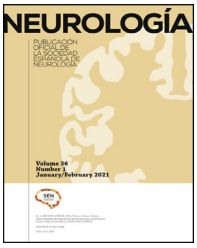
Neurología xxx (xxxx) xxx—xxx

NEUROLOGÍA

www.elsevier.es/neurologia



REVIEW ARTICLE

Incidence of Bell's palsy after coronavirus disease (COVID-19) vaccination: a systematic review and meta-analysis

Atena Soltanzadi[a], Omid Mirmosayyeb[b], Amin Momeni Moghaddam[a], Hamed Ghoshouni[b], Mahsa Ghajarzadeh[c,d,*]

[a] *Radiology Department, Taleghani Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran*
[b] *Isfahan Neurosciences Research Center, Isfahan University of Medical Sciences, Isfahan, Iran*
[c] *Multiple Sclerosis Research Center, Neuroscience Institute, Tehran University of Medical Sciences, Tehran, Iran*
[d] *Universal council of epidemiology (UCE), Universal Scientific Education and Research Network (USERN), Tehran University of Medical Sciences, Tehran, Iran*

Received 12 April 2022

KEYWORDS
Bell palsy;
Incidence;
COVID-19 vaccines

Resumen

Objetivo: Estimar la incidencia agrupada de la parálisis de Bell después de la vacunación contra el COVID-19.

Métodos: Realizamos búsquedas sistemáticas (dos investigadores independientes) en PubMed, Scopus, EMBASE, Web of Science y Google Scholar. También se realizaron búsquedas en la literatura gris, incluidas las referencias de las referencias y los resúmenes de congresos. Extrajimos datos sobre el número total de participantes, el primer autor, el año de publicación, el país de origen, femenino/masculino, el tipo de vacunas y el número de pacientes que desarrollaron parálisis de Bell después de la vacunación contra el COVID-19.

Resultados: La búsqueda bibliográfica reveló 370 artículos, eliminando posteriormente los duplicados que quedaban 227. Después de una cuidadosa evaluación de los textos completos, quedaron veinte artículos para el metanálisis. Las vacunas más comúnmente administradas fueron Pfizer seguida de Moderna.

En total, 4,54e+07 personas recibieron vacunas contra la COVID-19 y 1739 casos desarrollaron parálisis de Bell. En nueve estudios, se inscribieron controles (individuos sin vacunación). El número total de controles fue de 1809069, de los cuales 203 desarrollaron parálisis de Bell. La incidencia de la parálisis de Bell después de las vacunas COVID-19 fue ignorable. La probabilidad de desarrollar parálisis de Bell después de las vacunas contra la COVID-19 fue de 1,02 (IC 95 %: 0,79-1,32) (I2 = 74,8 %, p < 0,001).

DOI of refers to article: https://doi.org/10.1016/j.nrl.2022.10.002.
* Corresponding author.
E-mail address: m.ghajarzadeh@gmail.com (M. Ghajarzadeh).

https://doi.org/10.1016/j.nrleng.2023.06.002
2173-5808/© 2023 Sociedad Española de Neurología. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Please cite this article as: A. Soltanzadi, O. Mirmosayyeb, A. Momeni Moghaddam et al., Incidence of Bell's palsy after coronavirus disease (COVID-19) vaccination: a systematic review and meta-analysis, *Neurología*, https://doi.org/10.1016/j.nrleng.2023.06.002

Conclusión: los resultados de esta revisión sistemática y metanálisis muestran que la incidencia de parálisis facial periférica después de la vacunación contra el COVID-19 es despreciable y que la vacunación no aumenta el riesgo de desarrollar parálisis de Bell. Tal vez, la parálisis de Bell es un síntoma de presentación de una forma más grave de COVID-19, por lo que los médicos deben ser conscientes de esto.
© 2023 Sociedad Española de Neurología. Publicado por Elsevier España, S.L.U. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (http://creativecommons.org/licenses/by-nc-nd/4.0/).

PALABRAS CLAVE
Parálisis de Bell;
Incidencia;
Vacunas COVID-19

Incidencia de la parálisis de Bell después de la vacunación contra la COVID-19: una revisión sistemática y un metanálisis

Abstract
Objective: To estimate the pooled incidence of Bell's palsy after COVID-19 vaccination.
Methods: PubMed, Scopus, EMBASE, Web of Science, and Google Scholar were searched by 2 independent researchers. We also searched the grey literature including references of the references and conference abstracts. We extracted data regarding the total number of participants, first author, publication year, the country of origin, sex, type of vaccines, and the number of patients who developed Bell's palsy after COVID-19 vaccination.
Results: The literature search revealed 370 articles, subsequently deleting duplicates 227 remained. After careful evaluation of the full texts, 20 articles remained for meta-analysis. The most commonly administered vaccines were Pfizer followed by Moderna.

In total, 4.54e+07 individuals received vaccines against COVID-19, and 1739 cases developed Bell's palsy. In nine studies, controls (individuals without vaccination) were enrolled. The total number of controls was 1 809 069, of whom 203 developed Bell's palsy. The incidence of Bell's palsy after COVID-19 vaccines was ignorable. The odds of developing Bell's palsy after COVID-19 vaccines was 1.02 (95% CI: 0.79-1.32) (I2 = 74.8%, $P < .001$).
Conclusion: The results of this systematic review and meta-analysis show that the incidence of peripheral facial palsy after COVID-19 vaccination is ignorable and vaccination does not increase the risk of developing Bell's palsy. Maybe, Bell's palsy is a presenting symptom of a more severe form of COVID-19, so clinicians must be aware of this.
© 2023 Sociedad Española de Neurología. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

In December 2019, a new coronavirus was detected in Wuhan, China which spread rapidly all over the world.[1] It is in the pandemic stage and different vaccines have been developed to stop the pandemic.[2] The European Medicines Agency, the US Food and Drug Administration, and the UK Medicines and Healthcare products Regulatory Agency have approved various types of vaccines since December 2020.[2] Each vaccine has its safety and efficacy profiles which raises the necessity for careful evaluation. The side effects have a wide range from injection site pain (swelling) to extreme reactions such as anaphylaxis.[3,4] Neurological complications have been reported after COVID-19 vaccination including Guillain-Barré syndrome (GBS), neuromyelitis optica spectrum disorders (NMOSD), transverse myelitis, multiple sclerosis (MS), thrombosis with thrombocytopenia syndrome, and Bell's palsy.[5–10]

Bell's palsy is acute peripheral facial nerve with unknown aetiology and sudden onset of unilateral peripheral facial paralysis.[10] It is transient and more than half of the affected patients recover within 6 months without treatment.[11] The relationship between vaccination and incidence of Bell's palsy is unclear while mimicry of host molecules by the vaccinal antigen could be the possible explanation.[12] Up to now, different studies reported various incidence rates of Bell's palsy after vaccination with different vaccines.[13–16] So, we designed this systematic review and meta-analysis to estimate the pooled incidence of Bell's palsy after COVID-19 vaccination.

Methods

PubMed, Scopus, EMBASE, Web of Science, and Google Scholar were searched by 2 independent researchers. We also searched the grey literature including references of the references and conference abstracts by 10th February 2022.

After deleting duplicates, we screened the titles and abstracts of the potential studies and in the case of discrepancy, they asked the third one to solve the disagreement.

Then the full texts of the remained studies were assessed and the data were extracted. The extracted data were

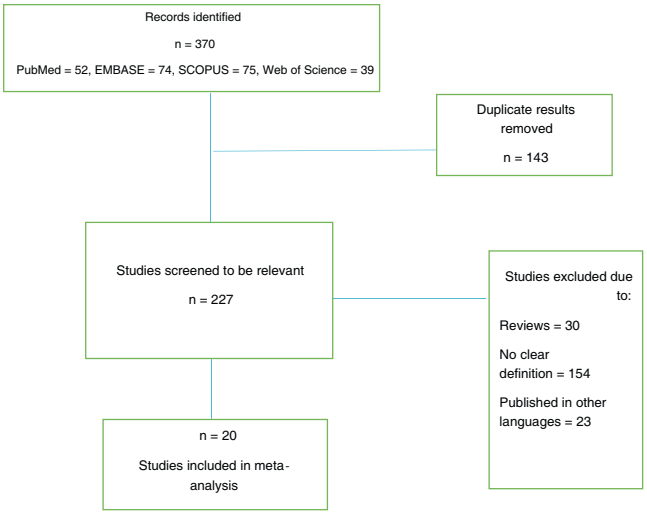


Figure 1 Flow diagram of including studies.

entered in a datasheet and the third one checked the data of two sources.

We extracted data regarding the total number of participants, first author, publication year, the country of origin, sex, type of vaccines, and the number of patients who developed Bell's palsy after COVID-19 vaccination.

The MeSH terms which were used for searching in the PubMed are attached in a supplementary file.

Inclusion criteria were: retrospective/prospective cohort studies which reported incidence of facial palsy after vaccination, articles published in English.

Exclusion criteria were: Letters to the editor, case-control, case reports, and cross-sectional studies which had no clear data.

Risk of bias assessment: Newcastle-Ottawa Scale (NOS) (adapted for cohort studies).[17]

Statistical analysis

All statistical analyses were performed using STATA (Version 14.0; Stata Corp LP, College Station, TX, USA.

To determine heterogeneity, inconsistency (I^2) was calculated.

We used random-effects model for meta-analysis as the heterogeneity between study results (I^2) was more than 50%.

Results

The literature search revealed 370 articles, subsequently after deleting duplicates 227 remained. After careful evaluation of the full texts, 20 articles remained for meta-analysis (Fig. 1).

The most commonly administered vaccines were Pfizer (in 16 studies [80%]) followed by Moderna (4 [25%]).

In total, 4.54e+07 individuals received vaccines against COVID-19, and 1739 cases developed Bell's palsy

Totally 1.79e+07 patients received Pfizer vaccines and 429 cases developed Bell's palsy. In 12 studies, it was determined the dose of the vaccines (first or second). In 9 studies, controls (individuals without vaccination) were enrolled. The total number of controls was 1 809 069, of whom203 developed Bell's palsy. The quality assessment scores of included studies ranged between 6 and 8 (Table 1).

The incidence of Bell's palsy after COVID-19 vaccines was ignorable (Fig. 2).

The odds of developing Bell's palsy after COVID-19 vaccines was 1.02 (95% CI: 0.79-1.32) (I^2 = 74.8%, P <0.001) (Fig. 3) (only 9 studies had controls).

Table 1 Basic characteristics of included studies.

Author/ year/ country	All vac	Male/ female/ unknown All vac	Vac type/ dose	Bell's palsy vac	Male/female Bell's palsy	Vac type/ dose Bell's palsy	All controls	Controls Bell's palsy	NOS score
Barbara H. Bardenheier/2021/ USA[18]	8275	Unknown	Pf = 5842 Mod = 2433	1	1/0	Pf : 1 1st = 1 2nd = 0 Mod = 0	11 072	0	8
Joshua TC Tan/2021/ Singapore[15]	64 661	59 574/4929/ 158	Pf : 37 367 1st = 37 367 2nd = 37 162 Mod : 27 294 1st = 27 294 2nd = 25 258	1	1/0	Pf : 1 1st = 1 2nd = 0 Mod : 0			7
Rana Shibli/2021/ Israel[19]	2 594 990	1 256 958/1 338 032	Pf 1st = 2 594 990 2nd = 2 434 674	284	153/131	Pf 1st = 132 2nd = 152			7
Filippos Filippatos/2021/ Greece[20]	502	393/109	Pf 2nd	1	1/0	Pf 1st = 0 2nd = 1			6
Eric Yuk Fai Wan/2022/ Hong Kong[10]	989 144	Unknown	Pf : 537 205 1st = 537 205 2nd = 247 957 CoronaVac : 451 939 1nd = 451 939 2nd = 324 632	44	29/15	Pf : 16 1st = 8 2nd = 8 CoronaVac : 28 1st = 19 2nd = 9			7
G. Gómez de Terreros Caro/ 2021/Spain[21]	877	Unknown	Pf 2nd	1	1/0	Pf 1st = 1 2nd = 0			6
H.M. El Sahly/2021/USA[22]	15 180	7917/7263	Mod	8		Mod 1st = 0	15 166	3	8

Table 1 (*Continued*)

Author/ year/ country	All vac	Male/ female/ unknown All vac	Vac type/ dose	Bell's palsy vac	Male/female Bell's palsy	Vac type/ dose Bell's palsy	All controls	Controls Bell's palsy	NOS score
						2nd = 8			
Jasmine Shimin Koh/ 2021/Singapore[14]	1 398 074	761 950/636 124	Pf : 1 212 130 Mod : 185 944 1st = 1 398 074 2nd = 915 344	11	5/6	Pf = 11 Mod = 0 1st = 6 2nd = 5			7
Nagla A El-Shitany/2021/Saudi Arabia[23]	455	163/292	Pf 1st = 203 2nd = 252	3		Pf 1st = 3 2nd = 0			7
Francisco Tsz Tsun Lai/2022/ Hong Kong[24]	335 620	161 467/174 153	Pf : 153 178 CoronaVac : 182 442 1st	13		Pf : 4 1st = 4 2nd = 0 CoronaVac: 9 1st = 9 2nd = 0	547 796	24	8
Martina Patone/2021/UK[25]	32 552 534	14 219 053/16 759 298/1 574 183	Pf : 12 134 782 AZD : 20 417 752 1st	685	319/366	Pf : 250 1st = 250 2nd = 0 AZD : 435 1st = 435 2nd = 0			7
Reid McMurry/2021/ USA[26]	68 266	28 408/39 857/1	Pf : 51 795 1st = 51 795 2nd = 39 058 Mod : 16 471 1st = 16 471 2nd = 11 851	26		Pf : 22 1st = 14 2nd = 8 Mod : 4 1st = 2 2nd = 2	68 266	75	8
David Shasha/2022/ Israel[27]	231 159	114 634/118 525	Pf	31		Pf	233 159	36	8

Table 1 (*Continued*)

Author/ year/ country	All vac	Male/ female/ unknown All vac	Vac type/ dose	Bell's palsy vac	Male/female Bell's palsy	Vac type/ dose Bell's palsy	All controls	Controls Bell's palsy	NOS score
			1st = 233 159 2nd = 131 033			1st = 23 2nd = 8			
Youn Young Choi/2021/Korea[28]	638	283/355	Pf	1	1/0	Pf			6
			1st = 638 2nd = 580			1st = 1 2nd = 0			
Noam Barda/2021/Israel[29]	884 828	461 590/423 238	Pf	81		Pf	884 828	59	8
Nicola P. Klein/2021/USA[30]	6 175 813	2 830 791/33 45 022	Pf : 3 539 611	535		mRNA(Pf/Mod)			7
			1st = 3 539 611 2nd = 3 214 737 Mod : 2 636 202 1st = 2 636 202 2nd = 2 454 578						
Merryn Voysey/2021/ Multicentre[16]	12 021	Unknown.	AZD	3			11 724	3	8
J. Sadoff/2021/ Multicentre	21 895	12 071/9820/4	J&J Single dose	3		J&J	21 888	2	8
Fernando P. Polack/ 2020/Multicentre[3]	18 860	9639/9221	Pf	4		Pf			7
			1st = 18 860 2nd = 18 556						
L.R. Baden/2021/USA[13]	15 181	7923/7258	Mod 1st = 15 181 2nd = 14 711	3		Mod	15 170	1	8

Pf = Pfizer, Mod = Moderna, AZD = AstraZeneca.
UK: United Kingdom.
The incidence of Bell's palsy after COVID-19 vaccines was ignorable (Fig. 2).

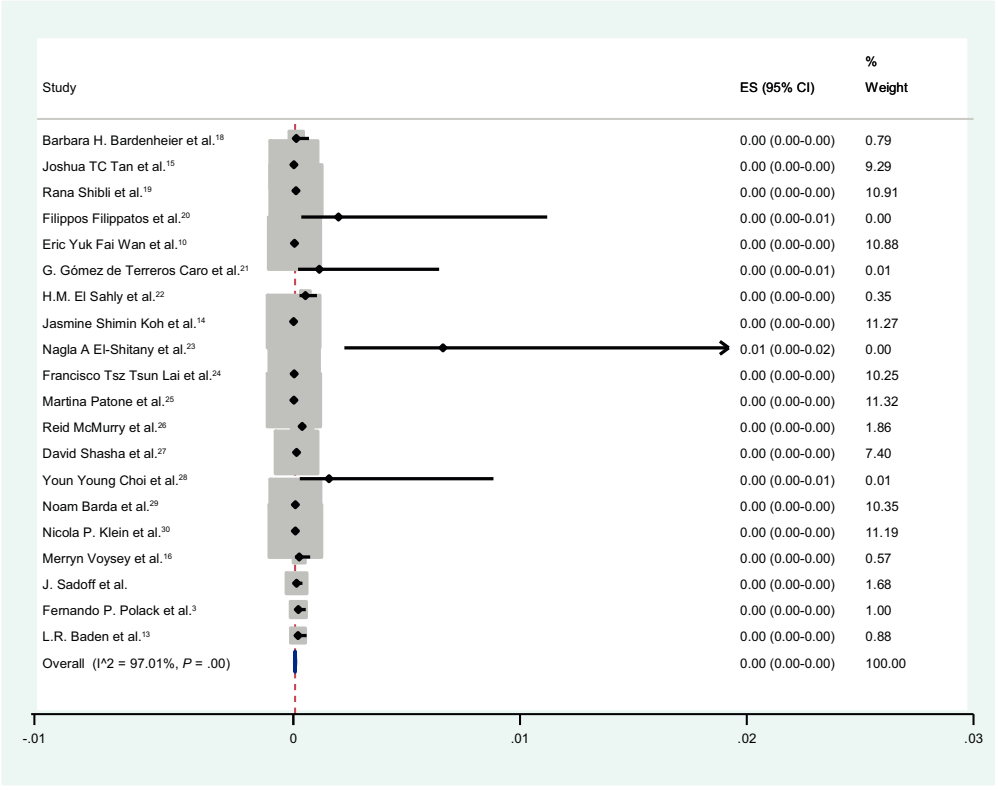


Figure 2 The incidence of Bell's palsy after COVID-19 vaccines.

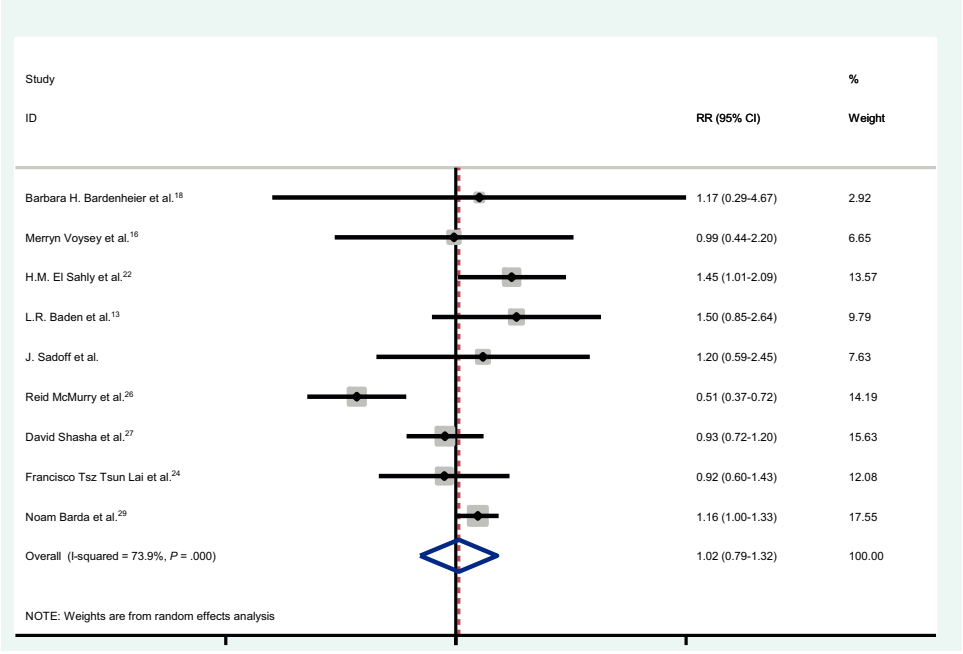


Figure 3 The odds of developing Bell's palsy after COVID-19 vaccines.

Discussion

To our knowledge, this is the first systematic review and meta-analysis estimating the pooled incidence of Bell's palsy after COVID-19 vaccines. The results show that the pooled incidence is ignorable and administration of the COVID-19 vaccines does not increase the risk of developing Bell's palsy.

In a multi-centric study in the USA which was conducted by Baden et al.,[13] 15 181 individuals who received Moderna vaccine and 15 170 controls were evaluated. Their results show that 3 individuals in the vaccinated group and one in the control group developed Bell's palsy.[13] The odds of developing Bell's palsy in their study was 1.5, which was not significant (95% CI: 0.85-2.6).

McMurry et al.[26] enrolled 68 266 vaccinated individuals and 68 266 controls. In their study, the incidence of Bell's palsy was higher among controls which suggested that administration of COVID-19 vaccines decreases the risk of Bell's palsy (OR = 0.51, 95% CI: 0.37-0.72).[26]

In another large study which was conducted in Israel, Barda et al.[29] recruited 884 828 vaccinated and the same number of controls. The incidence of Bell's palsy was higher in the vaccinated group while there was no significant association between Bell's palsy and COVID-19 vaccination.[29]

Association between vaccination and Bell's palsy occurrence had been reported previously. Strong associations were reported between the intranasal inactivated influenza vaccine and also influenza H1N1 monovalent vaccine.[31,32] The aetiology of Bell's palsy after vaccination is not fully understood while there are some hypotheses that re-activation of a herpes virus infection, mimicry of host molecules, or activation of dormant auto-reactive T cells play a role.[12] As the results of this systematic review show, there is no association between COVID-19 vaccination and Bell's palsy.

A new study shows that the incidence of neurological adverse effects after COVID-19 infection is higher than rates of neurological complications after vaccination, besides serious neurological adverse effects are rare.[33]

In all included studies in this systematic review, Pfizer, Moderna, and AstraZeneca vaccines were used. Pfizer and Moderna are mRNA vaccines while the Oxford-AstraZeneca vaccine is an adenoviral (ChAdOx1) vector-based COVID-19 vaccine with a wide range of complications including thrombosis with thrombocytopenia syndrome, transverse myelitis, Guillain-Barré syndrome, etc.[34–36] In only two included studies AstraZeneca was administered which showed no significant association between vaccination and Bell's palsy.

This study had some strengths. First, it is the first systematic review and meta-analysis in this field. Second, we estimated the odds of developing Bell's palsy after vaccination.

Conclusion

The results of this systematic review and meta-analysis show that the incidence of peripheral facial palsy after COVID-19 vaccination is ignorable and vaccination does not increase the risk of developing Bell's palsy. Maybe, Bell's palsy is a presenting symptom of a more severe form of COVID-19, so clinicians must be aware of this.

References

1. Moghadasi AN, Mirmosayyeb O, Barzegar M, Sahraian MA, Ghajarzadeh M. The prevalence of COVID-19 infection in patients with multiple sclerosis (MS): a systematic review and meta-analysis. Neurol Sci. 2021;42(8):3093—9.
2. Li X, Ostropolets A, Makadia R, Shoaibi A, Rao G, Sena AG, et al. Characterising the background incidence rates of adverse events of special interest for covid-19 vaccines in eight countries: multinational network cohort study. BMJ. 2021;373.
3. Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. N Engl J Med. 2020:2603—15.
4. Kim JH, Marks F, Clemens JD. Looking beyond COVID-19 vaccine phase 3 trials. Nat Med. 2021;27(2):205—11.
5. Čenščák D, Ungermann L, Štětkářová I, Ehler E. Guillan-Barré syndrome after the first vaccination dose against COVID-19: case report. Acta Med. 2021;64(3):183—6.
6. Chen S, Fan X-R, He S, Zhang J-W, Li S-J. Watch out for neuromyelitis optica spectrum disorder after inactivated virus vaccination for COVID-19. Neurol Sci. 2021;42(9):3537—9.
7. Khan E, Shrestha AK, Colantonio MA, Liberio RN, Sriwastava S. Acute transverse myelitis following SARS-CoV-2 vaccination: a case report and review of literature. J Neurol. 2021:1—12.
8. Khayat-Khoei M, Bhattacharyya S, Katz J, Harrison D, Tauhid S, Bruso P, et al. COVID-19 mRNA vaccination leading to CNS inflammation: a case series. J Neurol. 2021:1—14.
9. Kragholm K, Sessa M, Mulvad T, Andersen MP, Collatz-Christensen H, Blomberg SN, et al. Thrombocytopenia after COVID-19 vaccination. J Autoimmun. 2021;123:102712.
10. Wan EYF, Chui CSL, Lai FTT, Chan EWY, Li X, Yan VKC, et al. Bell's palsy following vaccination with mRNA (BNT162b2) and inactivated (CoronaVac) SARS-CoV-2 vaccines: a case series and nested case-control study. Lancet Infect Dis. 2022;22(1):64—72.
11. Peitersen E. Natural history of Bell's palsy. Acta Otolaryngol. 1992;112(sup492):122—4.
12. Principi N, Esposito S. Do vaccines have a role as a cause of autoimmune neurological syndromes? Front Public Health. 2020;361:361.
13. Baden LR, El Sahly HM, Essink B, Kotloff K, Frey S, Novak R, et al. Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine. N Engl J Med. 2020.
14. Koh JS, Hoe RHM, Yong MH, Chiew HJ, Goh Y, Yong KP, et al. Hospital-based observational study of neurological disorders in patients recently vaccinated with COVID-19 mRNA vaccines. J Neurol Sci. 2021;430:120030.
15. Tan JT, Tan C, Teoh J, Wahab M, Tan GZ, Chin RYZ, et al. Adverse reactions and safety profile of the mRNA COVID-19 vaccines among Asian military personnel. Ann Acad Med Singap. 2021;50(11):827—37.
16. Voysey M, Clemens SAC, Madhi SA, Weckx LY, Folegatti PM, Aley PK, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. Lancet. 2021;397(10269):99—111.
17. Wells G, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. Newcastle-Ottawa quality assessment scale cohort studies. University of Ottawa; 2014.
18. Bardenheier BH, Gravenstein S, Blackman C, Gutman R, Sarkar IN, Feifer RA, et al. Adverse events following mRNA SARS-CoV-2 vaccination among US nursing home residents. Vaccine. 2021;39(29):3844—51.

19. Shibli R, Barnett O, Abu-Full Z, Gronich N, Najjar-Debbiny R, Doweck I, et al. Association between vaccination with the BNT162b2 mRNA COVID-19 vaccine and Bell's palsy: a population-based study. Lancet Reg Health Europe. 2021;11:100236.
20. Filippatos F, Tatsi E-B, Dellis C, Dessypris N, Syriopoulou V, Michos A. Association of clinical and epidemiological characteristics with COVID-19 BNT162b2 mRNA vaccine short-term adverse reactions in healthcare workers. Human Vaccines Immunother. 2021:1—6.
21. de Terreros Caro GG, Díaz SG, Alé MP, Gimeno MM. Bell's palsy following COVID-19 vaccination: a case report. Neurologia (Barcelona, Spain). 2021:567—8.
22. El Sahly HM, Baden LR, Essink B, Doblecki-Lewis S, Martin JM, Anderson EJ, et al. Efficacy of the mRNA-1273 SARS-CoV-2 vaccine at completion of blinded phase. N Engl J Med. 2021;385(19):1774—85.
23. El-Shitany NA, Harakeh S, Badr-Eldin SM, Bagher AM, Eid B, Almukadi H, et al. Minor to moderate side effects of Pfizer-BioNTech COVID-19 vaccine among Saudi residents: a retrospective cross-sectional study. International journal of general medicine. 2021;14:1389.
24. Lai FTT, Huang L, Chui CSL, Wan EYF, Li X, Wong CKH, et al. Multimorbidity and adverse events of special interest associated with Covid-19 vaccines in Hong Kong. Nat Commun. 2022;13(1):1—8.
25. Patone M, Handunnetthi L, Saatci D, Pan J, Katikireddi SV, Razvi S, et al. Neurological complications after first dose of COVID-19 vaccines and SARS-CoV-2 infection. Nat Med. 2021;27(12):2144—53.
26. McMurry R, Lenehan P, Awasthi S, Silvert E, Puranik A, Pawlowski C, et al. Real-time analysis of a mass vaccination effort confirms the safety of FDA-authorized mRNA COVID-19 vaccines. Med. 2021;2(8):965—78.e5.
27. Shasha D, Bareket R, Sikron FH, Gertel O, Tsamir J, Dvir D, et al. Real-world safety data for the Pfizer BNT162b2 SARS-CoV-2 vaccine: historical cohort study. Clin Microbiol Infect. 2022;28(1):130—4.
28. Choi YY, Kim M-K, Kwon HC, Kim GH. Safety monitoring after the BNT162b2 COVID-19 vaccine among adults aged 75 years or older. J Korean Med Sci. 2021;36(45).
29. Barda N, Dagan N, Ben-Shlomo Y, Kepten E, Waxman J, Ohana R, et al. Safety of the BNT162b2 mRNA Covid-19 vaccine in a nationwide setting. N Engl J Med. 2021:1078—90.
30. Klein NP, Lewis N, Goddard K, Fireman B, Zerbo O, Hanson KE, et al. Surveillance for adverse events after COVID-19 mRNA vaccination. JAMA. 2021;326(14):1390—9.
31. Mutsch M, Zhou W, Rhodes P, Bopp M, Chen RT, Linder T, et al. Use of the inactivated intranasal influenza vaccine and the risk of Bell's palsy in Switzerland. N Engl J Med. 2004;350(9):896—903.
32. Bardage C, Persson I, Örtqvist Å, Bergman U, Ludvigsson JF, Granath F. Neurological and autoimmune disorders after vaccination against pandemic influenza A (H1N1) with a monovalent adjuvanted vaccine: population based cohort study in Stockholm, Sweden. BMJ. 2011;343.
33. Frontera JA, Tamborska AA, Doheim MF, Garcia-Azorin D, Gezegen H, Guekht A, et al. Neurological events reported after COVID-19 vaccines: an analysis of VAERS. Ann Neurol. 2022;2:756—71.
34. Introna A, Caputo F, Santoro C, Guerra T, Ucci M, Mezzapesa DM, et al. Guillain-Barré syndrome after AstraZeneca COVID-19-vaccination: a causal or casual association? Clin Neurol Neurosurg. 2021;208:106887.
35. Notghi AA, Atley J, Silva M. Lessons of the month 1: Longitudinal extensive transverse myelitis following AstraZeneca COVID-19 vaccination. Clin Med. 2021;21(5):e535.
36. Oldenburg J, Klamroth R, Langer F, Albisetti M, Von Auer C, Ay C, et al. Diagnosis and management of vaccine-related thrombosis following AstraZeneca COVID-19 vaccination: guidance statement from the GTH. Hämostaseologie. 2021:e1.