



Quality of care provided by Multiple Sclerosis Centers during Covid-19 pandemic: Results of an Italian multicenter patient-centered survey

Manuela Altieri^a, Rocco Capuano^a, Alvino Biseco^a, Alessandro d'Ambrosio^a, Mario Risi^a, Paola Cavalla^b, Marco Vercellino^b, Pietro Annovazzi^c, Mauro Zaffaroni^c, Nicola De Stefano^d, Maria Laura Stromillo^d, Emanuele D'Amico^e, Aurora Zanghì^e, Maria Chiara Buscarinu^f, Roberta Lanzillo^g, Giovanna De Luca^h, Massimiliano Calabreseⁱ, Lorena Lorefice^j, Massimiliano Di Filippo^k, Paola Valentino^l, Alberto Gajofattoⁱ, Girolama Alessandra Marfia^m, Aurora Fuianiⁿ, Viviana Nociti^o, Giocchino Tedeschi^a, Antonio Gallo^{a,*}

^a Multiple Sclerosis Center, Dept. of Advanced Medical and Surgical Sciences, University of Campania "Luigi Vanvitelli", Naples, Italy

^b Dept. of Neuroscience and Mental Health, City of Health and Science University Hospital of Torino, Turin, Italy

^c Multiple Sclerosis Study Center, ASST Valle Olona, Gallarate, VA, Italy

^d Dept. of Medicine, Surgery and Neuroscience, University of Siena, Siena, Italy

^e Multiple Sclerosis Center, G.F. Ingrassia, University of Catania, Catania, Italy

^f Dept. of Neuroscience, Mental Health and Sensory Organs, Sapienza University, S. Andrea Hospital-site, Rome, Italy

^g Multiple Sclerosis Clinical Care and Research Centre, Dept. of Neuroscience, Reproductive Science and Odontostomatology, Federico II University of Naples, Naples, Italy

^h Multiple Sclerosis Center, Policlinico SS. Annunziata, Chieti, Italy

ⁱ Multiple Sclerosis Center, Dept. of Neuroscience, Biomedicine and Movement Sciences, University Hospital of Verona, Verona, Italy

^j Multiple Sclerosis Center, Dept. of Medical Sciences and Public Health, Binaghi Hospital, ASL Cagliari, University of Cagliari, Cagliari, Italy

^k Section of Neurology, Dept. of Medicine and Surgery, University of Perugia, Perugia, Italy

^l Institute of Neurology, University of Catanzaro "Magna Graecia", Catanzaro, Italy

^m Dysimmune Neuropathies Unit, Dept. of Systems Medicine, Tor Vergata University of Rome, Rome, Italy

ⁿ Dept. of Neuroscience, Riuniti Hospital of Foggia, Foggia, Italy

^o Institute of Neurology, Fondazione Policlinico Universitario "A. Gemelli", IRCCS, Università Cattolica del Sacro Cuore, Rome, Italy

ARTICLE INFO

Keywords:

Multiple Sclerosis
Covid-19
Multiple Sclerosis Center
Patient centered study
Patient satisfaction

ABSTRACT

Background: Covid-19 pandemic impacted on management of people with Multiple Sclerosis (pwMS). Level of satisfaction of pwMS regarding the care received by the staff of Multiple Sclerosis Centers (MSCs) during the pandemic was not fully investigated. In a large patient-centered multicenter study, the therapeutic adherence and quality of care of MSCs was assessed.

Methods: In April–May 2021, an online survey was widespread by 16 Italian MSCs. Frequencies, percentages and/or means and standard deviations were calculated to describe the sample. ANOVAs were performed to evaluate the effect of sociodemographic and clinical variables on overall pwMS' rating of MSC assistance.

Results: 1670 pwMS completed the survey (67.3% women). During the pandemic, 88% did not change their disease modifying therapy schedule, and 89.1% reached their MSCs with no or little difficulties. Even if only 1.3% of participants underwent a tele-health follow-up visit with their MSC staff, the 80.1% believed that tele-health services should be improved regardless of pandemic. 92% of participants were satisfied of how their MSC took charge of their needs; ANOVAs revealed an effect of disease duration on pwMS' level of satisfaction on MSCs management during the pandemic.

Conclusions: The results revealed an efficient MSCs response to Covid-19 pandemic and provided the basis for the implementing of tele-health services that would further improve the taking charge of patients, particularly those with longer disease, higher disability, and/or living far from their MSC.

* Corresponding author.

E-mail address: antonio.gallo@unicampania.it (A. Gallo).

<https://doi.org/10.1016/j.msard.2023.104870>

Received 16 November 2022; Received in revised form 28 June 2023; Accepted 4 July 2023

Available online 14 July 2023

2211-0348/© 2023 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Covid-19 was considered a Public Health Emergency of International Concern on January 30, 2020, and it rapidly spread all over the world, being declared a pandemic by the World Health Organization on March 11, 2020 (WHO, 2020). To avoid and slow down the spreading of Sars-CoV-2 and to make room for the necessary expansion of basic healthcare and intensive care unit capacities (Goyal et al., 2021), most of governments imposed access restrictions to the national health systems (NHS), except for non-deferrable clinical conditions.

Therefore, since the first lockdown of early 2020, these restrictions caused a reduction on volume of hospitalizations and accesses in several essential clinical areas of NHS (Spadea et al., 2021). Neurology departments were also impacted by Covid-19 pandemic, as reported by a global survey that revealed a mild-to-complete disruption of neurological community-based services, long-term residential care, interventions for caregivers and neurorehabilitation (García-Azorín et al., 2021; Moss et al., 2020). This might have had an impact on management of people with chronic neurological diseases such as Multiple Sclerosis (MS) who need regular visits and additional care for relapses, disease progression, symptoms management and /or psychological support. In fact, studies focusing on possible changes in treatment and management during the Covid-19 pandemic of people with MS (pwMS) reported a significant reduction or delay in visits, access to MRI, laboratory tests and clinical trial activity; moreover, changes in modalities of visits were implemented, with an increase of tele-health services to overcome these difficulties (Portaccio et al., 2022; Chen et al., 2022).

The current literature on this topic, however, has not taken into account the level of satisfaction of pwMS regarding the healing/care received as well as information on Covid-19 provided by their neurologists and the staff of Multiple Sclerosis Centers (MSCs) after one year of pandemic. Given the importance of setting the standard of care of MSCs also considering the opinion of patients, the aim of the present patient-centered outcome study was to assess, in a large sample of pwMS, by means of a digital survey: (i) the impact of Covid-19 pandemic on access to (and care of) MSC; (ii) disease modifying therapy (DMT) changes during pandemic; (iii) the point of view of pwMS on psychological and/or tele-health services; (iv) the overall satisfaction/rating of MSCs provided by pwMS after one year of Covid-19 pandemic.

2. Materials and methods

Between April and May 2021, an online survey developed on Google Forms was widespread to a very large sample of pwMS throughout Italy. Sixteen Italian MSCs agreed to participate in the study and sent the

Table 1
Number of participants for each Italian Multiple Sclerosis Center (MSC).

MSC	pwMS enrolled by MSC (N)
Cagliari – Sardegna, Ospedale Binaghi	73
Catania – AOU Policlinico “G. Rodolico – San Marco”	108
Catanzaro – Università Magna Graecia	60
Chieti – Policlinico SS. Annunziata	90
Foggia – Ospedali riuniti di Foggia	44
Gallarate – ASST Valle Olona	210
Napoli – AOU “Federico II”	90
Napoli – AOU “Luigi Vanvitelli”	269
Perugia – Università degli Studi di Perugia	62
Roma – Policlinico Universitario “A. Gemelli”	43
Roma – Policlinico Tor Vergata (PTV)	50
Roma – Ospedale S. Andrea	96
Siena – Università di Siena	111
Torino – AOU Città della Salute e della Scienza “Molinette”	228
Verona – AOUI, Borgo Roma	136

Notes. MSC = Multiple Sclerosis Center; pwMS = people with Multiple Sclerosis.

survey to their MS patients; the complete list of MSCs involved is reported in Table 1. The survey included items aimed at collecting:

- I Socio-demographic and clinical characteristics (sex, age, referral MSC, disease duration and course, ambulatory capability) of pwMS.
- II Data about Covid-19 infection (including impact on MS symptoms) and vaccination.
- III Type/frequency of contacts with MSC since the start of Covid-19 pandemic in Italy (March 2020).
- IV DMT management during the Covid-19 pandemic.
- V Degree of satisfaction with MSCs activities and contacts during the Covid-19 pandemic.
- VI Opinions on psychological and tele-health services activated during the Covid-19 pandemic.

All participants were informed on the purposes of the study and agreed to complete the survey. The study was approved by Ethical Committee of University of Campania “Luigi Vanvitelli” and it was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

2.1. Statistical analyses

Descriptive analyses were performed by calculating frequencies, percentages and/or means and standard deviations as appropriate. Pie charts were generated to facilitate the readability of the results. Aggregated data from all MSCs were considered.

Frequencies of Covid-19 infection, types of Covid-19 treatment, and worsening of MS-related neurological symptoms during and after Covid-19 infections were compared between pwMS on different DMTs by means of chi square test. A comparison was performed on the following groups: (a) pwMS under no DMTs, pwMS on anti-CD20 DMTs (Ocrelizumab and Rituximab), and pwMS on other DMTs; (b) participants under no DMTs, on first line and second line DMTs.

Moreover, several univariate analyses of variance (ANOVA) were performed to evaluate the effect of sociodemographic and clinical variables on overall pwMS’ rating of MSCs assistance, with pwMS’ rating of MSC as dependent variable, and sex, age, geographical localization of MSC, disease duration and ambulation capability added as independent variables. Independent variables were added as categorical variables in the following way: I. sex: men and women; II. age: young adults (18–35 years), adults (36–64 years), older adults (65+ years); III. geographical localization of MSCs: Northern Italy MSCs, Central Italy MSCs, Southern Italy MSCs; IV. disease duration: short (<2 years), medium (3–5 years) and long disease duration (≥ 6 years); V. ambulation capability: high (pwMS who were able to walk without any limitations or more than 100 m without experiencing fatigue and without assistive devices), moderate (pwMS who were able to walk without less than 100 m or needing assistive devices, such as canes, crutches, walkers for most of the day) and low-absent (pwMS on wheelchair) ambulation capability; VI. MS phenotypes: relapsing remitting MS, primary progressive MS, and secondary progressive MS; VII. types of DMTs (no DMTs, first line DMTs, second line DMTs).

Finally, in pwMS who underwent a tele-health follow-up visit with their MSC staff, the possible association between going to a tele-health follow-up visit and socio-demographic and clinical variables was assessed by means of chi square test. Socio-demographic and clinical variables were coded as stated in the previous paragraph. Statistical analyses were carried out with SPSS, version 25.

3. Results

3.1. Characteristics of the sample

A total number of 1670 pwMS completed the survey (see Table 2;

Table 2
Socio-demographic and clinical characteristics of the sample.

	Whole sample (N=1670)	pwMS from northern Italy MSCs (N=574)	pwMS from central Italy MSCs (N=362)	pwMS from southern Italy MSCs (N=734)
Age^a	42.9 (12.1)	46.4 (11.5)	43.3 (11.2)	40.1 (12.3)
Sex (Women)^b	67.3	69.3	72.5	63.2
Educational attainment^b				
No qualification	0.4	0.2	0.6	0.5
Elementary education	0.3	0.2	0	0.5
Inferior middle license	16.8	21.3	9.1	17
High school diploma	50.4	47.7	50.8	52.3
Bachelor's degree	10.4	8.7	11.6	11
Master's degree or more	21.7	22	27.9	18.5
Age at onset^a	29.9 (10.7)	30.8 (11.3)	30.9 (10.2)	28.8 (10.3)
Age at diagnosis^a	32.5 (11)	33.7 (11.2)	32.9 (10.5)	31.2 (11)
Phenotype^b				
RRMS	76.3	73.5	75.7	78.9
PPMS	10.8	11.7	11	9.9
SPMS	12.9	14.8	13.3	11.2
Ambulation capability^b				
High	81.7	81.2	80.9	82.4
Moderate	14.9	15	13.8	15.3
Low-absent	3.5	3.8	5.2	2.3
DMT^b				
No therapy	10.1	8.7	14.1	9.5
Alemtuzumab	2.1	2.8	1.9	1.6
Azathioprine	0.6	0.5	0.9	0.3
Cladribine	3.1	2.1	3.9	3.5
Dimethyl-fumarate	18.6	15.7	21.3	19.5
Fingolimod	13.4	13.2	10.8	14.9
Glatiramer acetate	6.6	7.3	6.9	6
Interferon beta	7.2	7.3	6.4	7.2
Natalizumab	13.9	15	10.8	14.7
Ocrelizumab	14.4	15.9	14.9	12.9
Ponesimod	0.1	0.2	0	0
Rituximab	1.4	1.9	1.7	0.8
Siponimod	0.5	0.2	0.6	0.7
Teriflunomide	8	9.2	5.5	8.3
Symptomatic treatment^b				
No therapy	60	56.6	65.5	61.3
Yes, for anxiety	7.2	6.6	7.2	7.8
Yes, for depression	8.8	9.2	6.1	9.8
Yes, for insomnia	8.7	10.5	6.4	8.6
Yes, for fatigue	8.5	10.1	7.5	7.8
Yes, for spasticity	11.7	14.5	10.8	10.1
Yes, for sexual dysfunction	1.7	2.1	3	0.7
Yes, for bowel/bladder dysfunction	8.3	11	8.6	6
Yes, for pain/sensitive disorders	11.5	12.4	11.9	10.8
Yes, but I don't know why	0.9	0.9	1.1	0.8

Notes. pwMS = patient with Multiple Sclerosis; MSC = Multiple Sclerosis Center; RRMS = Relapsing-Remitting Multiple Sclerosis; PPMS = Primary Progressive Multiple Sclerosis; SPMS = Secondary Progressive Multiple Sclerosis; DMT = Disease-modifying therapy.

^a = data reported as mean (standard deviation).

^b = data reported as %.

34.4%, 21.7% and 44% of the sample were from northern, central, and southern Italy, respectively). The percentage of women in the whole sample was 67.3%; 17.5% did not reach a high school diploma, whereas 50.4% possessed a high school diploma and 32.1% attended college. Mean age at onset was 29.9 years, whereas the mean age at diagnosis was 32.5 years. High ambulation capability was reported by 81.7% of participants. As for DMT usage, 10.2% of the sample was not under DMTs, 34.6% was on first line DMTs, and 55.1% was on second line DMTs; among participants who were on DMTs, dimethyl fumarate (18.6%), ocrelizumab (14.4%) and natalizumab (13.9%) were the most used DMTs.

3.2. Covid-19 infection and vaccines

Of the whole sample, 10.2% reported a diagnosis of Covid-19 infection (78.8% confirmed by a nasopharyngeal swab, 21.2% by a general practitioner because of clinical presentation). In our sample, the comparison between participants under no DMTs, on first line and second line DMTs on frequency of Covid-19 infection revealed no significant differences ($\chi^2 = 4.133$, $df = 3$, $p = .127$). Moreover, people on anti-CD20 therapies (Ocrelizumab and Rituximab) were not more likely to be affected by Covid-19 when compared to people on other DMTs ($\chi^2 = 4.81$, $df = 1$, $p = .488$).

An asymptomatic course of Covid-19 was reported by 37% of patients who reported a Covid-19 diagnosis, whereas one or more symptoms suggestive of Covid-19 (dry cough, fever > 37.5 °C, anosmia and/or ageusia, new onset of muscle pain, asthenia) were reported by the remaining 63%. At the time of the survey, 0.8% of the whole sample was still tested positive for Covid-19.

As regards treatment for Covid-19, 50% of the patients stated that they did not carry out any treatment, 37.2% took medications prescribed by a doctor (e.g., antibiotics, corticosteroids, NSAIDs), 9.7% only took supplements, multivitamins, or homeopathic remedies and only 3% were hospitalized.

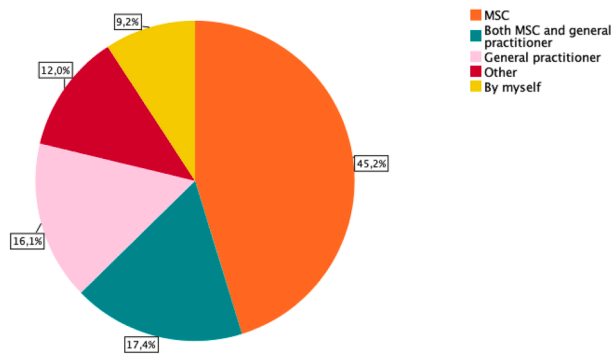
As for the impact of Covid-19 infection on MS-related neurological symptoms, 69.3% of the patients stated that they remained stable, whereas 21.5% reported a worsening of existing symptoms, 7.4% affirmed that new neurological symptoms emerged, while only 1.8% reported an improvement. Types of DMTs (anti-CD20 vs other DMTs vs no DMTs: $\chi^2 = 15.900$, $df = 10$, $p = .103$; second line DMTs vs first line DMTs vs no DMTs: $\chi^2 = 6.165$, $df = 10$, $p = .801$) were not statistically linked to a higher frequency of worsening or improvement of neurological symptoms.

At the time of the survey (April-May 2021), 60.6% of the patients was inoculated at least one dose of Covid-19 vaccine. As shown in Fig. 1, vaccination appointments were scheduled by MSC staff (44.9%), MSC staff together with the general practitioner (17.5%), the general practitioner alone (16.1%), or other institutions (12.1%; i.e., local health authority and/or the Italian Multiple Sclerosis Association, AISM;), and by themselves (9.3%). Among participants who did not receive any doses of Covid-19 vaccine (39.4%), 40.8% had already booked an appointment and were going to be vaccinated in the next few days/weeks, 17.6% was willing to be vaccinated but they did not book an appointment yet, while 19.3% was still undecided or they did not want to be vaccinated at all. Full reasons for not being vaccinated yet are reported in Fig. 1.

3.3. Changes in DMT compliance

Among participants who were on DMT (89.9%; 1501/1670) at the beginning of the pandemic outbreak, 88% did not change their DMT schedule, 7.8% reduced/delayed the intake of their DMT, and only the 4.2% skipped all scheduled doses of DMT during the Covid-19 outbreak.

For pwMS who got at least one shot of Covid-19 vaccine: who helped you scheduling the vaccination appointment?



Primary reason for not being vaccinated against Covid-19 yet:

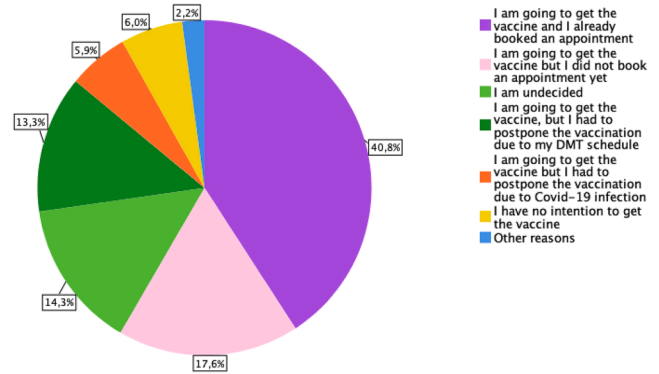


Fig. 1. Vaccination appointments and reasons for not being vaccinated against Covid-19.

Participants reducing/discontinuing DMT during Covid-19 pandemic did so for the following main reasons (see also Fig. 2): advice by their MSC neurologist (47.5%), forgetting to take their DMT (11.9%), and presence of co-pathologies that required a delay and/or stop of current DMT (i.e., cancer) (10.9%).

3.4. Contacts and access to MSC

More than two thirds of the sample (68.3%) reported contacts with their MSC or general practitioner regarding information and advice about Covid-19 pandemic and disease as well as prophylactic behaviors and vaccination. Specifically, 35.7% of the patients contacted directly the MSC, whereas 29.6% declared to have been contacted by the MSC staff.

Almost 9 out of 10 pwMS (89.1%) were able to reach their MSC with no or little difficulties (see Fig. 3). During the pandemic, almost all participants (68.6%) reported exchanges of information between themselves and MSC staff with at least one of the following means of communication: phone calls, messaging programs, emails, face-to-face encounters, tele-health software (see Fig. 3). The most recurrent means of communication included emails (68.6%), phone calls (59.3%) and messaging programs (24.9%). Face-to-face encounters and visits with tele-health software were reported by only 1.4% and 1.3% of

participants, respectively.

As regards the frequency of routine visits at MSC: (i) more than half of the sample (63.5%) performed their check-up visits at the MSC with the same frequency/schedule as the pre-pandemic period; (ii) 24.2% of the sample stated that there were some derangement/difficulties in their check-up visits due to the impossibility of MSC to provide scheduled follow-up visits, whereas (iii) 12.3% of the patients personally choose to skip at least one scheduled visit (see Fig. 2).

Main reasons for voluntary skipping follow-up visits at MSC regarded fear of getting Covid-19 (46%) and the sensation of feeling well without absolute/urgent need of a check-up visit (16.8%; see also Fig. 2).

3.5. Tele-health services

As reported above, only 1.3% of participants underwent a tele-health follow-up visit with their MSC staff by means of specific software during the Covid-19 pandemic. Chi-square test showed that there was no significant association between going to a tele-health follow-up visit and sex ($\chi^2 = 0.004$, $df = 1$, $p = 0.947$), geographical localization of MSC ($\chi^2 = 3.958$, $df = 2$, $p = 0.138$), age ($\chi^2 = 1.065$, $df = 2$, $p = 0.587$), ambulation capability ($\chi^2 = 1.525$, $df = 2$, $p = 0.467$), disease course ($\chi^2 = 5.046$, $df = 2$, $p = 0.08$), and types of DMTs ($\chi^2 = 0.115$, $df = 2$, $p = 0.944$).

Primary reason for changing/discontinuing DMT schedule

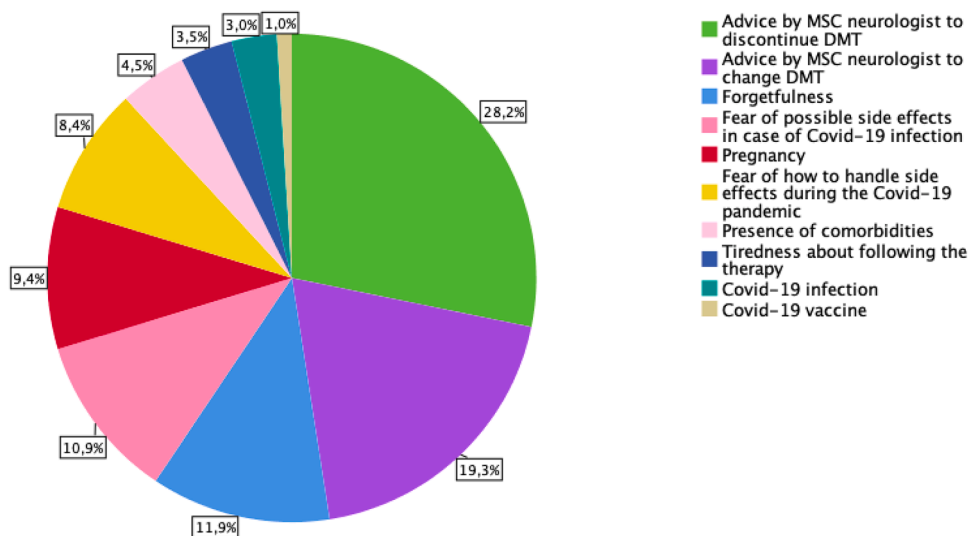


Fig. 2. Disease modifying therapy (DMT) discontinuation.

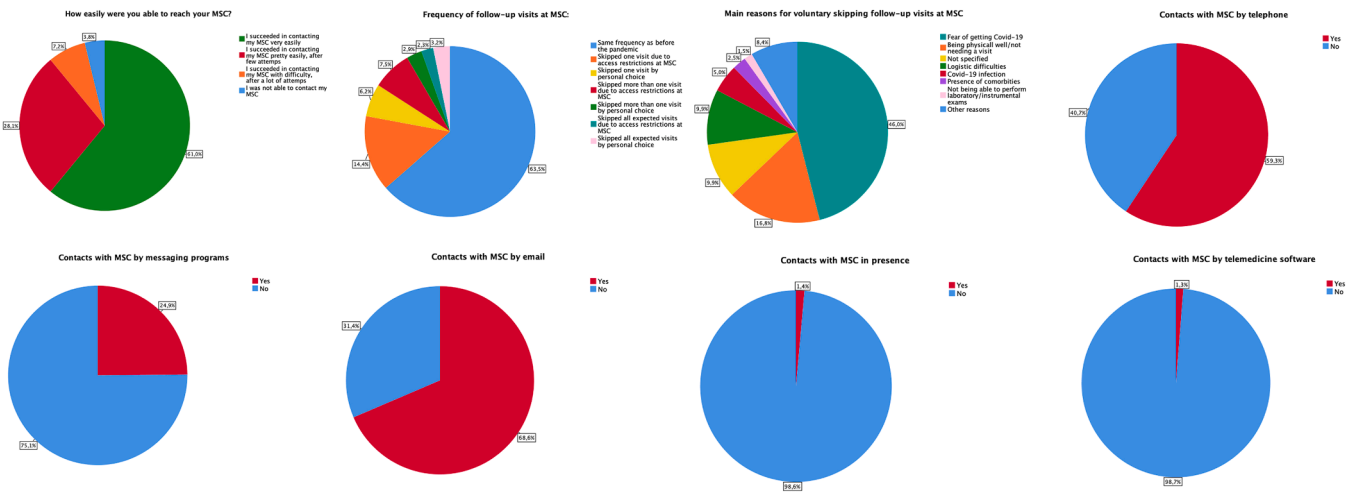


Fig. 3. Contacts with Multiple Sclerosis Centers (MSC) during Covid-19 pandemic.

All participants, regardless of whether they underwent a tele-health follow-up visit with their MSC, were asked an opinion about utility of tele-health services; the 80.1% of the sample believed that tele-health services should be improved and that they could be a very useful tool to perform follow-up visits (see Fig. 4).

3.6. Psychological services

75.2% of the sample was not aware if a remote/live psychological service was available at their MSC during the Covid-19 pandemic. Only 4.6% of participants attended a live (1.5%) or remote (3.1%) psychological service (see Fig. 4). Among participants who took psychological support sessions, 90.6% found the psychological sessions very or fairly useful; instead, the 69.5% of people who not attended or were not aware

of the presence of a psychological service reported that it would have been useful (see Fig. 4).

3.7. Overall satisfaction/rating of MSC during the Covid-19 pandemic

About 92% percent of participants reported to be very or fairly satisfied of how their MSC took charge of their requests or needs during the pandemic (see Fig. 5). The overall patients' opinion regarding the assistance provided by their MSC during Covid-19 outbreak was stable (61.3%) or became more positive (31.9%). Contrariwise, only 6.8% of the sample stated that they lost confidence (fully or partially) in their MSC (see Fig. 5).

The ANOVAs aimed at exploring whether sociodemographic/clinical variables could predict the overall pwMS' rating of MSC assistance

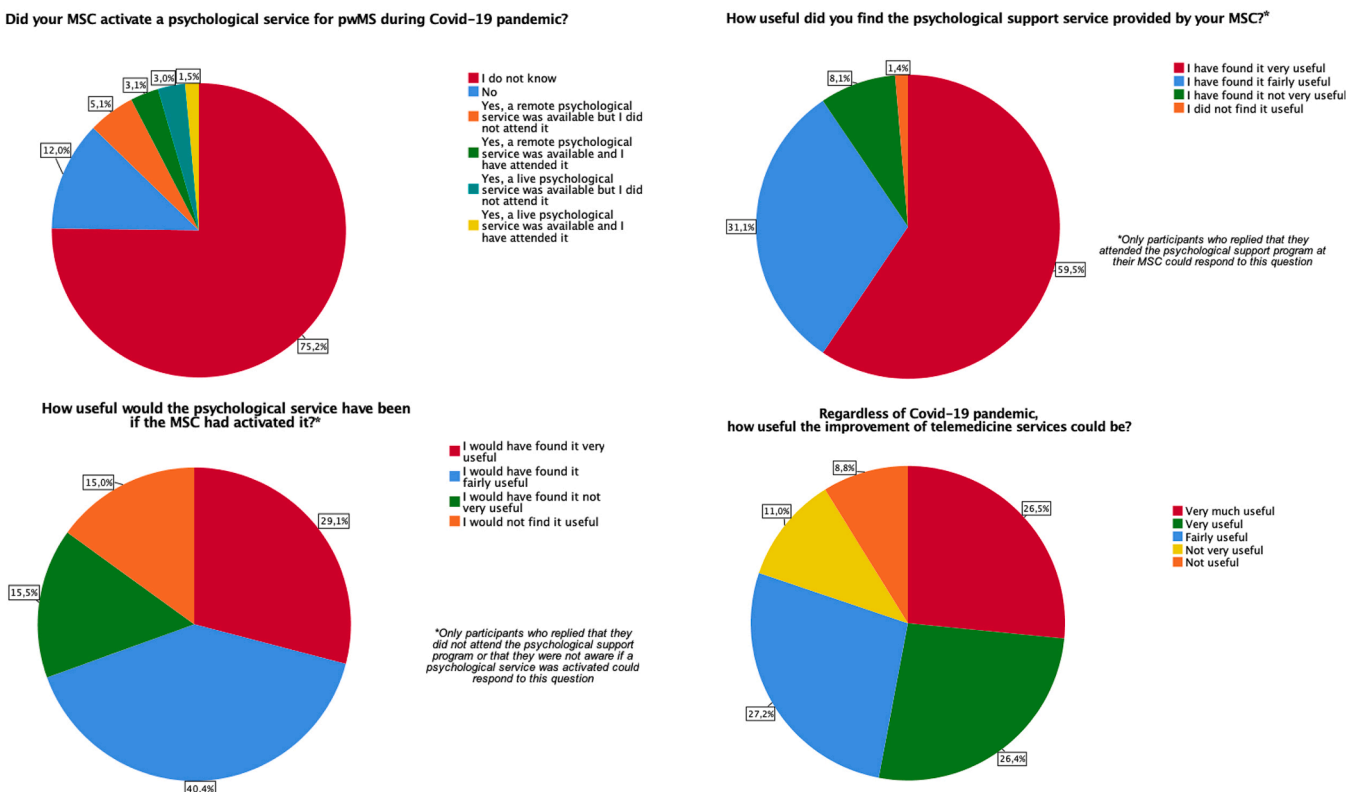


Fig. 4. Psychological and telemedicine services during Covid-19 pandemic.

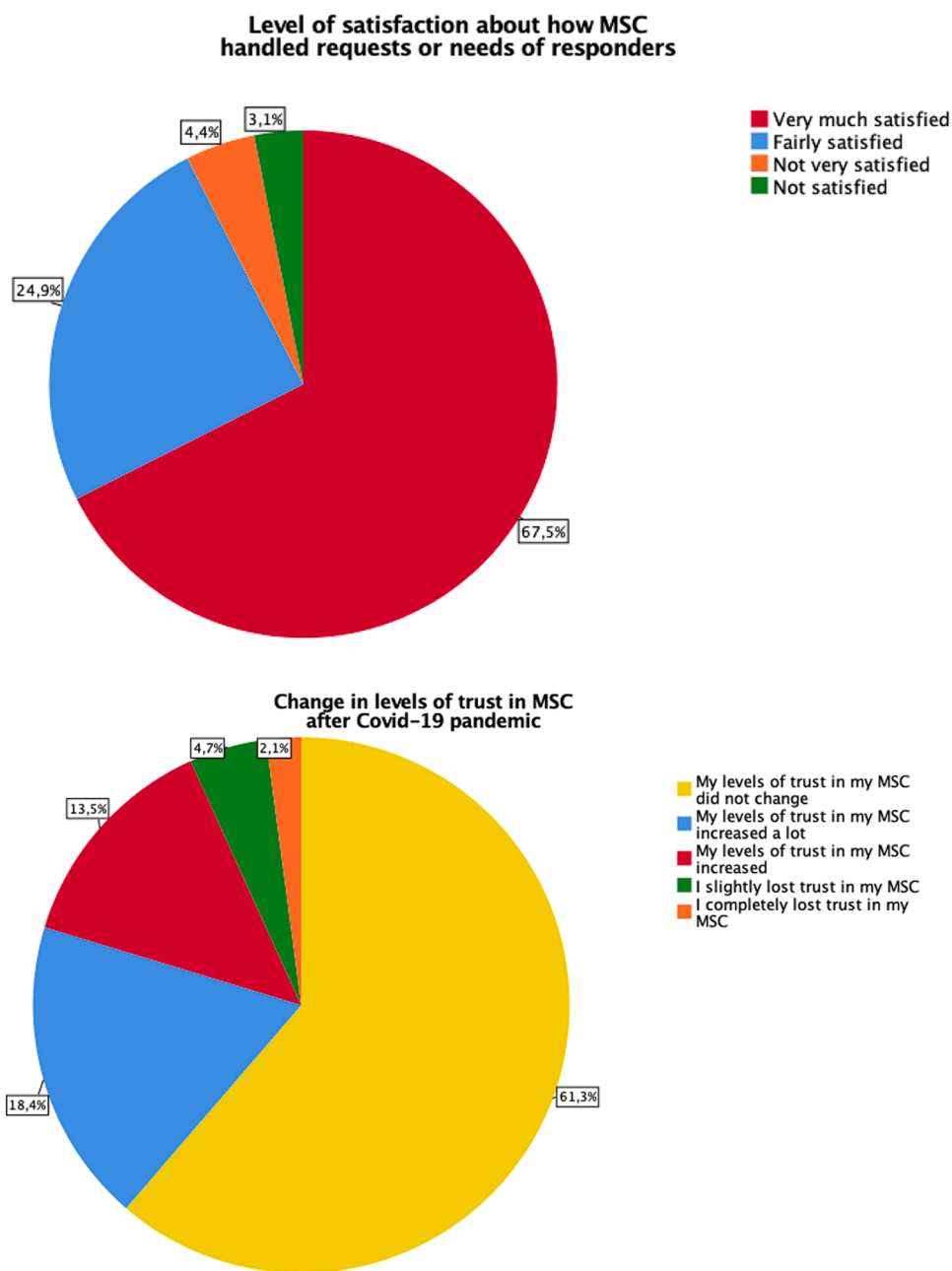


Fig. 5. Levels of satisfaction of Multiple Sclerosis Centers (MSC) support during Covid-19 pandemic and changes in levels of trust.

revealed a significant effect of disease duration ($F_{(1667,2)} = 7.190, p = 0.001$) on pwMS's overall rating of MSC, whereas sex ($F_{(1662,1)} = 0.310, p = 0.578$), geographical localization of MSC ($F_{(1667,2)} = 1.141, p = 0.320$), age ($F_{(1667,2)} = 0.093, p = 0.912$), ambulation capability ($F_{(1667,2)} = 2.051, p = 0.129$), disease course ($F_{(1667,2)} = 1.971, p = 0.140$) and types of DMTs ($F_{(1667,2)} = 0.611, p = 0.543$) were not significant. Post-hoc Bonferroni corrected analyses revealed that pwMS with a disease duration <2 years ($\bar{X} = 3.58, \sigma = 0.94$) reported a significant higher rating with respect to pwMS with a disease duration >6 years ($\bar{X} = 3.36, \sigma = 0.885$).

4. Discussion

The present study explores not only possible changes in management and access to MSCs, but also the level of satisfaction of pwMS towards clinical and management activities carried out by MSCs during the first year of Covid-19 pandemic according to a patient-centered perspective

and by employing a large sample of pwMS.

The results revealed that pwMS judged globally well the care and information received by their MSCs during Covid-19 pandemic. In particular, pwMS declared that MSCs were able to keep a high quality of care and to provide information about protective behavior against Covid-19 as well as support with Covid-19 vaccination. This finding may highlight that, although the first year of pandemic was characterized by extreme uncertainty and access restrictions to healthcare facilities (24.2% of the sample reported to have skipped at least one follow-up visit due to reduced access to MSCs), MSCs were able to maintain an adequate standard of care remaining in constant close contact, through multimodal channels (telephone, emails, and messaging services), with their patients. These results may also provide evidence of a quick organizational response to the public health emergency of the well-established Italian MSCs network. In fact, despite all pandemic restrictions and disruptions MSCs tried to preserve the patient-provider relationship, which is a fundamental element for maintaining

treatment adherence and quality of life (Costello et al., 2008; Rieckmann et al., 2015).

In fact, when investigating DMT changes during Covid-19 pandemic, most of pwMS from this sample did not change/stop their DMT intake, and only 4% reported to have done so due to fear of possible collateral effects or worries related to Covid-19 pandemic. It is possible that this high treatment adherence might have been also supported by keeping a consistent contact with pwMS, and by providing them with all available information about Covid-19 and DMT. Current evidence on DMT changes during the pandemic are discordant, with some studies reporting slightly higher percentages on patients' decision on discontinuing their DMT (e.g., 14.3% in Chertcoff et al. 2021 study), whereas other surveys - investigating the MS specialist approach to DMT prescription during the Covid-19 pandemic - revealed a higher rate of DMTs switch during the pandemic period (Portaccio et al., 2022; Morrison et al., 2021). This discrepancy may be ascribed to different study design and heterogeneous geographic provenience of the samples. As regards routine monitoring visits, our finding of 36.5% of missed visits is in line with a previous study that revealed that 38 to 50% pwMS reported missing or canceling an appointment or delays (Chen et al., 2022). When investigating Covid-19 infection and related outcomes, we also found that the type of DMT did not predict a higher rate of Covid-19 infection or negative outcomes in our sample. These analyses compared pwMS on first, second line DMT and no DMT; moreover, due to the evidence that pwMS on anti-CD20 monoclonal antibodies may be at higher risk of severe Covid-19 outcomes (Simpson-Yap et al., 2021; Landtblom et al., 2021), an additional analysis was performed to compare pwMS on anti-CD20 therapies (i.e., people on Ocrelizumab or Rituximab), people on other DMTs, and pwMS with no pharmacological therapy. However, in each analysis no differences were found between groups. The inconsistency between our results and previous studies may be explained by differences in socio-demographic and clinical data (i.e., time elapsed from last infusion, levels of humoral and cellular immunity, treatment duration) in the samples. Data collection regarding these clinical aspects was beyond the scope of the present study, so it was not possible to fully analyze these possible differences and this aspect should be taken into account.

The only variable that seemed to influence the judgment of pwMS on level of assistance provided by MSC was the disease duration, with newly diagnosed pwMS that reported higher levels of satisfaction with respect to pwMS with longer disease duration, and this difference could not be explained by different levels of ambulatory ability among pwMS, since it did not have an impact on levels of satisfaction regarding the MSC activities; although it is difficult to provide an explanation of this result, it has to be noted that newly diagnosed pwMS had just few or no contacts with their MSC before the pandemic (because they just received MS diagnosis or they were not diagnosed yet), so it is possible that, based on their experience - which was mostly related to the pandemic period - they did not perceive a reduction on access to MSC or an increase of disruption of neurological services. Another explanation of this finding may be that, since in this sample pwMS with lower disease duration were also significantly younger and with higher ambulation ability than those with higher disease duration, they may have been able to get in touch more easily (i.e., by employing multiple contact channels) with respect with older and more disabled pwMS with longer disease duration.

Moving on to the challenging modalities of support provided by MSC during the Covid-19 pandemic, such as tele-health services or psychological support, some differences emerged on tele-health services: in our study, only 1.3% of pwMS underwent a routine visit by means of tele-health software, whereas in other studies tele-health use was reported by a significantly larger number of participants (Chen et al. 2022: 61–62%; Keszler et al. 2021: 75.8%; McGinley et al. 2021: 90%; Portaccio et al. 2022: 92%). This discrepancy might be explained by the fact that, in these studies, all types of electronic communication were regarded as tele-health (i.e., email, messaging services, video-calls). On

the other hand, in this study, we considered and analyzed each contact modality separately, and the frequency of use of specific tele-health software was considered a distinct outcome. In fact, when we compared frequencies of usage of specific tele-health software/video-calls, the discrepancy reduced significantly: for example, Portaccio et al. (2022) reported a frequency of 4%. Interestingly, most of pwMS believed that tele-health services should be further ameliorated to provide better care and management to MS patients, in line with other studies (Landi et al., 2022). Preliminary studies on telemedicine for pwMS during Covid-19 pandemic demonstrated that it can be an effective and suitable care method for MS (Corea et al., 2021), it is well accepted by pwMS (Chen et al., 2022) and it can be employed not only as a temporary method of care, but as a permanent one, when the Covid-19 pandemic will end. Indeed, tele-health can be beneficial to both patients and MSC since it reduces access difficulties for pwMS, increases protection from exposure to infectious agents, reduces costs of travel for patients and it is associated with higher pwMS and caregivers' satisfaction (Hatcher-Martin et al., 2020, 2021). However, not all studies found a significant beneficial effect of telemedicine programs. For example, a recent study (Landtblom et al., 2019) reported a negative result in terms of better adherence or better health-related quality of life when comparing a tele-health program with standard technical support. Moreover, some concerns were raised by some neurologists on the efficacy of this type of medical care in MS and tele-health has been considered more suitable for other neurological patients, i.e., people with epilepsy or migraine (Landtblom et al., 2021). Our study found that frequency of follow-up tele-health visit did not depend on any socio-demographic and/or clinical variable; therefore, there was no specific category of pwMS who was more likely to undergo a telemedicine visit. However, due to the small number of pwMS who experienced a telemedicine visit in our sample, no definite conclusions should be made. Instead, it should be interesting to evaluate this issue with larger samples, and also to investigate which clinical and socio-demographic variables may predict a better efficacy of tele-health services, and which specific clinical activity may be carried on with a tele-health approach. Furthermore, future studies may further explore this interesting topic by evaluating the possible increase of percentages of usage of tele-health software over time. Our study only investigated the first year of pandemic, and it is possible that, in the subsequent Covid-19 pandemic waves, MSCs arranged novel tele-health services.

As for psychological services that were active or activated during the pandemic, most of pwMS were not informed on whether they were available or not at the time of the survey. Although pwMS did not show an increase of psychological distress after the Covid-19 outbreak (Altieri et al., 2022), prevalence rates of depression and anxiety are higher in pwMS than their healthy peers (Boeschoten et al., 2017) and access to mental health services should be facilitated in pwMS, independently from the pandemic. The results from our survey may prompt MSC staff to better communicate the presence of live or remote psychological services to their patients- if they are already available - or to organize psychological programs at pwMS' disposal. The access to psychological services within MSC may help increasing patients' resilience, quality of life, and trust in their healthcare providers: in fact, it has been highlighted that pwMS are more satisfied if psychological interventions are provided by mental health providers with expertise in MS and within their MSC (Rintell et al., 2012).

Of course, the results of this study should be interpreted in light of some limitations. For example, this study was on a voluntary basis, so a selection bias could not be excluded; moreover, since our survey was available online only, pwMS with limited access to the Internet could have been underrepresented. Moreover, geographical localization was not homogeneous, and so our sample could not have been fully representative of Italian MS population. Finally, since the sample was composed only by Italian pwMS, we could not assess possible differences among European and extra-European countries and the results may not be generalizable to pwMS living in other countries.

4.1. Conclusions

This multicentric survey has important implications for future management of MS, revealing not only an efficient MSC response to Covid-19 pandemic as regards pwMS management, but also providing the basis for future developments and improvement of care services, such as the implementing of remote psychological and tele-health services that would further improve the taking charge of patients, particularly those with longer disease, higher disability, and/or living far from their MSC.

CRediT authorship contribution statement

Manuela Altieri: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Rocco Capuano:** Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Alvino Bisecco:** Investigation, Methodology, Writing – review & editing. **Alessandro d’Ambrosio:** Investigation, Methodology, Writing – review & editing. **Mario Risi:** Investigation, Writing – review & editing. **Paola Cavalla:** Investigation, Writing – review & editing. **Marco Vercellino:** Investigation, Writing – review & editing. **Pietro Annovazzi:** Investigation, Writing – review & editing. **Mauro Zaffaroni:** Investigation, Writing – review & editing. **Nicola De Stefano:** Investigation, Writing – review & editing. **Maria Laura Stromillo:** Investigation, Writing – review & editing. **Emanuele D’Amico:** Investigation, Writing – review & editing. **Aurora Zanghi:** Investigation, Writing – review & editing. **Maria Chiara Buscarinu:** Investigation, Writing – review & editing. **Roberta Lanzillo:** Investigation, Writing – review & editing. **Giovanna De Luca:** Investigation, Writing – review & editing. **Massimiliano Calabrese:** Investigation, Writing – review & editing. **Lorena Lorefice:** Investigation, Writing – review & editing. **Massimiliano Di Filippo:** Investigation, Writing – review & editing. **Paola Valentino:** Investigation, Writing – review & editing. **Alberto Gajofatto:** Investigation, Writing – review & editing. **Girolama Alessandra Marfia:** Investigation, Writing – review & editing. **Aurora Fuiani:** Investigation, Writing – review & editing. **Viviana Nociti:** Investigation, Writing – review & editing. **Gioacchino Tedeschi:** Investigation, Writing – review & editing. **Antonio Gallo:** Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Antonio Gallo reports a relationship with Biogen that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Antonio Gallo reports a relationship with Merck Serono that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Antonio Gallo reports a relationship with Mylan ITALIA Srl that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Antonio Gallo reports a relationship with Novartis that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Antonio Gallo reports a relationship with Roche that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Antonio Gallo reports a relationship with Sanofi Genzyme that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Antonio Gallo reports a relationship with Teva Health that includes: consulting or advisory, speaking and lecture fees, and travel reimbursement. Lorena Lorefice reports a relationship with Biogen that includes: consulting or advisory and speaking and lecture fees. Lorena Lorefice reports a relationship with Novartis that includes: consulting or advisory and speaking and lecture fees. Lorena Lorefice reports a relationship with Sanofi that

includes: consulting or advisory and speaking and lecture fees. Lorena Lorefice reports a relationship with Sanofi Genzyme that includes: consulting or advisory and speaking and lecture fees. Lorena Lorefice reports a relationship with Merck Serono that includes: consulting or advisory and speaking and lecture fees. Lorena Lorefice reports a relationship with Teva Health that includes: consulting or advisory and speaking and lecture fees. Lorena Lorefice reports a relationship with Almirall Ltd that includes: speaking and lecture fees. Alvino Bisecco reports a relationship with Biogen that includes: consulting or advisory and speaking and lecture fees. Alvino Bisecco reports a relationship with Roche that includes: consulting or advisory and speaking and lecture fees. Alvino Bisecco reports a relationship with Merck & Co Inc that includes: consulting or advisory and speaking and lecture fees. Alvino Bisecco reports a relationship with Celgene Corp Los Angeles that includes: consulting or advisory and speaking and lecture fees. Alvino Bisecco reports a relationship with Sanofi Genzyme that includes: consulting or advisory and speaking and lecture fees. Massimiliano Calabrese reports a relationship with Biogen that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with Bristol Myers Squibb that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with Celgene Corp Los Angeles that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with Sanofi Genzyme that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with Merck Serono that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with Novartis that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with Roche that includes: speaking and lecture fees. Massimiliano Calabrese reports a relationship with International Progressive MS Alliance that includes: funding grants. Massimiliano Calabrese reports a relationship with Ministry of Health that includes: funding grants. Massimiliano Di Filippo reports a relationship with Bayer AG that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Biogen Italy that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Sanofi Genzyme that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Merck & Co Inc that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Mylan ITALIA Srl that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Novartis that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Roche that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Siemens Healthineers that includes: speaking and lecture fees and travel reimbursement. Massimiliano Di Filippo reports a relationship with Teva Health that includes: speaking and lecture fees and travel reimbursement. Gioacchino Tedeschi reports a relationship with Teva Health that includes: board membership. Gioacchino Tedeschi reports a relationship with Roche that includes: board membership. Gioacchino Tedeschi reports a relationship with Eli Lilly Italy that includes: board membership. Gioacchino Tedeschi reports a relationship with Allergan US that includes: board membership. Gioacchino Tedeschi reports a relationship with Sanofi-Aventis US LLC that includes: speaking and lecture fees and travel reimbursement. Gioacchino Tedeschi reports a relationship with Merck Serono Ltd that includes: speaking and lecture fees and travel reimbursement. Gioacchino Tedeschi reports a relationship with Bayer Schering Pharma AG that includes: speaking and lecture fees and travel reimbursement. Gioacchino Tedeschi reports a relationship with Biogen Italy that includes: speaking and lecture fees and travel reimbursement. Gioacchino Tedeschi reports a relationship with Novartis that includes: speaking and lecture fees and travel reimbursement.

Funding source

None.

References

- Altieri, M., Capuano, R., Bisecco, A., et al., 2022. The psychological impact of Covid-19 pandemic on people with Multiple Sclerosis: a meta-analysis. *Mult. Scler. Relat. Disord.* 61, 103774 <https://doi.org/10.1016/j.msard.2022.103774>.
- Boeschoten, R.E., Braamse, A.M.J., Beekman, A.T.F., et al., 2017. Prevalence of depression and anxiety in Multiple Sclerosis: a systematic review and meta-analysis. *J. Neurol. Sci.* 372, 331–341. <https://doi.org/10.1016/j.jns.2016.11.067>.
- Chen, M.H., Goverover, Y., Botticello, A., et al., 2022. Healthcare disruptions and use of telehealth services among people with Multiple Sclerosis during the Covid-19 pandemic. *Arch. Phys. Med. Rehabil.* 103, 1379–1386. <https://doi.org/10.1016/j.apmr.2021.12.028>.
- Chertcoff, A., Bauer, J., Silva, B.A., et al., 2021. Changes on the health care of people with multiple sclerosis from Latin America during the Covid-19 pandemic. *Mult. Scler. Relat. Disord.* 54, 103120 <https://doi.org/10.1016/j.msard.2021.103120>.
- Corea, F., Ciotti, S., Cometa, A., et al., 2021. Telemedicine during the Coronavirus Disease (Covid-19) pandemic: a Multiple Sclerosis (MS) outpatients service perspective. *Neurol. Int.* 13, 25–31. <https://doi.org/10.3390/neurolint13010003>.
- Costello, K., Kennedy, P., Scanzillo, J., 2008. Recognizing nonadherence in patients with multiple sclerosis and maintaining treatment adherence in the long term. *MedGenMed Medscape Gen. Med.* 10 (9), 225.
- García-Azorín, D., Seher, K.M., Newton, C.R., et al., 2021. Disruptions of neurological services, its causes and mitigation strategies during Covid-19: a global review. *J. Neurol.* 268, 3947–3960. <https://doi.org/10.1007/s00415-021-10588-5>.
- Goyal, D.K., Mansab, F., Naasan, A.P., et al., 2021. Restricted access to the NHS during the Covid-19 pandemic: is it time to move away from the rationed clinical response? *Lancet Reg. Health Eur.* 8, 100201 <https://doi.org/10.1016/j.lanep.2021.100201>.
- Hatcher-Martin, J.M., Adams, J.L., Anderson, E.R., et al., 2020. Telemedicine in neurology: telemedicine work group of the American academy of neurology update. *Neurology* 94, 30–38. <https://doi.org/10.1212/WNL.00000000000008708>.
- Hatcher-Martin, J.M., Busis, N.A., Cohen, B.H., et al., 2021. American academy of neurology telehealth position statement. *Neurology* 97, 334–339. <https://doi.org/10.1212/WNL.00000000000012185>.
- Keszler, P., Maloni, H., Miles, Z., et al., 2021. Telemedicine utilization and perceptions of Multiple Sclerosis health care providers. *Mult. Scler. J.* 27 (1 SUPPL), 96.
- Landi, D., Ponzano, M., Nicoletti, C.G., et al., 2022. Patient's point of view on the use of telemedicine in multiple sclerosis: a web-based survey. *Neurol. Sci.* 43, 1197–1205. <https://doi.org/10.1007/s10072-021-05398-6>.
- Landtblom, A.M., Berntsson, S.G., Boström, I., Iacobaeus, E., 2021. Multiple sclerosis and Covid-19: the Swedish experience. *Acta Neurol. Scand.* 144, 229–235. <https://doi.org/10.1111/ane.13453>.
- Landtblom, A.M., Guala, D., Martin, C., et al., 2019. RebiQoL: a randomized trial of telemedicine patient support program for health-related quality of life and adherence in people with MS treated with Rebif. *PLOS One* 14, e0218453. <https://doi.org/10.1371/journal.pone.0218453>.
- McGinley, M.P., Gales, S., Rowles, W., et al., 2021. Expanded access to Multiple Sclerosis teleneurology care following the Covid-19 pandemic. *Mult. Scler. J. Exp. Transl. Clin.* 7, 2055217321997467 <https://doi.org/10.1177/2055217321997467>.
- Morrison, E.H., Michtich, K., Hersh, C.M., 2021. How the Covid-19 Pandemic has changed Multiple Sclerosis clinical practice: results of a nationwide provider survey. *Mult. Scler. Relat. Disord.* 51, 102913 <https://doi.org/10.1016/j.msard.2021.102913>.
- Moss, B.P., Mahajan, K.R., Bermel, R.A., et al., 2020. Multiple Sclerosis management during the Covid-19 pandemic. *Mult. Scler.* 26, 1163–1171. <https://doi.org/10.1177/1352458520948231>.
- Portaccio, E., Fonderico, M., Hemmer, B., et al., 2022. Impact of Covid-19 on Multiple Sclerosis care and management: results from the European Committee for treatment and research in Multiple Sclerosis survey. *Mult. Scler.* 28, 132–138. <https://doi.org/10.1177/13524585211005339>.
- Rieckmann, P., Boyko, A., Centonze, D., et al., 2015. Achieving patient engagement in multiple sclerosis: a perspective from the multiple sclerosis in the 21st century steering group. *Mult. Scler. Relat. Disord.* 4, 202–218. <https://doi.org/10.1016/j.msard.2015.02.005>.
- Rintell, D.J., Frankel, D., Minden, S.L., Glanz, B.I., 2012. Patients' perspectives on quality of mental health care for people with MS. *Gen. Hosp. Psychiatry* 34, 604–610. <https://doi.org/10.1016/j.genhosppsych.2012.04.001>.
- Simpson-Yap, S., De Brouwer, E., Kalincik, T., et al., 2021. Associations of disease-modifying therapies with Covid-19 severity in Multiple Sclerosis. *Neurology* 97, e1870–e1885. <https://doi.org/10.1212/WNL.00000000000012753>.
- Spadea, T., Di Girolamo, C., Landriscina, T., et al., 2021. Indirect impact of Covid-19 on hospital care pathways in Italy. *Sci. Rep.* 11, 21526. <https://doi.org/10.1038/s41598-021-00982-4>.
- WHO Director-General's opening remarks at the media briefing on Covid-19 - 11 March 2020. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19--11-march-2020>. Accessed 29 Jun 2022.