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Shoulder injury related to vaccine administration (SIRVA): What do we know about its incidence and impact?

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ABSTRACT

Background: Shoulder injury related to vaccine administration (SIRVA) has been recognised as the compensable term for any shoulder injury that may result from an improper vaccination technique since 2017, however, its incidence and impact remain poorly understood.
Objectives: To examine knowledge of SIRVA through reported cases, determine SIRVA incidence related to COVID-19 vaccinations, and investigate recovery rates.
Methods: Six pharmacovigilance agencies in the United States of America (USA), Canada, United Kingdom, European Union, Australia, and New Zealand were systematically search to identify all reported cases of SIRVA between January 2017 to July 2021. Primary outcome measures were SIRVA case reports. Secondary outcome measures included recovery status as well as vaccine received, age, and sex. SIRVA-related outcome measures were retrieved between July 18th and July 22nd 2021, with UK data received via personal correspondence.
Results: Retrospective analysis yielded 505 SIRVA cases since 2017, with 330 (65%) of cases reported from January to July 2021. Sub-analysis, using COVID-19 data of 189 SIRVA cases from 891,906,986 vaccinations, estimated incidence to be 2 per 10 million. 32 cases (7%) had recovered from symptoms at the time of reporting, with 311 (62%) reported as 'not recovered', and 162 cases (32%) 'unknown'. Females represented 75% of reported cases.
Conclusion: SIRVA case report numbers and incidence from COVID-19 data, compared with prior evidence, raises questions around health practitioner knowledge and reporting accuracy of SIRVA. Recovery rates are poorly understood. A global consensus definition of SIRVA and more transparent and routine reporting is required. The disproportionate representation of females is of concern with no known reasons for this disparity. Further research is needed on SIRVA knowledge in healthcare practitioners, reporting rates, incidence, management, and long-term outcomes for those impacted. Pharmacist vaccinators should be aware of their role in preventing SIRVA and be active in its detection.

1. Introduction

Shoulder Injury Related to Vaccine Administration (SIRVA) is an adverse event following immunisation (AEFI).[1] Initially a medicolegal term introduced in 2010 by the Vaccine Injury Compensation Program (VICP) following an increase in vaccine-related shoulder injury claims it was added officially to the Vaccine Injury Table in 2017.[2,3] SIRVA is now documented in literature, educational material for vaccinators, and is the preferred term used by governing bodies monitoring AEFIs for any shoulder injury that may result from an improper vaccination technique.[4] SIRVA is proposed to be preventable through use of proper landmarking combined with a strong understanding of underlying shoulder anatomy.[1] Pharmacists globally are administering vaccines at an unprecedented rate, most recently due to their being an essential part of the COVID-19 vaccination rollout in many countries.[5] Consequently, pharmacists, as with all vaccinators, should be aware of their role in preventing SIRVA, and active in its detection.[4]

In SIRVA, the shoulder injury that results can occur when the vaccine is administered too high into the shoulder (glenohumeral) joint, missing the deltoid muscle bulk and resulting in the vaccine being injected into the capsule.[6–8] It can also occur when a vaccine is administered too laterally or too low, causing damage to the axillary nerve or radial nerve, respectively.[6–8] The subsequent AEFI can result from direct trauma caused by the needle itself, or an inflammatory response stemming from a localised

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reaction to the vaccine.[8] Common presenting symptoms of SIRVA include shoulder pain, stiffness, range reductions, and weakness,[7] while less common symptoms of neuropathic pain, paralysis, or neuropathy are noted in cases of nerve damage.[9] Common conditions that result include adhesive capsulitis, subacromial or subdeltoid bursitis, rotator cuff pathology, and synovitis, with less common conditions such as osteonecrosis and nerve pathologies also reported.[10–12]

Criteria for medicolegal classification of SIRVA as an AEFI typically involves sudden loss of joint range and shoulder function within 24–48 h post immunisation, with a subsequent duration longer than 7–10 days, and no response to over-the-counter analgesics.[8,13] This eliminates the possibility of the anticipated localised immunological reaction being the primary cause of symptoms.[14] However, exact criteria differ between governing bodies. Criteria for Australia using Surveillance of Adverse Events Following Vaccination In the Community (SAEFVIC) include onset of symptoms within 24–48 h; suspicion of incorrect technique of vaccine administration; restricted range of motion of the affected limb; pain on movement; and abnormalities present on medical imaging.[15] Alternately, the United States of America using the Vaccine Adverse Event Reporting Scheme (VAERS) and the Vaccine Injury Compensation Program (VICP) defines SIRVA as being when pain occurs within 48 h; pain and reduced range on motion are limited to the limb of the injection site; no other differential diagnosis present; no neurological injuries or abnormalities; and no prior history of pain, inflammation, or dysfunction.[13,16] Medical Dictionary for Regulatory Activities (MedDRA) utilises the VICP definition of SIRVA, which excludes any neurological conditions.[17] Despite this, numerous research articles discuss nerve damage attributed to deltoid intramuscular injections (IM) and include neurological conditions in their SIRVA reports.[7,8,15] This inconsistency in SIRVA definitions adds complexity to our understanding of the condition.

Literature relating to SIRVA presentations has been sparse, with no systematic reviews examining the topic, and previous data largely compiled from lower quality sources, ranging from case studies and case series to retrospective cohort studies.[10–12,18–20] These do not allow for an accurate understanding of SIRVA or its incidence. Further, treatment and recovery rates remain relatively unknown.[10–12,18–20] Estimating the incidence of SIRVA is challenging. The highest quality and largest study investigating incidence was performed by Hibbs et al.,[18] examining reports of 'atypical shoulder pain and dysfunction' following influenza vaccination in 2010–2017. They investigated reported SIRVA induced conditions (e.g., bursitis, adhesive capsulitis, tendon pathologies) received by the VAERS database as the term "SIRVA" had not been offficially implemented by VICP and VAERS at this time, as the term was only recognised by MedDRA in 2017.[18] In one country alone and with only influenza vaccines examined, 1220 possible reports were found in a 7-year period, with an estimated incidence of 1.5%–2.5% per influenza season (1500–2500 per 100,000).[18] Of note, nerve-related injuries were excluded in this study.

Historically, only the number of case reports to the number of vaccines purchased per year have been available. Purchased vaccines, however, does not mean administered. Global reporting of COVID-19 vaccination data presents a unique opportunity to attempt to more accurately determine the incidence of SIRVA. Further, vaccinations and their adverse reactions have never been so prominently featured in media and the public consciousness as they have during the COVID-19 pandemic. Public awareness, due to the global vaccination process, has placed an intense focus on pharmacovigilance and AEFI reporting rates in an era of new vaccine technologies. For the first time, there is more complete reporting of the number of vaccines actually administered due to COVID-19 vaccination records,[21] and the potential for more accurate recording of SIRVA cases through the increased monitoring of AEFI of all types. This coupled with a defined timeframe in which the vaccines are administered provides researchers with a unique opportunity to determine a clearer understanding of a more accurate incidence of SIRVA. As SIRVA has been recognised as the compensable term encompassing shoulder injuries as an AEFI, through specifically investigating SIRVA reports, the study aimed to establish knowledge of SIRVA amongst vaccinators and health professionals who play a role preventing, recognising, reporting, and managing this condition. Additionally, it investigated the specific global case rates of SIRVA to establish the related incidence for SIRVA based on COVID-19 vaccination data, and determine reported recovery rates, which, to date have not been documented.

2. Methods

2.1. Study design

A retrospective person-time incidence rate study design was utilised.

2.2. Study population

All SIRVA cases reported by six pharmacovigilance agencies in the United States of America (USA), Canada, United Kingdom (UK), European Union (EU), Australia (AUS), and New Zealand (NZ) across the population since 2017 were retrieved. These included the VAERS (USA), Canada Vigilance Program, Medicines and Healthcare products Regulatory Agency (MHRA) (UK), EudraVigilance (EU), Therapeutic Goods Administration (TGA) (AUS), and Medsafe (NZ). Inclusion criteria for SIRVA were: the case report should note SIRVA as the AEFI, with shoulder pain commencing within 24–48 h of vaccination, and symptoms continuing for 7 days or longer. This was due to the aim of investigating both knowledge of SIRVA amongst those reporting and managing shoulder injury AEFIs, and SIRVA incidence specifically related to COVID-19 vaccinations.

2.3. Outcome measures

Primary outcome measures of this study were known reports of SIRVA, and the year reports were received by pharmacovigilance agencies from January 2017 through to June 2021, due to SIRVA being recognised by MedDRA since 2017. Secondary outcome measures included recovery status and further information regarding vaccine received, age, and sex were noted to determine if differences existed. Where reported recovery status was listed as recovering, they were deemed to have not fully recovered from their reported symptoms and have been grouped as 'not recovered'. Where data were unavailable, variables are reported as 'unknown'.

2.4. Data collection

Government bodies responsible for pharmacovigilance in the USA, Canada, UK, EU, Australia, and New Zealand were contacted regarding access to primary data on reported cases of SIRVA between 2017 and June 2021.[20,22,23] Access for the UK data were granted through a freedom of information request by the MHRA (Fig. 1, Step 3.). The TGA (AUS), Canada Vigilance Program, VAERS (USA), Medsafe (NZ), and EudraVigilance (EU) were unable to provide an equivalent report, however, no clear privacy or ethical reasons were provided. Consequently, primary data were retrieved from publicly available data from the relevant pharmacovigilance agencies over a 5-day period between July 18th and July 22nd 2021 while UK data for the same time period were received June 30th 2021 via personal correspondence.

The search term of SIRVA was defined using MedDRA.[15] Where possible, pharmacovigilance database searches of all recorded medicines were performed in a singular search. Data were collected from Canada Vigilance Program and VAERS reporting systems using this initial process with search parameters noted in Appendix A., Fig. 1., Step 1. and 2. respectively.[24,25] Searches for the MedDRA term SIRVA were performed manually for these agencies using publicly available pharmacovigilance data using known deltoid intramuscular antigens.[12,19,20,22,23,25,26] Manual search terms used to systematically obtain data from Medsafe, TGA, and EudraVigilance pharmacovigilance databases are listed in Appendix A., Fig. 1., Steps 3., 4., and 5. respectively. All cases that reported using the term SIRVA were included. The total number of COVID-19 vaccines delivered in each of the six countries recorded from first date of delivery in January 2021 up to

Table 1
Known SIRVA cases January 2017–July 2021: Country of report by year of report.

	AUS	UK	USA	Europe	NZ	CAN
2017	–	–	1	–	–	–
2018	–	3	30	3	–	–
2019	3	2	39	14	–	–
2020	–	9	64	7	–	–
2021	1	57	165	104	–	3
Total	**4**	**71**	**299**	**128**	**0**	**3**

30th June 2021 were accessed from COVID Data Tracker.[21] SIRVA incidence was then determined from a sub-group analysis of the reported cases attributed to COVID-19 vaccinations and total number of vaccinations delivered. The data collection process utilised meant ethics approval was not required for this research as confirmed but the University of Canberra Human Research Ethics Committee.

3. Results

According to our search criteria, from January 2017 to July 2021, 505 cases of SIRVA were reported across the surveyed nations primary data (Table 1). SIRVA cases reported increased since 2017, with only 1 report in 2017 and 330 (65%) of known cases having occurred between January to July 2021. Greatest numbers were noted in the USA, with 299 cases since 2017, forming 59.4% of known cases. Reports from the EU and the UK formed 25.4% and 14.3% of cases respectively. Australia reported only 4 cases and Canada only 3 since 2017, while New Zealand reported no cases of SIRVA at any time (Table 1). Vaccination type was highly varied between 2017 and 2020, with a variety of vaccines such as influenza, pneumococcal, and diphtheria, tetanus, and acellular pertussis (DTaP) noted (Fig. 1). Reporting in 2021 predominantly involved COVID-19 vaccinations of any brand (Fig. 1) with COVID-19 vaccinations forming 189 of 297 (63%) known injections resulting in a report of SIRVA. Vaccination type was unknown in 67% of reports. Some reports contained multiple vaccinations resulting in vaccination type being greater than reported cases. Based on sub-analysis of COVID-19 SIRVA cases and the total number of COVID-19 vaccinations delivered across the 6 countries between January to 30th June 2021, SIRVA incidence was estimated at 0.00002% (189/891,906,986), or 2 per 10 million doses.

Case recovery was reported in data from the EU, Australia, and USA, of which there were 431 total cases. Of these cases, only 32 (7%) were reported to be recovered from symptoms at time of report. Recovery status was 'not recovered' in 311 (72%) cases. Taking into account all countries, including those who did not report recovery status, it was 'unknown' for 162 of the total 505 (32%) cases. No further recovery data were provided.

Table 2
Sex of report by reported age group.

	Males	Females	Unknown	Total
<12 months	3	1	–	4
12 months – 5 years	–	–	–	0
6–17 years	1	3	–	4
18–64 years	74	226	1	301
65–85 years	24	77	–	101
85+ years	–	1	–	1
Age unknown	20	70	4	94
Total	**119**	**378**	**5**	**505**

Case ages ranged from <1 month old to above 85 years (Table 2). Average age of case was undetermined due to only age ranges being reported, and age data from the UK was unknown. Females represented 378 of the 505 cases, forming 75% of reports (Table 2).

4. Discussion

This study is the first to examine the knowledge of SIRVA through reported global case rates, establish SIRVA incidence from actual vaccines administered, and provide data on recovery rates and groups most affected. With 505 case reports identified, and based on the sub-group analysis of COVID-19-related known cases and vaccination data, we estimated SIRVA incidence to be 2 per 10 million doses.[6,18,27–30] Reports received in 2021 came primarily from COVID-19 vaccines, likely due to their significant impact on global vaccination rates. However, overall, cases between 2017 and 2021 came from a wide variety of vaccines (Fig. 1.) supporting previous evidence noting SIRVA to be an AEFI due to incorrect vaccination procedure and independent of the administered antigen.[5] Recovery status was not recorded as standard in many pharmacovigilance agencies, being available in only 68% of case reports. Concerningly, only 6% of cases had symptom recovery/resolution at time of report, with no follow-up data available from any surveyed pharmacovigilance agency.

4.1. SIRVA incidence

According to the data analysed in this review, the incidence of SIRVA would appear extremely low at 2 per 10 million doses.[6,18,27–30] However, based on previous evidence in the literature, these low recorded case numbers are of considerable concern and raise significant questions around both

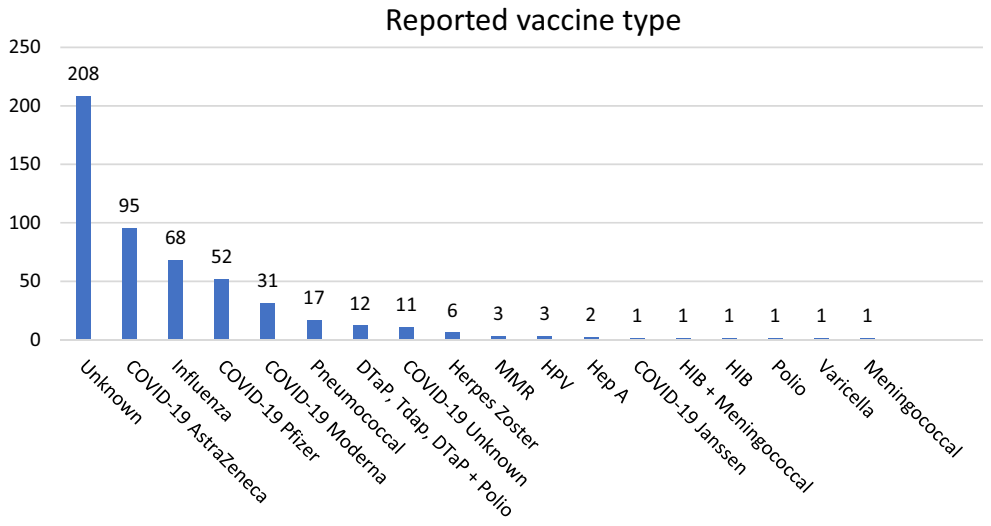

Fig. 1. Vaccination/injection reported for SIRVA cases between January 2017–July 2021.

the knowledge and reporting of SIRVA amongst health professionals. The highest quality and largest previous study, performed by Hibbs et al.,[18] estimated incidence of 1.5%–2.5%. Notably, this study excluded nerve-related injuries, and lacked an accurate vaccine denominator (vaccines delivered). Using this incidence rate of 2.5%,[18] however, we can extrapolate an estimated incidence of SIRVA from COVID-19 vaccinations at approximately 254,700,000 cases having potentially occurred globally to date. This would indicate that current reporting of SIRVA may be inaccurate, with cases of shoulder injury potentially being reported via their induced conditions but not being classified as SIRVA specifically, or not being reported at all. This is of concern, as it raises questions about the knowledge of SIRVA in health professionals who play a role in preventing, recognising, and managing this AEFI. Further, it specifically impacts our understanding of the risks for, and impact of SIRVA.

Most cases reported since 2017 occurred within the first 6 months of 2021. Although exact reasons behind this recent rise remain unknown, it may be due to several factors. Consideration must be given to a possible link between the increase at this specific time in the number of vaccination doses given in a single day due to mass vaccinations for COVID-19, and the number of possible SIRVA cases reported. This is particularly pertinent as rushed vaccination rollouts may have increased risk of errors in vaccine delivery. Australian and UK medicines regulatory bodies have also recently undertaken media and marketing campaigns to promote self and healthcare professional reporting of adverse events following immunisation.[23,25] It may be that the relative increase, therefore, is a greater awareness of SIRVA amongst healthcare professionals and the public, and thereby the 'spike' in cases reflects more accurate reporting as opposed to being a true increase in incidence. While currently unclear, the reasons behind the apparent recent increase in incidence of SIRVA needs to be explored.

Lack of access to global data was of key concern during this study. Vaccine surveillance specific to AEFI suffers universally from a lack of timely and accurate reports.[30,31] Extracting data on SIRVA from publicly available government pharmacovigilance real-time reports, is fraught with challenges. The search methods that need to be used to access data are highly variable, and thereby, the same key terms cannot be used across databases or across countries - examples are given in Appendix A, Figs. 1–5. When access to data is limited through these difficult self-search functions created by each country, clear understanding of the scope of the condition is reduced. Primary data available from individual pharmacovigilance agencies are highly variable in not only search methods but also level of detail. The level of detail provided about individual reported cases of SIRVA is also inconsistent. Further, there is a lack of information regarding management of the injury's induced conditions following SIRVA categorisation, as well as recovery rates and timeframes. The difficulty in obtaining data related to SIRVA may restrict the knowledge of this condition in healthcare professionals due to ease of access. More transparent, uniform reporting schemes between countries would greatly improve the understanding of SIRVA, and likely many other vaccination-related conditions at a global level.

4.2. Potential causes for incidence disparity in SIRVA

The reason behind the disparity in SIRVA incidence reported in this study compared with expected rates based on prior research remains unclear, however, there are a number of potential factors. The lack of consensus around the diagnostic definition and difficulties accessing global data from pharmacovigilance databases poses considerable challenges. To assist in more accurate reporting, the first recommendation from this study is that a uniform definition must be utilised. The exclusion of nerve injuries by MedDRA creates a significant disparity in which cases are deemed SIRVA, based on which definition is used in each country or even each case series. Nerve injuries have been causally linked to deltoid intramuscular injections and, as such, should be included in the criteria for SIRVA.[9,32,33] Review of the diagnostic criteria used by various regulatory bodies is required to form a globally uniform and regulated diagnostic criteria for SIRVA. We propose that the SAEFVIC criteria of SIRVA be globally utilised, due to its clarity around shoulder symptoms, symptom timeframes, clear noting of suspected error in vaccination technique, and inclusion of neurological conditions.[15]

It may be that the term SIRVA has been widely under-utilised by reporting practitioners due to a lack of knowledge of the term itself, resulting in a lack of timely and accurate reports. The medicolegal classification has only been recognised by MedDRA since 2017, and as such will only be found in pharmacovigilance databases since that date. The paucity of educational materials related to SIRVA is of concern as practitioners have few avenues for gaining insight into the medicolegal classification. Available materials from the Australian Immunisation Handbook lack detail related to underlying anatomical structures, instead focussing only on landmarking techniques for prevention.[34] Consequences of incorrect administration technique are poorly explained and little insight is provided into the long-term impacts for patients.[34] Educational materials on SIRVA should address the relevant anatomical structures, strategies for prevention, the definition and diagnostic criteria for SIRVA, and consequences and long-term outcomes for patients.

In the current COVID-19 pandemic climate, health care practitioners may be reluctant to report cases of SIRVA as such adverse events related to vaccination may gain traction in the media, potentially amplifying anti-vaccination sentiments. Social media such as tweets discussing more rare side effects of vaccines have been demonstrated to fall victim to cherry-picking and recirculation as misinformation tweets.[35] This can contribute to vaccine hesitancy in non-medical professional social media users.[35] As SIRVA appears both relatively uncommon and iatrogenic in nature, its discussion, however necessary, may be used to spur anti-vaccine propaganda.

The iatrogenic nature of SIRVA carrying the potential for fear of litigation may also reduce reporting rates. No-fault compensation schemes have been proposed to reduce this fear of litigation at a national level to improve reporting of SIRVA and other potentially iatrogenic conditions.[30] However, as of 2020, only 13% of World Health Organisation member states were found to have implemented a no-fault compensation program.[29]

Lastly, there has been much confusion regarding the term of SIRVA and its use as a 'diagnosis' for patients. SIRVA, while now recognised as the umbrella term for an AEFI that gives rise to induced shoulder conditions (e.g., subacromial bursitis, adhesive capsulitis, etc.), is a medicolegal term. This may result in shoulder injuries post-vaccination potentially still being reported by their consequent conditions rather than being classified consistently as SIRVA. In line with the proposal that a consensus definition is required, there also appears the need to be able to report shoulder injuries post-vaccination both as SIRVA and with specific reference to their corresponding SIRVA induced condition to determine their individual treatment and symptom progressions/management. Reporting in this way will enable future research to provide a greater understanding of the true extent of SIRVA, but also provide evidence regarding its impact, best management, and long-term outcomes for individuals with the related shoulder conditions that result.

4.3. Recovery and potential long-term impact

The impact of SIRVA on individuals is largely unknown as most cases identified within the literature were not resolved upon their reporting to governing bodies.[18] Time to resolution has been mixed in previous literature, with some reporting median time to symptom resolution of 70 days, and others reporting residual pain and activity restriction lasting for years.[4,8,18] Nerve-related injuries follow similar timeframes to symptom resolution but concerningly, often requiring surgical intervention. However, in some cases where treatment had not been undertaken, symptoms have been reported as persisting up to 15 months.[33] Prospective studies are needed to determine effective management, symptom progession, and time to symptom resolution.

Further, management of SIRVA is rarely reported and poorly understood. The authors appreciate the complexities regarding management as treatment of a SIRVA induced bursitis will be vastly different from

that of a SIRVA induced osteonecrosis of the humeral head. However, some researchers have proposed using corticosteroid injections as a first line of treatment, failing to consider the effectiveness for induced conditions other than bursitis.[36] Clearly more research is needed regarding the management of SIRVA with a focus on treatment of induced conditions more specifically, to better inform SIRVA management overall.

4.4. Age and sex disparities within available SIRVA pharmacovigilance incidence data

Children receive numerous vaccinations during childhood and adolescence. The Australian Immunisation Handbook considers the deltoid muscle to be the preferred route of IM delivery in both children and adults, however, it is considered unsuitable in individuals with low muscle mass such as young children (<12 months), underweight adults, or the elderly where the anterolateral thigh is used.[6,34] Despite this, 4 cases of SIRVA were identified in children under the age of 12 months.

Needle length guidelines based on age alone increases the risk of overpenetration during vaccination, however, this increased risk is not represented in paediatric pharmacovigilance reports of SIRVA.[11] Prior literature has reported only 4 cases of SIRVA found in individuals under the age of 18. The youngest reported case (case four) was a 12 year old male following a Tdap/IPV booster vaccination, received at his school in Ireland.[28] In this instance the vaccination was delivered well below the deltoid tuberosity in the distal third of the humerus. From this handful of cases, we know that SIRVA does not discriminate. But it remains unknown as to why there are significantly fewer reports of the injury in children when adverse events following immunisation as a collective are generally higher in the peadiatric population.[37] While not yet explored in the literature, one reason for the higher incidence of SIRVA in adults could be that they may be more likely to report any adverse events post-vaccination to a healthcare professional.

Typically, children are the focus of vaccination programs, however, the COVID-19 vaccine rollout has prioritised adult vaccination. Children aged 5 years and up, will be mass vaccinated to protect against COVID-19 over 2022 which, along with the 2021 inclusion of 12- to 18-year-olds to the global COVID vaccination rollout, may increase the incidence of SIRVA in this group.

Case reports identified in this study showed that SIRVA is more common in females than males, with females forming 75% of cases. Previous SIRVA literature has also noted a significant sex disparity with a greater number of females affected, with rates as high as 82.5% of cases being female reported in some studies.[11,16,18,19] Proposed contributing factors include: low body mass index, reduced deltoid fat pad thickness and/or deltoid muscle bulk, greater vaccination uptake, increased adverse event reporting rates, or increased rates of care seeking behaviours in females.[19] However, these factors have been questioned.[19] Modesty, may be another reason, as females are more likely to roll up their sleeve, or pull down their shirt over their shoulder to present the deltoid, than remove their shirt altogether, when compared to males, however, no primary research exists in this area. More research is needed to identify why these sex disparities in SIRVA may exist.

4.5. Strengths and limitations

A strength of this study is that it is the first to investigate SIRVA knowledge utilising case reports from pharmacovigilance agencies. Further, we were able to provide an estimated incidence of SIRVA related to COVID-19 vaccinations due to the mass COVID-19 vaccination rollout resulting in a highly accurate reporting of the number of vaccines actually administered during this period. However, limitations of the study included the lack of a current consensus definition of SIRVA, potential lack of accurate reporting of SIRVA cases, and difficulties that exist regarding access to global reporting data.

5. Conclusion

SIRVA is a known avoidable AEFI related to incorrect vaccination technique. Examination of 6 pharmacovigilance agencies between 2017 and 2021 estimated SIRVA incidence to be 2 per 10 million doses, which stands in contrast to previous evidence indicating its incidence at 25 per 1000 vaccinations. These low recorded case numbers raise questions around SIRVA knowledge amongst health practitioners and the reporting accuracy of this condition. When exploring the incidence of SIRVA, both the lack of consensus on a standard definition and access to global data are key concerns. This potentially impacts the awareness and knowledge of SIRVA in pharmacist vaccinators and other healthcare professionals. More transparent and uniform reporting schemes between countries would greatly improve the knowledge around SIRVA. Further, shoulder injuries post-vaccination should be able to be classified both as SIRVA and with reference to their induced conditions for transparency and to enable future research to provide evidence regarding best management and long-term outcomes. Pharmacists globally should be acutely aware of SIRVA and their role in its prevention, detection, and management.

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CRediT authorship contribution statement

Laura J. Mackenzie: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Mary-Jessimine A. Bushell:** Conceptualization, Methodology, Formal analysis, Writing – review & editing, Project administration, Supervision. **Phillip Newman:** Conceptualization, Methodology, Formal analysis, Writing – review & editing, Project administration, Supervision. **Jaquelin A. Bousie:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Project administration, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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