AIMS Medical Science

AIMS Medical Science, 10(4): 318–328.
DOI: 10.3934/medsci.2023025
Received: 16 September 2023
Revised: 12 November 2023
Accepted: 19 November 2023
Published: 04 December 2023

http://www.aimspress.com/journal/medicalScience

Review

COVID-19 vaccines and autoimmune disorders: A scoping review protocol

Claudia Chaufan[1,*], Laurie Manwell[2], Camila Heredia[3] and Jennifer McDonald[4]

[1] School of Health Policy and Management, York University, 4700 Keele St, Toronto, ON, M3J 1P3, Canada
[2] Wilfrid Laurier University, Canada
[3] School of Health Policy and Management, York University, Canada
[4] University of Central Lancashire Medical School, UK

*** Correspondence:** Email: cchaufan@yorku.ca; Tel: +14373434476.

Abstract: Two years into the global vaccination campaign, important questions about COVID-19 vaccines and autoimmune disorders have arisen. A growing number of reports have documented associations between vaccination and autoimmunity, and research is needed to elucidate the nature of these linkages as well as the mechanisms and causal directions (i.e., whether persons with no history of autoimmune disorders may experience them upon vaccination or persons with autoimmune disorders may experience exacerbation or new adverse events, autoimmune or not, post-vaccination). This scoping review will follow Arksey and O'Malley's framework, which is enhanced by Levac et al.'s team-based approach, to address the relationship between COVID-19 vaccinations and autoimmune disorders. Moreover, it will explore the evidence informing the consensus of care concerning COVID-19 vaccinations in people experiencing these disorders. Data from refereed articles and preprints will be synthesized through a thematic analysis. A subgroup analysis will compare the findings according to the previous existence of autoimmune disorders, presence of co-morbidities, vaccine type, and other potentially relevant factors. COVID-19 has triggered the largest vaccination campaign in history. Drug safety is critical to properly assess the balance of risks and benefits of any medical intervention. Our investigation should yield information useful to assist in clinical decision-making, policy development, and ethical medical practices.

Keywords: COVID-19; vaccines; adverse events post-vaccination; autoimmune disorders; type 1 diabetes mellitus; rheumatoid arthritis; multiple sclerosis; systemic lupus erythematosus; Graves' disease; Hashimoto's thyroiditis

1. Introduction

In 2020, a mass population-level vaccination was promoted by health authorities as a necessary part of the Covid-19 pandemic exit strategy; specifically, it was argued that safe and effective vaccines that reduced severe illness, death, and even disease transmission, would allow for a lessening of restrictions and a return to normalcy [1–3]. Nevertheless, a vaccine-based exit strategy to the pandemic that requires sufficient population coverage must address the needs of individuals who have reasonable concerns, including patients with chronic autoimmune inflammatory diseases at risk of vaccine-induced symptom potentiation (e.g., relapse, worsening, or new symptoms) [4]. In fact, since the launch of the global COVID-19 vaccination campaign in December 2020, there has been a slow but increasing recognition of adverse events post-vaccination. For instance, a July 2023 article in the peer-reviewed journal *Science* admitted to "apparent" complications, including "a debilitating suite of symptoms that resembles Long COVID"—among others, such as postural orthostatic tachycardia syndrome (POTS), abnormal blood clotting, heart inflammation, muscle weakness, fatigue, persistent headaches, and brain fog [5]. While the list of what the authors refer to as "Long Vax", namely, problems identified post-vaccination, does not include autoimmune disorders, the literature reveals several areas of concern involving these disorders and COVID-19 vaccination worthy of examination.

For example, in 2021, Rocco et al. reported the onset of autoimmune hepatitis upon COVID-19 vaccination in an elderly woman with a history of Hashimoto's thyroiditis [6]. That same year, McShane et al. reported on a similar case, also in an elderly patient, with no prior history of autoimmune disorders [7]. Two years into the global vaccination program, an observational, cross-sectional, pharmacovigilance cohort study examined individual case safety reports from VigiBase, which is the World Health Organization's pharmacovigilance database, and identified a statistically significant association between COVID-19 vaccines and transverse myelitis, a condition that, as per the NIH, involves autoimmune processes [8]. Finally, more recent case reports, including one of a healthy, 14-year-old girl deceased upon a third dose of an mRNA COVID-19 vaccine, described death resulting from a fatal multiorgan inflammation activation, with the potential involvement of multiple immune pathways [9]. Another case report described the onset of type 1 diabetes following the second dose of the COVID-19 vaccine in a middle-aged woman with no prior history of the disease [10].

Additionally, there is a dearth of ongoing research on persons experiencing autoimmune disorders. On the one hand, public health agencies and medical organizations continue to strongly endorse COVID-19 vaccinations among these persons and assert that the benefits outweigh what these agencies and organizations consider rare risks [11–14]. On the other hand, the linkages between COVID-19 vaccinations and these disorders—whether the former increases the risks of autoimmune adverse events, or whether patients with autoimmune disorders experience either exacerbation or new adverse events post-vaccination—remain poorly understood, documented, and studied. A search of scoping reviews in the Cochrane Collaboration and Joanna Briggs websites, and of systematic reviews in the PROSPERO website, conducted on August 22, 2023, revealed zero and seven planned studies, respectively, examining the relationship between COVID-19 vaccinations and autoimmune disorders,

though none of them focused on the six most frequent disorders: type 1 diabetes, rheumatoid arthritis, lupus, multiple sclerosis, Hashimoto's thyroiditis, and Graves' disease [15] and autoimmune disorders more generally, thus our proposed review.

1.1. Vaccination and autoimmune disorders

The relationship between vaccinations in general and autoimmunity is well documented, and many potential mechanisms have been hypothesized and demonstrated, both in the lab and in the clinic. Autoimmunity is characterized by abnormal immune system responses directed against the host rather than a foreign invader and can lead to the production of autoantibodies or a cell-mediated response, and the subsequent development of autoimmune diseases such as type 1 diabetes mellitus (T1DM), rheumatoid arthritis (RA), multiple sclerosis (MS), systemic lupus erythematosus (SLE), Graves' disease, and Hashimoto's thyroiditis [16]. Associations between vaccinations and autoimmunity have been identified for the influenza vaccine and Guillain-Barré syndrome, the oral polio vaccine and transverse myelitis, and combination vaccines such as diphtheria-tetanus-pertussis (DTP) and measles-mumps-rubella (MMR) and arthritis. Similarly, review reports suggest a causal link between COVID-19 vaccination and new-onset and/or relapsing autoimmune disorders including SLE, RA, T1DM, Hashimoto's thyroiditis, and Graves' disease [17–19]. For example, new-onset cases have been reported within weeks of COVID-19 vaccinations: 12 cases of new-onset SLE were documented, 7 cases of new-onset RA were reported, characterized by morning stiffness, swelling, pain, and positive rheumatoid factor (RF) serological tests, and 13 cases of new-onset T1DM were reported, with symptoms including excessive thirst, urination, and fatigue, and symptom reversal with insulin treatment [18]. These autoimmune phenomena have occurred with various COVID-19 vaccines, including the adenovirus vector and mRNA types [20,21].

1.2. General mechanisms linking vaccination and autoimmune disorders

It has been proposed that some viral infections may cause autoimmunity, and thus it is likely that similar mechanisms are involved in the link between vaccinations and autoimmunity [22]. Mechanisms of autoimmunity can be antigen-specific, non-specific, or a combination of both. The most commonly occurring autoimmune events post-vaccination include autoantibodies, encephalitis, neuropathy, demyelination, vasculitis, and arthritis [22]. Potential mechanisms for the relationship between vaccinations and autoimmunity include (1) molecular mimicry, (2) bystander activation, (3) epitope spreading, (4) polyclonal activation of B cells, (5) adjuvant-induced immune stimulation, and other adverse events that aggravate immune system responses [18,22]. *Molecular mimicry*, which is an antigen-specific mechanism, occurs when foreign antigens are recognized as host antigens, such as when lipopolysaccharides and peptides produced by microorganisms mimic those of the host in the immune, nervous, and endocrine systems [16]. *Bystander activation*, which is an antigen-*non*-specific mechanism, occurs whenever an infection triggers innate immune response or the release of self-antigens leading to the activation of autoreactive T cells, cytokine secretion, inflammation, and more autoreactive lymphocytes [16]. *Epitope spreading (ES)* occurs when the immune response to an epitope differs from the dominant epitope and lacks cross-reactivity. Therefore, the immune response can then spread by either intramolecular diffusion (i.e., to other epitopes on the same protein) or by intermolecular diffusion (i.e., to epitopes on different proteins) [18]. *Polyclonal activation* occurs

when chronic immune system activation leads to the proliferation of B cells and immune complex formation circulation [18].

Finally, *vaccine adjuvants* (i.e., compounds added to vaccines as delivery systems or immune potentiators) have also been shown to cause adverse reactions, which are collectively referred to as *autoimmune/inflammatory syndrome induced by adjuvants* (ASIA) [23]. Of note, dozens of patients have been diagnosed with ASIA post-COVID-19 vaccination [24]. The mechanism of action of adjuvants in ASIA varied and included enhanced uptake of antigens, inflammasome activation, increased cell recruitment at the site of injection, and toll-like receptor activation [23]. Various adjuvants linked to ASIA include aluminum-based materials, mineral oils, and silicone compounds [23,25].

1.3. Autoimmunity, the neuroimmunoendocrine system, and COVID-19 vaccination

Moreover, another understudied area is the relationship between COVID-19 vaccinations and the neuroimmunoendocrine system. Psychoneuroimmunoendocrinology (PNIE) focuses on the relationship between structural/functional (e.g., nervous, immune, and endocrine systems) and psychological (e.g., cognition, emotion, and behaviour) aspects of the human organism, and is important to address the etiology and treatment of immune-mediated diseases for two reasons: (1) many immune-mediated diseases are characterized by the significant dysregulation of multiple organ systems, including high expression of proinflammatory cytokines, alterations of the blood-brain barrier (BBB), neuroinflammation, and changes in anabolic and/or catabolic hormones; and (2) many immune-mediated diseases involve feedback mechanisms, wherein psychological stressors can induce and/or exacerbate autoimmune disorders that, in turn, create significant psychological stress [26]. Thus, PNIE is critical to understanding autoimmunity during the COVID-19 crisis because of the significant and widespread psychological stressors, such as social isolation, which was experienced by populations following public-health countermeasures such as prolonged quarantines and mass lockdowns [27–30].

SARS-CoV-2 infections crossing the BBB and invading neurons and glia expressing angiotensin-converting enzyme 2 (ACE2) in the hypothalamic-pituitary region may cause autoimmune responses that can precipitate and/or exacerbate the hypothalamic-pituitary-adrenal (HPA) stress response system [26]. Additionally, corticoids released in the stress response play an important role in preventing damage to tissues through a negative feedback system that works to suppress the production and circulation of cytokines, including tumor necrosis factor α (TNF-α), interleukin 1 beta (IL-1β), and interleukin 6 (IL-6) involved in COVID-19 pathogenesis [26,31,32]. Specifically, it is thought that the virus disrupts normal HPA function through the induction of anti-adrenocorticotropic hormone (ACTH) antibodies, thus leading to reduced efficacy of the body's immune response [26]. The proposed mechanism for HPA autoimmunity is a molecular mimicry of amino acid sequences of the host ACTH [26]. Moreover, SARS-CoV-2 can induce mast cell activation, which has been associated with neuroinflammation, neurodegeneration, and psychological stress [32]. Additionally, increased neuroinflammatory responses could exacerbate pathology in individuals affected by other immune-mediated diseases such as multiple sclerosis (MS), amyotrophic lateral sclerosis (ALS), Huntington's disease, Alzheimer's disease (AD), and Parkinson's disease (PD) [32,33]. Dysregulation of the neuroimmunoendocrine system, which is critical in maintaining homeostasis during periods of stress, helps to explain the greater vulnerability of individuals with immune-mediated diseases and

immunosenescence to the combination of SARS-CoV-2 infection and significant psychological distress arising from governmental responses to the pandemic.

2. Materials and methods

2.1. Protocol design

Systematic or scoping reviews generally evaluate "interventions", although can also be performed to document and appraise broader phenomena from diverse sources (i.e., "phenomena of interest"). Our phenomenon of interest is the evidence for bidirectional relationships and underlying mechanisms between COVID-19 vaccinations and autoimmune disorders. To achieve our research objective, we will conduct a scoping review of the literature following Arksey and O'Malley's framework [34]. These authors propose that, in contrast to systematic reviews that "typically focus on a well-defined question where appropriate study designs can be identified in advance [and] provide answers to questions from a relatively narrow range of quality assessed studies", scoping reviews help to "address broader topics where many different study designs might be applicable [and are] "less likely to seek to address very specific research questions nor, consequently, to assess the quality of included studies", thus our choice of this review approach. Our analysis will be enhanced by Levac et al.'s team-based approach [35], which proposes that throughout the review, the process should be iterative and cooperative (i.e., "team-based"), from articulating a research question, identifying, and selecting relevant studies, charting the data and collating, summarizing, and reporting results. This approach should help to address unforeseen practical challenges, such as the need to refine inclusion/exclusion criteria as during the screening and selection process. This protocol was registered with the Open Science Framework, https://osf.io/n4gxz, DOI https://doi.org/10.17605/OSF.IO/N4GXZ. The scoping review will follow the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). Because the data are publicly available, no IRB approval is required.

2.2. Objectives of the review and review questions

Our broad objective is to appraise what the existing literature reports about the association between COVID-19 vaccines and autoimmune disorders, in general, and specifically concerning type 1 diabetes (T1DM), multiple sclerosis (MS), Hashimoto's thyroiditis, rheumatoid arthritis (RA), lupus, and Graves' disease. Specific objectives will address the following questions: (1) In persons with autoimmune disorders, either general or specific—type 1 diabetes mellitus (T1DM), rheumatoid arthritis (RA), multiple sclerosis (MS), systemic lupus erythematosus (SLE), Graves' disease, and Hashimoto's thyroiditis—can COVID-19 vaccination *trigger* autoimmune disorders?; (2) In persons with autoimmune disorders, either general or specific—type 1 diabetes mellitus (T1DM), rheumatoid arthritis (RA), multiple sclerosis (MS), systemic lupus erythematosus (SLE), Graves' disease, and Hashimoto's thyroiditis—can COVID-19 vaccinations *exacerbate* autoimmune disorders?; (3) Are persons with autoimmune disorders at a higher risk of experiencing additional autoimmune disorders compared to persons without autoimmune disorders?; (4) What are the mechanisms connecting autoimmune disorders with COVID-19 vaccination?; (5) Can COVID-19 vaccinations interact, either positively or negatively, with immunosuppressive therapy in persons with either general or specific

autoimmune disorders under treatment with this therapy?; (6) Does the risk of either general or specific autoimmune disorders following COVID-19 vaccinations differ by vaccine type, age, gender, or other still unidentified characteristics (e.g., SES)?; and (7) What is the consensus of care concerning COVID-19 vaccinations in persons with either general or specific autoimmune disorders, and what evidence informs it?

2.3. Data identification

2.3.1. Types of data

This scoping review will include articles in English that refer to the association between any type of COVID-19 vaccine and autoimmune disorders (listed under objectives) reporting on empirically verifiable clinical manifestations of autoimmunity, with no temporal or geographic restrictions, in populations of any age, sex/gender/race/ethnicity, socioeconomic class, or national origin, accessible through the libraries of the authors' academic/professional affiliations. To capture the broadest range of perspectives on the association between COVID-19 vaccines and autoimmune disorders, all articles, regardless of type (e.g., original article, case report, technical note) will be included, provided they meet the inclusion criteria [36].

2.3.2. Sources of data retrieval

We will retrieve data from (1) PubMed and the (2) WHO (World Health Organization) database. For PubMed, we will use the search MeSH Major Topic terms ["Hashimoto's Thyroiditis" OR "Graves' disease" OR "rheumatoid arthritis" OR "type 1 diabetes" OR "systemic lupus erythematosus" OR "multiple sclerosis" OR "autoimmunity" OR "autoimmune diseases" OR ''autoimmune disorders'']. These terms will be combined with ["COVID-19 vaccines"]. For the WHO search, the same terms will be searched as [Title, abstract, subject]. At the outset of the search, specific eligibility criteria will include the following: (i) between 2000 and 2023, (ii) English only, and (iii) pre-print or published." Reports by leading national and international health agencies—e.g., Centers for Disease Control and Prevention, and World Health Organization—will be used to contextualize the study.

2.3.3. Search methods for identifying data

Before including articles for assessment, we will conduct a preliminary screening of the literature search to discard irrelevant material. One reviewer will initially scan titles and remove those that do not meet the following inclusion criteria: (1) articles on the possible or actual association between any type of COVID-19 vaccine and any type of autoimmune disorder; (2) focus on empirically verifiable clinical manifestation of autoimmune disorders; (3) available through any of the library websites of author's affiliated universities; and (4) is in English. Next, two reviewers will independently scrutinize the remaining abstracts in relation to review objectives (as described earlier) and eliminate those that meet any of the following exclusion criteria: (1) not on COVID-19; (2) not on vaccines; (3) not on autoimmunity; (4) no identifiable clinical outcome; (5) no original or primary data; and (6) not in English. Where there is uncertainty in the abstract about the relevance of an article, a third reviewer will break the tie, and if needed, the full text will be retrieved.

2.3.4. Data selection

Once the abstract review process is complete, we will retrieve full copies of the selected articles for assessment. Two reviewers will independently determine if the articles meet the inclusion criteria. Disagreements will be resolved by full team discussion. We will monitor inter-rater reliability throughout the screening stage on a regular basis (after about one-fourth of retrieved articles are screened), and act if the reliability falls below 80% [37]. We will report these scores in the final review, maintain a clear record of the articles included and excluded at each stage of the process, and note the reasons for excluding specific articles. Articles that do not meet the inclusion criteria but include relevant contextual material (e.g., policy papers) may be narratively summarized in the background section of the final manuscript. Throughout the screening process, we will use the Rayyan literature review management software (https://www.rayyan.ai/) to (1) facilitate double-blind screening, (2) record inclusion and exclusion decisions, and (3) identify any disagreements between reviewers.

2.4. Data analysis and synthesis

2.4.1. Data charting

Data charting will be performed with a Microsoft Excel sheet and tailored to capture the phenomenon of interest. Outcomes will include the following: details about article type; data informing our phenomenon of interest (e.g., autoimmune manifestation; vaccine type; age of patient; clinical background); and contextual factors (e.g., country where event was reported). Data charting will be performed by two researchers. Before beginning full charting, two reviewers will independently chart data from a common sample of studies, and the team will meet to calibrate the approach and discuss results. Tables for all included articles will be created and included as appendices in the final review.

2.4.2. Data synthesis

In convergent synthesis designs, data is transformed into either qualitative or quantitative findings. In convergent *qualitative* synthesis, our chosen approach results from diverse methodologies and are transformed into qualitative findings such as concepts, patterns, and themes [38,39]. In this scoping review, data will be synthesized through descriptive numerical summaries, which describe general characteristics of included studies, and a thematic analysis [34].

2.4.3. Subgroup analysis

A subgroup analysis of the primary outcomes will be performed to compare findings according to the following: (1) the previous existence of an autoimmune disorder; (2) the presence of relevant co-morbidities [40]; (3) vaccine type; and (4) other relevant factors that we may encounter as the research proceeds.

2.4.4. Assessment of risk of bias

Scoping reviews chart the evidence concerning a particular subject, pinpoint core concepts, theories, sources, and areas where gaps in knowledge exist, and offer a comprehensive outlook on existing evidence, without considering the methodological quality of charted articles. As a result, sources of evidence in this scoping review will not be subjected to a quality assessment.

3. Discussion and conclusions

As noted in the *Science* article mentioned earlier, the "Post-COVID" or "Long COVID" and the "Long Vax" syndromes share a range of symptoms, such as persistent cough, shortness of breath, and chest pain, severe and chronic fatigue, sleep disorders, headaches, and cognitive impairments, including compromised concentration and memory loss [21,24]. In both cases, these symptoms could be related to the accumulation of the SARS-CoV-2 spike protein in the blood vessel epithelium which comprise the blood-brain-barrier (BBB) and further lead to signs of encephalomyelitis/chronic fatigue syndrome (ME/CFS) [24]. It follows that COVID-19 vaccinations could operate through spike protein production that further compromises neuroimmunoendocrine function by producing novel autoantibodies [21]. In conclusion, COVID-19 has triggered the largest vaccination campaign in world history, targeting literally the global human community. Drug safety is a crucial aspect of any medical intervention, critical to a proper assessment of the balance of risks and benefits. Our investigation should yield information useful to inform further research, as well as improve medical and public health practice in multiple ways, including assisting in clinical decision-making, policy development, and ethical medical practice.

4. Preliminary timeframe

An eight-month frame will be dedicated to data gathering, selection, charting, and manuscript drafting, with a tentative completion date of April 2024.

Use of AI tools declaration

The authors declare that they have not used Artificial Intelligence (AI) tools in the creation of this article.

Authors' contributions

CCH designed the scoping review, wrote the protocol, and will oversee, and participate in, every step of the project until the completion and publication of the umbrella review. LM assisted with the study design and protocol drafting, provided expertise in neuroimmunoendocrinology, and will participate in article selection, data charting/synthesis/analysis, and final review writing. CH assisted with the study design, provided expertise in methodology, conducted the first round of data screening, and will participate in article selection, data charting/synthesis/analysis, and final review writing. JM assisted with the study design and will participate in article selection, data charting/synthesis/analysis, and final review writing. All the authors have read and approved the final version of this protocol.

Acknowledgments

This work has been partially funded by a New Frontiers in Research Fund (NFRF) 2022 Special Call, NFRFR-2022-00305.

Conflict of interest

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article. Funders and professional/academic affiliations have played no role in its conception, or decision to conduct the research, or submit it for publication.

References

1. Alwan NA, Burgess RA, Ashworth S, et al. (2020) Scientific consensus on the COVID-19 pandemic: We need to act now. *Lancet* 396: e71–e72. https://doi.org/10.1016/S0140-6736(20)32153-X
2. Centers for Disease Control and Prevention, Benefits of Getting a COVID-19 Vaccine. USA Centers for Disease Control and Prevention, 2020. Available from: https://web.archive.org/web/20201124234740/https://www.cdc.gov/coronavirus/2019-ncov/vaccines/vaccine-benefits.html. Accessed on 12 Nov. 2023.
3. WHO, WHO Director-General's opening remarks at the media briefing on COVID-19—4 September 2020. WHO, 2020. Available from: https://web.archive.org/web/20200906210508/https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---4-september-2020. Accessed on 12 Nov. 2023.
4. Velikova T, Georgiev T (2021) SARS-CoV-2 vaccines and autoimmune diseases amidst the COVID-19 crisis. *Rheumatol Int* 41: 509–518. https://doi.org/10.1007/s00296-021-04792-9
5. Vogel G, Couzin-Frankel J (2023) Studies probe COVID-19 shots' link to rare symptoms. *Science* 381: 18–19. https://doi.org/10.1126/science.adj5607
6. Rocco A, Sgamato C, Compare D, et al. (2021) Autoimmune hepatitis following SARS-CoV-2 vaccine: May not be a casuality. *J Hepatol* 75: 728–729. https://doi.org/10.1016/j.jhep.2021.05.038
7. McShane C, Kiat C, Rigby J, et al. (2021) The mRNA COVID-19 vaccine—A rare trigger of autoimmune hepatitis?. *J Hepatol* 75: 1252–1254. https://doi.org/10.1016/j.jhep.2021.06.044
8. Nguyen S, Bastien E, Chretien B, et al. (2022) Transverse myelitis following SARS-CoV-2 vaccination: A pharmacoepidemiological study in the world health organization's database. *Ann Neurol* 92: 1080–1089. https://doi.org/10.1002/ana.26494
9. Nushida H, Ito A, Kurata H, et al. (2023) A case of fatal multi-organ inflammation following COVID-19 vaccination. *Leg Med* 63: 102244. https://doi.org/10.1016/j.legalmed.2023.102244
10. Moon H, Suh S, Park MK (2023) Adult-onset type 1 diabetes development following COVID-19 mRNA vaccination. *J Korean Med Sci* 38: e12. https://doi.org/10.3346/jkms.2023.38.e12
11. British Society for Rheumatology, Principles for COVID-19 Vaccination in Musculoskeletal and Rheumatology for Clinicians. UK British Society for Rheumatology, 2022. Available from: http://arma.uk.net/covid-19-vaccination-and-msk/. Accessed on 20 Jul. 2023.

12. Curtis JR, Johnson SR, Anthony DD, et al. (2023) American College of Rheumatology Guidance for COVID-19 vaccination in patients with rheumatic and musculoskeletal diseases: Version 5. *Arthritis Rheumatology* 75: E1–E16. https://doi.org/10.1002/art.42372
13. Canadian Rheumatology Association, CRA GRADE Recommendation on Covid-19 Vaccination and Feedback Survey. Canada Canadian Rheumatology Association, 2021. Available from: https://rheum.ca/resources/cra-grade-recommendation-on-covid-19-vaccination-and-feedback-survey/. Accessed on 20 Jul. 2023.
14. Public Health Agency of Canada, Immunization of persons with chronic diseases: Canadian Immunization Guide. Canada Public Health Agency of Canada, 2023. Available from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-3-vaccination-specific-populations/page-7-immunization-persons-with-chronic-diseases.html. Accessed on 20 Jul. 2023.
15. Cooper GS, Stroehla BC (2003) The epidemiology of autoimmune diseases. *Autoimmun Rev* 2: 119–125. https://doi.org/10.1016/S1568-9972(03)00006-5
16. Wraith DC, Goldman M, Lambert PH (2003) Vaccination and autoimmune disease: What is the evidence?. *Lancet* 362: 1659–1666. https://doi.org/10.1016/S0140-6736(03)14802-7
17. Rodríguez Y, Rojas M, Beltrán S, et al. (2022) Autoimmune and autoinflammatory conditions after COVID-19 vaccination. New case reports and updated literature review. *J Autoimmun* 132: 102898. https://doi.org/10.1016/j.jaut.2022.102898
18. Guo M, Liu X, Chen X, et al. (2023) Insights into new-onset autoimmune diseases after COVID-19 vaccination. *Autoimmun Rev* 22: 103340. https://doi.org/10.1016/j.autrev.2023.103340
19. Moody R, Wilson K, Flanagan KL, et al. (2021) Adaptive immunity and the risk of autoreactivity in COVID-19. *Int J Mol Sci* 22: 8965. https://doi.org/10.3390/ijms22168965
20. Chen Y, Xu Z, Wang P, et al. (2022) New-onset autoimmune phenomena post-COVID-19 vaccination. *Immunology* 165: 386–401. https://doi.org/10.1111/imm.13443
21. Mahroum N, Elsalti A, Alwani A, et al. (2022) The mosaic of autoimmunity—Finally discussing in person. The 13th international congress on autoimmunity 2022 (AUTO13) Athens. *Autoimmun Rev* 21: 103166. https://doi.org/10.1016/j.autrev.2022.103166
22. Agmon-Levin N, Paz Z, Israeli E, et al. (2009) Vaccines and autoimmunity. *Nat Rev Rheumatol* 5: 648–652. https://doi.org/10.1038/nrrheum.2009.196
23. Pellegrino P, Clementi E, Radice S (2015) On vaccine's adjuvants and autoimmunity: Current evidence and future perspectives. *Autoimmun Rev* 14: 880–888. https://doi.org/10.1016/j.autrev.2015.05.014
24. Jara LJ, Vera-Lastra O, Mahroum N, et al. (2022) Autoimmune post-COVID vaccine syndromes: Does the spectrum of autoimmune/inflammatory syndrome expand?. *Clin Rheumatol* 41: 1603–1609. https://doi.org/10.1007/s10067-022-06149-4
25. Seida I, Seida R, Elsalti A, et al. (2023) Vaccines and autoimmunity—from side effects to ASIA syndrome. *Medicina* 59: 364. https://doi.org/10.3390/medicina59020364
26. Bellastella G, Cirillo P, Carbone C, et al. (2022) Neuroimmunoendocrinology of SARS-CoV-2 infection. *Biomedicines* 10: 2855. https://doi.org/10.3390/biomedicines10112855
27. Allen DW (2022) Covid-19 lockdown cost/benefits: A critical assessment of the literature. *Int J Econ Bus* 29: 1–32. https://doi.org/10.1080/13571516.2021.1976051
28. Bzdok D, Dunbar RIM (2020) The neurobiology of social distance. *Trends Cogn Sci* 24: 717–733. https://doi.org/10.1016/j.tics.2020.05.016

29. Loades ME, Chatburn E, Higson-Sweeney N, et al. (2020) Rapid systematic review: the impact of social isolation and loneliness on the mental health of children and adolescents in the context of COVID-19. *J Am Acad Child Adolesc Psychiatry* 59: 1218–1239.e3. https://doi.org/10.1016/j.jaac.2020.05.009
30. Sikali K (2020) The dangers of social distancing: how COVID-19 can reshape our social experience. *J Community Psychol* 48: 2435–2438. https://doi.org/10.1002/jcop.22430
31. Jara LJ, López-Zamora B, Ordoñez-González I, et al. (2021) The immune-neuroendocrine system in COVID-19, advanced age and rheumatic diseases. *Autoimmun Rev* 20: 102946. https://doi.org/10.1016/j.autrev.2021.102946
32. Kempuraj D, Selvakumar GP, Ahmed ME, et al. (2020) COVID-19, mast cells, cytokine storm, psychological stress, and neuroinflammation. *Neuroscientist* 26: 402–414. https://doi.org/10.1177/1073858420941476
33. Ortega MA, García-Montero C, Fraile-Martinez O, et al. (2022) Immune-mediated diseases from the point of view of psychoneuroimmunoendocrinology. *Biology* 11: 973. https://doi.org/10.3390/biology11070973
34. Arksey H, O'Malley L (2005) Scoping studies: towards a methodological framework. *Int J Soc Res Method* 8: 19–32. https://doi.org/10.1080/1364557032000119616
35. Levac D, Colquhoun H, O'Brien KK (2010) Scoping studies: advancing the methodology. *Implement Sci* 5: 69. https://doi.org/10.1186/1748-5908-5-69
36. Peh WC, Ng KH (2008) Basic structure and types of scientific papers. *Singapore Med J* 49: 522–525.
37. Shea BJ, Hamel C, Wells GA, et al. (2009) AMSTAR is a reliable and valid measurement tool to assess the methodological quality of systematic reviews. *J Clin Epidemiol* 62: 1013–1020. https://doi.org/10.1016/j.jclinepi.2008.10.009
38. Braun V, Clarke V (2006) Using thematic analysis in psychology. *Qual Res Psychol* 3: 77–101. https://doi.org/10.1191/1478088706qp063oa
39. Thomas J, Harden A (2008) Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Med Res Methodol* 8: 45. https://doi.org/10.1186/1471-2288-8-45
40. Justino DCP, Silva DFO, da Silva Costa KT, et al. (2022) Prevalence of comorbidities in deceased patients with COVID-19: A systematic review. *Medicine* 101: e30246. https://doi.org/10.1097/MD.0000000000030246

AIMS Press