, 12.02–13.45) per 100,000 person-years, respectively. The incidence of shoulder dislocations is on par with previously reported incidence rates for the general U.S. population. Zachilli and Owens reported an incidence rate of 23.9 dislocations per 100,000 person-years, with estimates in Canada (23.1 dislocations per 100,000 person-years), Denmark (12.3 dislocations per 100,000 person-years), Sweden (27.5 dislocations per 100,000 person-years), and Norway (56.3 dislocations per 100,000 person-years) also suggesting the burden of shoulder instability is significant.<sup>1,14-16</sup> To understand the near-endemic level of these injuries, this reported incidence of shoulder dislocations (49.46 injuries per 100,000 person-years) is greater than 9 times that of elbow dislocations (5.21 injuries per 100,000 person-years), although it still lags behind other common musculoskeletal injuries like ankle sprains (215 injuries per 100,000 person-years).<sup>17,18</sup> While shoulder dislocations may have a lesser burden on the general U.S. population compared to injuries like ankle sprains, in young, active populations and the military, the incidence of shoulder dislocations increases to 169 injuries per 100,000 person-years or greater.<sup>2,3</sup>

The present study reports an incidence rate of shoulder dislocations that is over double that previously reported within the general U.S. population. This may be the result of Zacchilli and Owens reporting the incidence of shoulder dislocations in the U.S. using emergency department gathered data.<sup>1</sup> The present study captures data from emergency departments within the state of Rhode Island as well as those patients who present directly to their primary care physician or a sports medicine specialist, likely capturing a greater proportion of the shoulder instability and increasing the incidence rate. However, like Zacchilli and Owens, this study was unable to capture athletes who presented to athletic trainers within their respective facilities, likely leading to an incidence rate that underrepresents the true burden of shoulder instability.<sup>1</sup> While the present study did include glenohumeral subluxations, these accounted for only 20.47% of all instability events, a previous study described subluxations accounting for 85% of all glenohumeral instability.<sup>19</sup> This suggests the vast majority of patients with shoulder subluxations are electing to not seek medical care, likely leading to a dramatically underdiagnosed number of subluxations.

Sex as a nonmodifiable risk factor for glenohumeral instability has long been described with much of the literature reporting significantly increased incidence among males when compared with females.<sup>5,9,20,21</sup> However, emerging data suggests when males and females participate in sports with similar risk exposure, the incidence of shoulder instability is also similar.<sup>9</sup> Peck *et al.* reported nearly identical rates of glenohumeral instability in male and female rugby athletes and Owens *et al.* reported the same among males and females participating in collegiate soccer, basketball, baseball/softball, and hockey.<sup>22,23</sup> This study initially demonstrates a significant difference between the incidence of shoulder instability among males and females (**Table 2**). The incidence of shoulder instability in males was 73.13 (95% CI, 70.67–75.69) injuries per 100,000 person-years, compared to 51.83 injuries (95% CI, 49.81–53.84) in females (IRR = 1.41, 95% CI, 1.34–1.49,  $p < 0.05$ ). On a pure percentage of recurrence basis, males experienced recurrent instability 65.5% more often than their female counterparts. However, when controlling for type of instability, directionality, and age at primary instability, sex as a risk factor of recurrent instability loses its significance. This information agrees with the emerging literature that suggests sex may not be as significant of a risk factor as once believed.

Of the 5,930 patients included in this study, 287 (4.84%) had surgical stabilization of the shoulder. This surgical stabilization rate is higher than that reported by Bokshan *et al.* (3.47%) who analyzed similar data within the state of Florida.<sup>24</sup> This is likely the result of the present study having a larger proportion of patients with recurrent instability, which is a higher risk population that often receives surgical intervention at increased rates compared to those

with primary instability. Males (6.36%) and females (2.80%) received surgical intervention at significant different rates. Olds *et al.* in a meta-analysis of risk factors for recurrent dislocation describe males having over a three-fold increase in risk of recurrent dislocation compared to females.<sup>25</sup> As research has shown that males and females of similar age and level of activity experience recurrent instability at similar rates, this discrepancy may be the result of surgeons being cautious with the young, male population. Since research regarding sex as a significant risk factor of recurrent instability has been inconsistent up to this point, surgeons are likely going to be more willing to perform surgery to limit the likelihood of recurrence in a population that has been shown in some research to be at increased risk.

Regarding recurrent instability, 1,806 of the 5,930 patients (30.46%) experienced a recurrent instability event during the study period. However, 1,160 of these patients initially presented during the study period with recurrent instability, while the remaining 646 patients initially presented with a primary instability event and subsequently redislocated during the study period. When considering the population who presented during the study period with primary instability, 13.54% experienced recurrent instability. Wasserstein *et al.* reported a pooled rate of recurrence after primary shoulder instability to be higher at 21% (range: 19% to 88%).<sup>26</sup> This may be the result of the Wasserstein study excluding those patients aged 12 years or younger and having an increased percentage of younger aged males, both of which would lead to higher reported rates of recurrence. Similar to the present study, Wasserstein *et al.* describe age at the time of primary glenohumeral instability as one of the most important prognostic factors for recurrent instability.<sup>26</sup> The current study found both age and initial dislocation (compared to subluxation) to be significant risk factors for recurrent instability, but unlike the Wasserstein study, sex was not a statistically significant risk factor.

Further analysis was done to compare rates and cumulative percentages of patients who received surgical stabilization and those who experienced recurrent instability dependent on age (**Figures 2a** and **2b**). This study demonstrates a significant difference in both the timing and cumulative percentage of surgical stabilization and recurrent instability among different 20-year age groups. The management of primary glenohumeral instability remains controversial as many physicians elect to reserve surgery for those patients who fail conservative management. However, studies of the young, athletic population have demonstrated a significant relative risk reduction in subsequent shoulder instability following arthroscopic stabilization.<sup>19,27,28</sup> This information corroborates the differences in surgical management and rates of recurrence between the younger and older populations. Younger, active patients are more likely to experience recurrent instability, making them better candidates for surgical stabilization, leading to increased rates of surgery in

the younger population. Furthermore, people over the age of 40 years are more likely to experience rotator cuff tears and will therefore undergo rotator cuff repair rather than labral repair. Labral repair is less frequently done within this population due to postoperative concerns, namely decreased satisfaction, stiffness, and reoperation.<sup>29</sup>

## LIMITATIONS

There are limitations to this study. Given the inherent nature of any database study, there is a possibility of missed shoulder instability events due to improper coding and no way of assessing the severity of the dislocation as this would impact the decision to manage a patient surgically rather than nonoperatively. Second, the underreporting of shoulder subluxations due to people not seeking medical care for these instability events likely led to a dramatic underestimate of the overall burden of shoulder instability within the state of Rhode Island. While the reported incidence of shoulder dislocation is more accurate, we recommend further research into the burden of shoulder subluxations within the state as there is likely a large population who has experienced such an event and not sought medical care. Third, as Rhode Island is a small state geographically, there is the chance patients crossed state borders to receive care, in which case these claims would not be captured in the Rhode Island APCD. It should also be noted that patients using Medicare FFS were excluded from the study as per the state's directive. The combination of these limitations likely led to an underestimate of the overall incidence of shoulder instability within Rhode Island but should have minimal influence on the analysis and comparisons made between types of instability, directionality, recurrence, and sex due to the sufficiently large and representative sample sizes. However, as some patients from adjacent states may have crossed into Rhode Island for treatment of their shoulder instability, this may have led to an overestimate of the incidence of shoulder instability. Despite these limitations, given the large number of cases over the nine-year study period, these data are likely reflectively of the general orthopaedic community nationwide. We were able to capture a large number of patients and complete a well-powered study to characterize the epidemiology and management of shoulder instability.

## CONCLUSION

The incidence of shoulder instability within the state of Rhode Island between January 1, 2011 and December 31, 2019 was calculated to be 62.20 injuries (95% CI, 60.61–63.78) per 100,000 person-years, with the incidence of shoulder dislocations specifically at 49.46 injuries (95% CI, 48.05–50.88). Using the Rhode Island APCD, this study characterized the epidemiology of shoulder instability and

demonstrated how increasing age decreases both the likelihood of receiving surgical stabilization and experiencing recurrent shoulder instability.

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## Funding

There was no funding source for this study.

## Disclosures

BDO has received funding personally from Mitek, Conmed, Miach, and Vericel for consulting.

BDO has received grants from the DoD, NIAMS, and CDMRP.

BDO has received personal royalties from Conmed.

BDO holds stock options for Vivorte, Inc.

BDO has received personal research support from Mitek, Arthrex, and MTF.

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