Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Incidence of COVID-19 after vaccination in people with multiple sclerosis in Argentina: Data from the nationwide registry RelevarEM

Juan I. Rojas a,∗, Geraldine G. Luetic c, Carlos Vrech d, Agustín Pappolla c,f, Liliana Patrucco a, Edgardo Cristiano a, Mariano Marrodan g, María C. Ysraelet g, Marcela Fiol g, Jorge Correale g, Leila Cohen h, Ricardo Alonso h,i, Berenice Silva g, Magdalena Casas g, Orlando Garcea g, Norma Deri j, Marcos Burgos k, Susana Liwacki k, Verónica Tkachuk l, Andres Barboza m, Raúl Piedrabuena k,n, Patricio Blaya o, Judith Steinberg p,Alejandra Martínez q, Adriana Carr a,f, Dario Tavolini q, Pablo López i, Eduardo Knorre h, Pedro Nofal y, Edgar Carnero Contentti i, Amelia Alves Pinheiro w, Felisa Leguizamon x, Emanuel Silva x, Javier Hryb y, María Eugenia Balbuena l, Gisela Zanga y, Matías Kohler a, Luciana Lazaro h, Santiago Tizio o, Carolina Mainella c, Jorge Blanche b, Marcela Parada Marcilla e, María Eugenia Fracaro F, María Laura Menichini G, Gustavo Sgrilli H, Pablo Divi j, Miguel Jacobo i, Mariela Cabrera i, Jimena Míquez c, Nora Fernandez Liguori h, Juan Pablo Viglione k, Debora Nadur l, Marina Alonso Serena l, Sebastián Nunez M.

a Centro de esclerosis múltiple de Buenos Aires, Billinghurst 1611, Buenos Aires CP 1181, Argentina
b Servicio de Neurología, Unidad de EM y Enfermedades Desmielinizantes, Hospital Universitario de CEMIC, Buenos Aires, Argentina
c Instituto de Neurociencias de Rosario, San Lorenzo, Rosario, Santa Fe, Argentina
d Departamento de Enfermedades desmielinizantes, Sanatorio Allende, Córdoba, Argentina
e Servicio de Neurología, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina
f Hospital Rams Meija, Centro Universitario de Esclerosis Múltiple, CABA, Argentina

Corresponding author.
E-mail address: rojasjuanignacio@gmail.com (J.I. Rojas).

https://doi.org/10.1016/j.msard.2022.104104
Received 26 May 2022; Received in revised form 16 July 2022; Accepted 10 August 2022
Available online 12 August 2022
2211-0348/© 2022 Elsevier B.V. All rights reserved.
1. Introduction

Different vaccines have been evaluated and implemented to achieve immunization against COVID-19 in the world (Achiron et al., 2021; Alonso et al., 2021a, 2021b; Belete, 2021). In people with multiple sclerosis (PwMS), during the last months, several publications have demonstrated evidence about the effect of vaccination against COVID-19 mainly on serological responses and, to a minor extent, on T cell response (Achiron et al., 2021; Brill et al., 2021; Sahin et al., 2020; Salter et al., 2021). This was translated in a reduction in the frequency of PwMS infected post vaccination as well as a reduction in the severity of COVID-19 cases (Achiron et al., 2021; Brill et al., 2021; Sahin et al., 2020; Salter et al., 2021) (Belete, 2021; Reyes et al., 2021; Sormani et al., 2021; Tortorella et al., 2022). However, much of the information comes from studies done in Europe or North America and scarce studies were done to evaluate technologies like Sputnik, Astra-Zeneca or inactivated vaccines for COVID-19 in PwMS like SinoPharm as well as heterologous schemes of those vaccines (Achiron et al., 2021; Belete, 2021; Brill et al., 2021; Reyes et al., 2021; Sahin et al., 2020; Salter et al., 2021; Sormani et al., 2021; Tortorella et al., 2022).

The objective of the study was to evaluate the incidence of COVID-19 infections after complete vaccination in PwMS in Argentina included in the Argentinean MS and NMOSD registry (RelevarEM, NCT 03375177).

2. Methods

This was an ambispective cohort study that started in May 2021 and finished in December 2021. The study was run on the current MS registry in Argentina, RelevarEM (Rojas et al., 2020, 2019). RelevarEM is a longitudinal, strictly observational MS and neumomyelitis optica spectrum disorders (NMOSD) registry in Argentina (Rojas et al., 2020, 2019). It is open to all practicing neurologists and MS specialists and their teams across the country. The registry tracks the outcomes of routine clinical practice of patients with MS and NMOSD in a web-based platform that allows researchers to register and follow up their patients. The primary objective of the registry was to create an MS physician network in Argentina that captures pragmatic and relevant information from MS patients in terms of clinical and demographic aspects (Rojas et al., 2020, 2019). Eligible subjects were contacted by their neurologist. Once the patient was included data was collected about demographic and clinical data of the disease (age at vaccination, EDSS at study entry, ongoing treatment, MS phenotype, and comorbidities); vaccine received at first dose, second dose, dose, and dates; adverse events of vaccination and follow up time. Patients were actively followed during at least three months since the second dose of COVID-19 vaccine (complete suggested vaccine scheme).

The primary outcome was the appearance of infection during the follow up time (at least three months after complete vaccination (second dose of vaccination)). This data was collected through the contact between the treating physician and the patient. Specific information was requested (date, symptoms, need for hospitalization, ventilatory assistance, treatment, and evolution). The contact was made every 30 days after the period of 3 months after the full dose vaccination. A positive COVID-19 case was defined according to the definition established by the Ministry of Health in Argentina. Cumulative incidence was reported by Kaplan Meier survival curves as well as incidence density. Results: A total of 576 PwMS were included, mean age 45.2 ± 13 years, 432 (75%) RRMS, 403 (70%) were female. The mean and median time of follow-up after the second dose was 91 ± 17 and 94 ± 21 days respectively. Most frequent first and second dose received was Astra-Zeneca vaccine, followed by Sputnik V vaccine. During follow-up over a total of twenty COVID-19 cases were observed for a total exposure time of 39,557 days. The overall cumulative incidence for the observed period was 3.4% (SE 0.4%) with an overall incidence density of 5 × 10,000 patients/day (95%CI 0.7–12). We observed more cases in women than in men with an incidence density of 6 × 10,000 patients/day (95%CI 0.9–9) vs. 3 × 10,000 patients/day (95%CI 0.2–6) respectively, but not significantly different (IRR 1.7 95% CI 0.56–7.37 p = 0.15).

Conclusion: we found an incidence density of breakthrough COVID-19 infection of 5 × 10,000 patients/day (95% CI 0.7–12) after vaccination in Argentina.

ARTICLE INFO

Keywords:
Multiple sclerosis
COVID-19
Vaccines
Argentina
Incidence
Breakthrough
possibility of selection bias, we seek to include all professionals in Argentina who oversee caring for patients with MS in Argentina and are active members of RelevarEM.

Each center submitted the project for approval following the competent local regulations.

An institutional ethics committee approved the registration or declare that it is exempt from the need for approval as well as its informed consent (IC).

4. Statistical analysis

Baseline characteristics of the cohort were reported in percentages for categorical data and in median and range or mean ± SD for continuous data. Only patients with a complete vaccination scheme (at least two doses) and at least three months follow up were included in the analysis. Cumulative incidence of COVID-19 infections was reported for the entire cohort by Kaplan Meier survival curves as well as incidence density. Sub-analysis of incidence of infection by gender, vaccine received and homologous or heterologous scheme during follow up was also done.

5. Results

A total of 576 PwMS were included during the study period that started in May 2021 and finished in December 2021. The mean age of included patients was 45.2 ± 13 years, mean disease duration 10.7 ± 6.4 years, 432 (75%) were RRMS, 403 (70%) were female, median EDSS 2.7 ± 2. The rest demographic and clinical variables are shown in Table 1.

The mean and median time of follow up after the second dose in included patients was 91 ± 17 and 94 ± 21 days and 55 (9.5%) patients reported to be infected by COVID-19 pre-vaccination (Table 2). Most frequent first and second dose received was Astra-Zeneca vaccine, followed by Sputnik vaccine (Table 2) and when homologous or heterologous scheme was described, 82.5% received a homologous scheme (Sputnik-Sputnik or Astra Zeneca-Astra Zeneca or Sinopharm-Sinopharm) vs. 17.5% that received and heterologous scheme of vaccination to complete the scheme (Table 2).

During follow up a total of twenty COVID-19 cases were observed for a total exposure time of 39,557 days (only one case of hospitalization (exposure time 33,300 days) (Table 3). When we stratified by gender, the observed period was 3.4% (SE 0.4%) with an overall incidence density of 5.000 patients/day (95%CI 0.7–3) vs. 3.3% (SE 0.3%) 3.9% (SE 0.5%) in the homologous vs. heterologous scheme.

3. Results

A total of 576 PwMS were included during the study period that started in May 2021 and finished in December 2021. The mean age of included patients was 45.2 ± 13 years, mean disease duration 10.7 ± 6.4 years, 432 (75%) were RRMS, 403 (70%) were female, median EDSS 2.7 ± 2. The rest demographic and clinical variables are shown in Table 1.

The mean and median time of follow up after the second dose in included patients was 91 ± 17 and 94 ± 21 days and 55 (9.5%) patients reported to be infected by COVID-19 pre-vaccination (Table 2). Most frequent first and second dose received was Astra-Zeneca vaccine, followed by Sputnik vaccine (Table 2) and when homologous or heterologous scheme was described, 82.5% received a homologous scheme (Sputnik-Sputnik or Astra Zeneca-Astra Zeneca or Sinopharm-Sinopharm) vs. 17.5% that received and heterologous scheme of vaccination to complete the scheme (Table 2).

During follow up a total of twenty COVID-19 cases were observed for a total exposure time of 39,557 days (only one case of hospitalization (exposure time 33,300 days) (Table 3). When we stratified by gender, the observed period was 3.4% (SE 0.4%) with an overall incidence density of 5.000 patients/day (95%CI 0.7–3) vs. 3.3% (SE 0.3%) 3.9% (SE 0.5%) in the homologous vs. heterologous scheme.

Table 1
Baseline characteristics of included patients.

| N = 576 |
|---|
| Mean age at study entry, years (SD) | 45.2 (13) |
| Mean disease duration, years (SD) | 10.7 (6.4) |
| RRMS, n (%) | 432 (75) |
| SPMS, n (%) | 67 (11.6) |
| PPMs | 77 (13.4) |
| Female gender, n (%) | 403 (70) |
| Median EDSS, (SD) | 2.7 (2.0) |
| Interferon beta, n (%) | 84 (14.58) |
| Glatiramer acetate, n (%) | 43 (7.47) |
| Teriflunomide, n (%) | 50 (8.68) |
| Fingolimod, n (%) | 102 (17.71) |
| Dimethylfumarate, n (%) | 25 (4.34) |
| Natalizumab, n (%) | 48 (8.33) |
| Alemtuzumab, n (%) | 25 (4.34) |
| Ocrelizumab, n (%) | 33 (5.73) |
| Rituximab, n (%) | 9 (1.56) |
| Cladribine, n (%) | 37 (6.42) |
| No treatment | 120 (20.83) |
| Median Charlson score of comorbidities, (SD) | 0.23 (0.52) |

RRMS= relapsing remitting multiple sclerosis; SPMS= secondary progressive multiple sclerosis; PPMs= primary progressive multiple sclerosis; EDSS= expanded disability status scale; SD= standard deviation.

Table 2
Follow up time and vaccines received in included patients.

| N = 576 |
|---|
| Median follow up time after second dose, days (SD) | 94 ± 21 |
| Mean follow up time after second dose, days | 91 ± 17 |
| Previous covid infection, n (%) | 55 (9.54%) |
| First dose vaccine received | |
| Sputnik V, n (%) | 54 (9.4%) |
| Astra Zeneca, n (%) | 172 (29.86%) |
| Sinopharm | 268 (49.3%) |
| Jansens | 106 (18.40%) |
| Second dose vaccine received | |
| Sputnik V, n (%) | 123 (21.35%) |
| Astra Zeneca, n (%) | 312 (54.16%) |
| Sinopharm | 94 (16.3%) |
| Moderna | 26 (4.51) |
| Pfizer | 21 (3.64) |
| Mean time between first and second vaccine dose, (SD) | 55±18 |
| Homologous vaccine scheme, n (%) | 475 (82.5) |
| Heterologous vaccine scheme, n (%) | 101 (17.5) |

Table 3
Incidence of COVID-19 after vaccination.

| Breakthrough COVID-19 infections during follow up (n) | 20 |
| Hospitalizations cases of COVID-19 infections, n | 1 |
| Total exposure time (days) | 39,557 |
| Overall cumulative incidence of infection | 3.4% (SE 0.4%) |
| Overall incidence density of infection | 5 × 10,000 patients/day (95% CI 0.7–12) |
| Cumulative incidence in men (4 cases) /women (16 cases) | 2.3% (SE 0.3%) / 3.9% (SE 0.5%) |
| Incidence density in men (exposure time 12,364 days) /women (exposure time 27,546 days) | 3 × 10,000 patients/day (95% CI 0.2–0) / 6 × 10,000 patients/day (95% CI 0.9–9) |
| Frequency of infections per vaccines used | |
| Sputnik-Sputnik n (%) | 4 (20) |
| Astra-Astra, n (%) | 10 (50) |
| Sinopharm-Sinopharm n (%) | 5 (25) |
| Heterologous vaccine scheme, n (%) | 1 (5) |
| Frequency of infections per treatment used | |
| Interferon beta, n (%) | 2 (0.02) |
| Glatiramer acetate, n (%) | 1 (0.02) |
| Teriflunomide, n (%) | 2 (0.04) |
| Fingolimod, n (%) | 3 (0.02) |
| Dimethylfumarate, n (%) | 1 (0.04) |
| Natalizumab, n (%) | 2 (0.04) |
| Alemtuzumab, n (%) | 1 (0.04) |
| Ocrelizumab, n (%) | 5 (0.15) |
| Rituximab, n (%) | 1 (0.11) |
| Cladribine, n (%) | 1 (0.02) |
| No treatment | 1 (0.008) |
| Cumulative incidence in homologous scheme (19 cases) | 3.3% (SE 0.4%) |
| Incidence density in homologous scheme (exposure time 33,300 days) /and heterologous scheme (1 cases, exposure time 6610 days) | 5 × 10,000 patients per day (95%CI 0.8–8) / 1 × 10,000 patients per day (95%CI 0.02–3) |
respectively, IRR 3.77, 95%CI 0.59–26, p = 0.15) Table 3).

6. Discussion

This is the first study in the country and one of the first studies in the region to evaluate the incidence of COVID-19 infection post vaccination in PwMS.

In our Study we observed a cumulative incidence of 3.4% (SE 0.4%) with an overall incidence density of COVID-19 infection post vaccination of 5 × 10,000 patients/day (95%CI 0.7–12). The frequency observed by vaccines used and schemes (homologous vs. heterologous scheme) was quite similar and only one patient required hospitalization (Table 3).

Our study is in line with previous studies performed in other regions. Sormani et al. in a long term clinical follow up of the COVAXIMS (COVID-19 vaccine in multiple sclerosis) evaluated the SARS-CoV-2 breakthrough infections incidence and the impact of DMTs on cumulative incidence of infections (Sormani et al., 2021). In that study, of a total of 1705 patients who had a full vaccination cycle (2 doses), 23 breakthrough infections were identified, displaying a cumulative incidence of 1.5% SE 0.3% after a mean of 108 days after the second dose (Sormani et al., 2021). Authors analyzed the role of treatments on the risk of infections and severity of infections and showed that the probability to be infected was associated with SARS-CoV2 antibody levels measured after the second vaccine dose (HR = 0.63, p = 0.007) and antibody levels of 660 U/mL as the cut-off (Sormani et al., 2021). In another study that followed 19,641 MS patients after complete vaccination for a median of 8 months, authors identified 137 breakthrough infections (cumulative incidence of 0.69%), and the sub analysis of risk between the incidences across DMTs showed an increased in patients treated with ocrelizumab and fingolimod (p < 0.001) (Schiavetti et al., 2022). Rose et al. investigated breakthrough coronavirus disease 2019 (COVID-19) in vaccinated people with multiple sclerosis (PwMS) on DMT (Rose et al., 2021). A total of 13 patients of 344 fully vaccinated people with multiple sclerosis on disease modifying therapies were diagnosed with COVID-19 after vaccination (cumulative incidence of 3.77%). No incidence density was described in the study (Rose et al., 2021).

It is important to comment that many of the included patients in our cohort were not receiving a specific treatment for MS (20.83%). This was mainly because we included PPMS (13.4%) and SPMS (11.6%) and many of those patients were untreated for the disease. It is also important to mention that when we developed the study, for the Argentine health system, the complete vaccination schedule consisted of having two doses of the COVID-19 vaccines available in our country. That is why from the design we proposed that mathematical parameter in each MS patient and we did not consider extra doses of COVID – 19 vaccines.

Our study has many limitations that should be mentioned. First and probably the most relevant is that we were not able to perform a serological test to all the included patients, however, this was not the objective of the study. Second the observational design implemented and the possibility of information bias, however the strictest follow up was possible was implemented to try to limit this possibility. Finally, we could not stratify the analysis by treatment received per patient to analyze the incidence risk by DMT. A future study is ongoing to answer this aspect with an increase sample.

In conclusion, we found an incidence density of breakthrough COVID-19 infection of 5 × 10,000 patients/day (95%CI 0.7–12) after vaccination in Argentina mainly with Sputnik or Astra Zeneca vaccines. Despite increasing evidence is being collected and the gap of evidence is narrowing, still much is needed regarding the response to other vaccines and other factors like the ones we consider in our study.

Funding

This study was possible due to an unrestricted educational grant provided by Biogen.

Credit author statement

Juan I. Rojas1 and Sebastián Nuñez39 Conceptualization, Methodology, Data Curation Writing- Original draft preparation, riting- Reviewing and Editing and Formal analysis

Geraldine G. Luetic2, Carlos Vrech3, Agustin Pappolla5, Liliana Patrucco4, Edgardo Cristiano4, Mariano Marrodan4, Maria C. Yssraelit5, Marcela Fiol7, Jorge Correale6, Leila Cohen7, Ricardo Alonso7,8, Berenice Silva7, Magdalena Casas7, Orlando Garcea7, Norma Deri7, Marcos Burgos7, Susana Liwacki11, Veronica Tkachuk12, Andres Barboza13,11, Raúl Piedrabuena11,14, Patricio Blaya13, Judith Steinberg15, Alejandro Martínez16, Adriana Carra17,18, Darío Tavolini19, Pablo López20, Eduardo Knorre21, Pedro Nofal22, Edgar Carnero Contenttini23, Amelia Alves Pinheiro24, Felisa Leguizamón25, Emanuel Silva24, Javier Hryb25, Maria Eugenia Balbuena26, Gisela Zanga27, Matías Kohler27, Luciana Lazaro28, Santiago Tizó29, Carolina Mainella29, Jorge Blanche29, Marcella Paola Marcelli30, Maria Eugenia Praço30,32, María Laura Meni33, Gustavo Sgrilli34, Pablo Dív135, Miguel Jacobo35, Mariela Cabrera36, Jimena Miguez37, Nora Fernandez Liguori38, Juan Pablo Vigliome39, Debra Nadur40, Mariona Alonso Serena41 Writing – Review, Data Curation

Author declaration

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property

Declaration of Competing Interest

Authors declare no potential conflicts of interest regarding this research, authorship and/or publication of this article.

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome

References

Achiron, A., Done, M., Menasce, S., Zohar, D.N., Dreyer-Alster, S., Miron, S., Shiebinti, F., Magalashvili, D., Flechter, S., Givon, U., Guber, D., Stern, Y., Polliaic, M., Falh, R., Guerevic, M., 2021. COVID-19 vaccination in patients with multiple sclerosis what we have learnt by February 2021. Mult. Scler. 27 (6), 864–870.

Alcayde, R., Chertcoff, A., Leguizamón, F.D.V., Galleguillos Goiry, L., Eizaguirre, M.B., Alonso, R., Silva, B., Garcea, O., Diaz, P.E.C., Dos Passos, G.R., Navarro, D.A.R., Valle, L., Brill, L., Rechtman, A., Zveik, O., Haham, N., Oiknine-Djian, E., Wolf, D.G., Levin, N., Martínez, C., Cabrera, J., Alonso, R., Serena, M.A., de Jong-Martis, A., Giachello, S., Gurevich, M., 2021. COVID-19 vaccination in patients with multiple sclerosis: what we have learnt by February 2021. Mult. Scler. 27 (6), 864–870.

Schiavetti et al., 2022. Rose et al. investigate breakthrough coronavirus disease 2019 (COVID-19) in vaccinated people with multiple sclerosis (PwMS) on DMT (Rose et al., 2021). A total of 13 patients of 344 fully vaccinated people with multiple sclerosis on disease modifying therapies were diagnosed with COVID-19 after vaccination (cumulative incidence of 3.77%). No incidence density was described in the study (Rose et al., 2021).

It is important to comment that many of the included patients in our cohort were not receiving a specific treatment for MS (20.83%). This was mainly because we included PPMS (13.4%) and SPMS (11.6%) and many of those patients were untreated for the disease. It is also important to mention that when we developed the study, for the Argentine health system, the complete vaccination schedule consisted of having two doses of the COVID-19 vaccines available in our country. That is why from the design we proposed that mathematical parameter in each MS patient and we did not consider extra doses of COVID – 19 vaccines.

Our study has many limitations that should be mentioned. First and probably the most relevant is that we were not able to perform a serological test to all the included patients, however, this was not the objective of the study. Second the observational design implemented and the possibility of information bias, however the strictest follow up was possible was implemented to try to limit this possibility. Finally, we could not stratify the analysis by treatment received per patient to analyze the incidence risk by DMT. A future study is ongoing to answer this aspect with an increase sample.

In conclusion, we found an incidence density of breakthrough COVID-19 infection of 5 × 10,000 patients/day (95%CI 0.7–12) after vaccination in Argentina mainly with Sputnik or Astra Zeneca vaccines.

Despite increasing evidence is being collected and the gap of evidence is narrowing, still much is needed regarding the response to other vaccines and other factors like the ones we consider in our study.

Funding

This study was possible due to an unrestricted educational grant provided by Biogen.
2 vaccination in patients with multiple sclerosis treated with ocrelizumab. JAMA Neurol. 78 (12), 1510–1514.

Reyes, S., Cunningham, A.L., Kalincik, T., Havrdova, E.K., Isobe, N., Pakpour, J., Airas, L., Bunyan, R.F., van der Walt, A., Oh, J., Mathews, J., Mateen, F.J., Giovannoni, G. 2021. Update on the management of multiple sclerosis during the COVID-19 pandemic and post pandemic: an international consensus statement. J. Neuroimmunol. 357, 577627.

Rojas, J.J., Alonso Serena, M., Garcea, O., Patrucco, L., Carra, A., Correale, J., Vrech, C., Pappolla, A., Miguez, J., Doldan, M.L., Silva, E., Fiol, M., Gaitan, M.L., Marrodan, M., Nofal, P., Volman, G., Vrech Pinheiro, A., Alvez Pinheiro, A., Lopez, P.A., Cohen, L., Rotta, F., Silva, C., Filo, M., Gaitan, M.L., Marrodan, M., Nofal, P., Volman, G., Alvez Pinheiro, A., Hryb, J., Tavolini, D., Blaya, P.A., Silva, E., Blanche, J., Tizio, S., Caceres, P., Saladino, M.L., Zanga, G., Fracaro, M.E., Grilli, G., Pagani Carrassa, F., Vazquez, G., Sinay, V., Menichini, M.L., Lazaro, L., Cabrera, L.M., Bestoso, S., Divi, P., Jacobo, M., Kohler, E., Kohler, M., Giunta, D., Mainella, C., Manzi, R., Parada Marcilla, M., Viglione, J.P., Martos, I., Reich, E., Jose, G., Cristiano, E., Fernandez Liguori, N., on behalf Relevar, E.M.i., 2020. Multiple sclerosis and neuromyelitis optica spectrum disorders in Argentina: comparing baseline data from the Argentinean MS registry (RelevarEM). Neurol. Sci. 41 (6), 1513–1519.

J. Neuroimmunol. 357, 577627.