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## Implementing education: Personal communication with a healthcare professional is a critical step to address vaccine hesitancy for people with multiple sclerosis

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### ABSTRACT

**Background:** People with Multiple Sclerosis (PwMS) were first able to access COVID-19 vaccines in Australia from March 2021, when vaccine hesitancy in the general population was high (14–43%). High uptake of vaccination is important globally and critical to protect this vulnerable population. We conducted an on-line survey to examine factors influencing COVID-19 vaccination willingness among PwMS in Australia.

**Methods:** 149 PwMS living in Australia completed the on-line survey (April–September 2021) examining demographic, environmental and clinical factors with respect to vaccine willingness, including attitudes towards COVID-19 illness and vaccines. Additional items explored the influence of different information sources on vaccination decisions. Continuous and ordinal data were compared using the Mann-Whitney U test. All tests were two-tailed, with alpha set at 0.5.

**Results:** A majority of the respondents were female (87.2%) with relapsing-remitting MS (77.5%) treated by a neurologist (94.0%). A majority were on high efficacy disease-modifying therapies (DMTs) (64.9%), while 19.9% were on no DMTs. About one third of respondents (32.9%) had had two doses, 20.8% had received their first dose, and 22.1% were unvaccinated, while 24.2% of responses were missing. When asked about vaccine intentions, 60.6% of the unvaccinated indicated they were *likely to extremely likely* to get vaccinated, while 15.2% were *very unlikely or extremely unlikely* to do so and 24.2% were undecided. Unvaccinated people were significantly more concerned about vaccine side effects (mean 5.3 versus 3.1/10;  $p < .001$ ). Only 53.3% of people on DMTs were vaccinated, compared to 75% of those who were not. People on ocrelizumab therapy ( $n = 35$ ) had a lower vaccination rate (39%) than those on other medications ( $n = 86$ , 59%). Vaccine willingness in the unvaccinated was most highly correlated with knowledge regarding the vaccine ( $r_s^2 = .709$ ), agreement with the statement that COVID-19 vaccination is “too new for me to be confident about getting vaccinated” ( $r_s^2 = -.709$ ), anticipation of regret due to side effects of vaccination ( $r_s^2 = -.642$ ), and lack of knowledge regarding interactions between COVID-19 vaccines and DMTs ( $r_s^2 = -.570$ ).

Almost two thirds had read MS-specific information about COVID-19 vaccinations and found it easy to understand (67.6%) and applicable to their situation (53.6%). However, less than half (47.8%) reported the information helped them make a personal vaccination decision. Over two-thirds (64.9%) had discussed vaccinations with their healthcare professional and 31.1% had not. Those who had not, were significantly more uninformed about the interactions of the vaccine with MS medications (mean 3.9 versus 2.9/10;  $p = .044$ ) and significantly lower intention of vaccine uptake than those who had (mean 5.8 versus 7.9/10;  $p = .009$ ).

**Conclusion:** Our study highlights that vaccination efforts should be delivered by healthcare professionals, focus on educating those who are managed with DMTs, and include individual recommendations related to specific DMTs, how the vaccines work, expectations regarding potential side-effects, potential exacerbation of MS symptoms, likelihood of recovery from any exacerbation, and the relative risks of side effects versus COVID-19 infection. Specific recommendations are provided.

### 1. Introduction

In March 2020, a pandemic was declared by the World Health Organization in response to the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which caused the illness named COVID-19. The Australian government's national recovery plan, based

on modeling from the Doherty Institute, hinges critically on vaccinating a substantial proportion of the population (e.g. 80% of the adult (16+) population) (Doherty Institute, 2021). The first COVID-19 vaccine (Pfizer-BioNTech BNB162B2) was approved for emergency use in the United Kingdom and Europe in December 2020. However, the COVID-19 vaccination program in Australia was delayed, so people with

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<https://doi.org/10.1016/j.msard.2022.103933>

Received 1 February 2022; Received in revised form 30 March 2022; Accepted 28 May 2022

Available online 1 June 2022

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Multiple Sclerosis (PwMS) were first able to access vaccines from 22nd March 2021.

Multiple Sclerosis (MS) is an auto-immune disease and current management often includes long-term administration of disease-modifying treatments (DMTs) which act to lower or alter the body's immune response. Prior to COVID-19, DMTs were associated with increased infection risk and hospitalization risk due to infection (Luna et al., 2020; Wijnands et al., 2017). Thus, concerns emerged regarding the potential effects of DMTs on COVID-19 outcomes (Sormani, 2020).

There are numerous considerations regarding optimal timing of vaccination depending on the type of DMT. The Australian and New Zealand Association of Neurologists, in collaboration with MS Australia, published evidence-based clinical guidance regarding COVID-19 vaccination, accompanied by comprehensive guidance in lay language for PwMS, in February 2021 (MS Australia, 2021). This guidance has been regularly updated to reflect new evidence and include advice for timing of vaccinations for people taking various DMTs.

Although vaccines for COVID-19 have been recommended for PwMS, vaccine hesitancy has been reported in a significant proportion of PwMS in different countries (Diem et al., 2021; Ehde et al., 2021; Xiang et al., 2021). Confidence in the safety and effectiveness of vaccines plays an important role in vaccine uptake. Relatively few PwMS were included in clinical safety and efficacy trials of COVID-19 vaccines, leaving uncertainties. Trust in government has also been associated with vaccination uptake (Lazarus et al., 2021). In Australia, the Federal Government is responsible for procurement, distribution, and management regarding eligibility for vaccines, whereas the State and Territory Governments are responsible for delivering vaccines and healthcare.

From March–July 2021, rates of vaccine hesitancy in the Australian population varied from 14–43% across states, which were affected differently by outbreaks, lockdowns, and border closures. Most of Australia experienced some stay-at-home orders during the first wave of COVID-19 infections in March–May 2020. The state of Victoria, however, experienced a large and prolonged second wave of COVID-19 infections which triggered a strict lockdown from July–October 2020, lasting 112 days, which was the longest continuous lockdown in the world to date (BBC, 2020).

In a survey of Australians with MS who attended a single centre for infusion DMT during the first 6 months of the pandemic (prior to vaccines being available), 57% of respondents indicated their primary COVID-19-related concern was increased risk of catching the illness, followed by an increased risk of poor outcomes, if infected (30%)(11). However, when asked to compare COVID-19 concerns versus MS-related concerns, such as relapse or worsening, more people either reported MS-related concerns as higher or both as equal (Seery et al., 2020). In that early pandemic period, only 35% of those surveyed indicated they had communicated with a neurologist during routine appointment to gain information about COVID-19 and its influence upon their health care, whereas only 20% had accessed the MS Australia website and 15% had contacted non-medical staff in the MS Unit regarding COVID-19 (Seery et al., 2020).

High uptake of vaccination is important on several levels. With the introduction of more contagious variants of COVID-19 of concern, Delta then Omicron BA.1 and BA.2, there have been predictions that achieving winter herd immunity would require more than 70–80% of individuals to be immune (Murray and Piot, 2021). Before COVID-19 vaccines were authorized for use in people under 12 years, only about 81% of Australians were eligible to be immunized. Even with the excellent uptake of vaccines in Australia in recent months, 90% of the 12+ population only equates to 72.9% of the total population. Many PwMS are in their child-bearing years with unvaccinated children returning to school; public health advice strongly recommends that adults living and working with children be immunised to help limit the spread of infections to the wider community. There are also global pressures to vaccinate immunocompromised populations, because several case reports have indicated that highly-mutated SARS-CoV-2 variants of concern

preferentially emerge during prolonged infections in immunosuppressed hosts (Choi et al., 2020; Corey et al., 2021). Differences in vaccine hesitancy have been recorded across geographic, demographic and clinical factors, emphasizing the need for targeted studies of specific subgroups in different countries (Salomoni et al., 2021).

Published studies comparing mortality and outcomes from COVID-19 in PwMS convey widely variable results (Ghadiri et al., 2021; Parrotta et al., 2020; Prosperini et al., 2021). There are several factors to consider in making the decision of whether and when to get vaccinated, including the theoretical risk of MS relapse, the potential for aggravation of MS symptoms in the context of a febrile reaction to vaccination (pseudorelapse) (Garjani et al., 2021; Stastna et al., 2021) and influences that some DMTs have upon the serological response (Hughes et al., 2021; Monschein et al., 2021). Thus, we sought to examine factors influencing COVID-19 vaccination willingness among PwMS in Australia.

## 2. Materials and methods

### 2.1. Study design: observational, cross-sectional

The online survey was approved by Melbourne Health Human Research Ethics committee (2021-21264-16221-2.) Respondents were recruited through word of mouth at the Royal Melbourne Hospital MS Centre, printed fliers, a link posted on the Multiple Sclerosis Research Australia website and newsletter, and via social media. Inclusion criteria were adults with self-reported MS living in Australia in 2020. The survey was hosted on the University of Melbourne REDCap server and was available online from 22nd April to 23rd September, 2021.

The survey requested demographic information (age, gender, educational level, essential worker status, post code and residential area type (rural/regional/urban), MS characteristics (subtype, duration, primary MS care provider, DMT and other medications, and patient determined disease steps (PDDS). The survey also included questions regarding physical activity and exercise routine disruptions, which will be reported separately.

Twenty four questions were selected from an early study on COVID-19 vaccination acceptability (CoVAccs) (Sherman et al., 2021). These items encompass constructs that have been shown to influence vaccine uptake. Previous studies suggest that behavior intention is the best predictor of actual vaccination behavior (Corace et al., 2016). Behavior intention is influenced most strongly by beliefs and attitudes (Corace et al., 2016), followed by subjective norms (the opinion of important others, including healthcare practitioners) (Corace et al., 2016; Coe et al., 2012; Rosenthal et al., 2011). Vaccine uptake is also influenced by the perception of health risk (Jones et al., 2015), past vaccination behavior (Coe et al., 2012), contextual influences, communication environment and knowledge awareness. (Sherman et al., 2021; Larson et al., 2015) These constructs were surveyed using an 11-item scale, where responses ranged from 0 (strongly disagree) to 10 (strongly agree), and were treated as continuous variables.

Participants were asked whether they had read information regarding COVID-19 vaccination written for people with MS and the source of that information. Those who responded 'yes' were asked their opinion on the understandability, relevance, and helpfulness in decision-making of the information provided on an 11-item scale, as described above.

Questions about perceived general population and personal risk from COVID-19 were also taken from the CoVAccs study; these responses were recorded on a 5-item scale, with 1=no risk and 5= major risk (Sherman et al., 2021). Vaccination status was recorded as no, one dose or two doses. For those reporting no COVID-19 vaccination, vaccination intent was recorded on an 11-item scale with 0=extremely unlikely, 5=undecided, and 10=extremely likely.

Demographic and residence information and disease characteristics are reported with descriptive statistics: mean (SD) for normally

distributed and median (IQR) for non-parametric continuous variables and frequency (percentage) for categorical variables.

Statistical analyses were conducted using IBM-SPSS 27 (IBM Inc., Chicago, IL, USA). Continuous data were compared using the independent samples t-test, if normally distributed, or the Mann-Whitney U test, which was also used for comparing ordinal variables. For variables with missing data, the number of valid values is stated. All tests were two-tailed, with alpha set at 0.5.

### 3. Results

Some 311 people engaged with the pre-screening form, 17 were ineligible and 37 did not consent. Of the remaining 257 eligible people, 149 (58%) completed the survey and were included in the analysis.

**Table 1**  
Participant clinical and personal characteristics.

Gender		N	%
Gender	Female	130	87.2%
	Male	17	11.4%
	non-binary	2	1.3%
Age Groups (years) median age 48	18-29	5	3.3%
	30-39	26	17.2%
	40-49	46	30.5%
	50-59	44	29.1%
	60-69	15	9.9%
	70-79	5	3.3%
	unreported	10	6.6%
Type of MS	Relapsing-Remitting	117	77.5%
	Primary Progressive	12	7.9%
	Secondary Progressive	15	9.9%
	Clinically-isolated syndrome	1	0.7%
	Unsure	6	4.0%
Years Since Diagnosis median 7y	0-1	17	11.3%
	2-5	44	29.1%
	6-10	35	23.2%
	11-20	33	21.9%
	21-30	17	11.3%
	30+	5	3.3%
PDDS median 2.0	0	36	23.8%
	1	33	21.9%
	2	16	10.6%
	3	25	16.6%
	4	16	10.6%
	5	8	5.3%
	6	9	6.0%
	7	5	3.3%
	Missing	3	2.0%
	Residence	Metro/urban	85
Outer urban		21	13.9%
Large Regional Hub		15	9.9%
Small/Medium Regional		23	15.2%
Rural/remote		7	4.6%
Education	Primary or High school	28	18.5%
	Vocational or TAFE	20	13.2%
	Apprenticeship	1	0.7%
	Undergraduate degree	52	34.4%
	Other technical or professional qualification	18	11.9%
	Postgraduate Degree (Master's)	26	17.2%
	Medical Specialist or Doctorate	6	4.0%
Keyworker Status	Health or Social Care Worker	32	21.2%
	Education or Childcare	20	13.2%
	Public Service	5	3.3%
	Government	3	2.0%
	Food or Essential Goods	7	4.6%
	Public Safety	1	0.7%
	Transport	1	0.7%
	Utilities	2	1.3%
	None	78	51.7%
	Prefer not to say	2	1.3%

Demographic and clinical characteristics are presented in Table 1. A large majority of the respondents were female (87.2%) with relapsing-remitting MS (77.5%) treated by a neurologist (94.0%). The age range was 18–79, mean (SD) 48 (Seery et al., 2020) years. Over half lived in metro/urban areas (56.3%), followed by small/medium regional towns (15.2%), outer urban areas (13.9%), large regional centres (9.9%) and rural/remote areas (4.6%). Most respondents had minimal to no disability as per the Patient Determined Disease Steps (PDDS 0-1) (45.7%), or mild disease (PDDS 2-4) (37.8%), with only 14.6% with greater disability. A majority were on high efficacy DMTs (64.9%), while 19.9% were on no DMTs. Most of the participants lived in Victoria (47.7%), followed by NSW/ACT (39.7%). The remaining respondents were from QLD (4.6%), WA (2.6%), TAS (1.3%), SA (0.7%). Nearly half of the respondents reported being “essential workers”, who were exempt from work-from-home orders. These included healthcare workers (21.2%), childcare or education workers (13.2%), and workers in the food or other essential goods distribution pipeline (4.6%) or public health (3.3%).

About one third of respondents (32.9%) had had two doses, 20.8% had received their first dose, and 22.1% were unvaccinated, while 24.2% of responses were missing. When asked about vaccine intentions, 39.4% of the unvaccinated indicated they were *very likely to extremely likely* to get vaccinated, 21.2% were *likely* to do so, while 15.2% were *very unlikely or extremely unlikely* to do so and 24.2% were undecided.

Descriptive statistics of the beliefs and attitudes items are presented in Tables 2 and 3. Completion of these items was >99%. Univariate analyses comparing beliefs and attitudes between vaccinated and unvaccinated people are presented in Table 4. Since adherence with multiple dose schedules is known to be very high, those who had one dose were considered as vaccinated.

#### 3.1. Health risk perception

Only four respondents reported having contracted COVID-19. Respondents perceived higher risk of COVID-19 to Australians in general (mean 3.0/5) than to themselves personally (mean 2.7/5), although belief in personal immunity to COVID-19 was rare. All reported thinking the coronavirus posed some risk to people in Australia and only 2% perceived no personal risk. Vaccinated respondents expressed perception of greater risk to people in Australia (mean 3.2/5) from the coronavirus than unvaccinated people (mean 2.8/5;  $p = .007$ ). The vast majority (79.5%) were worried to some extent about COVID-19 infection and disagreed that it would always be a mild infection (80.8%). Unvaccinated respondents were less likely to agree that “without a coronavirus vaccination, I am likely to catch COVID-19” (mean 4.2 versus 5.5/10;  $p < .001$ ). However, there was no difference in concern regarding catching COVID-19 and no difference in perceived severity of the disease according to vaccination status.

#### 3.2. Vaccination beliefs and prior practices

Unvaccinated people disagreed more with the statement that “If I get a coronavirus vaccination, I will be protected against coronavirus” (mean 3.8 versus 4.6;  $p = .021$ ). People who had received an influenza vaccination in 2019 were three times more likely to take up the COVID-19 vaccine. Most (88.7%) did not believe they were immune to COVID-19, six people (7%) believed they were immune to COVID-19; one was unvaccinated (an undecided about getting it), three had had one vaccine dose and two were fully vaccinated. Very few (3.9%) people thought that the vaccine could give them the coronavirus.

#### 3.3. Vaccine concerns

Roughly equivalent numbers of respondents were concerned as opposed to not concerned about side effects of the vaccination (47.7% vs. 43.7% respectively). Unvaccinated people were significantly more

**Table 2**

Descriptive statistics for continuous items measuring beliefs and attitudes about COVID-19 and a COVID-19 vaccination and vaccination intention. Data are mean (standard deviation) on a 0–10 numerical rating scale (0 = strongly disagree, 10 = strongly agree).

Attitudes and beliefs about COVID-19	Mean	SD
To what extent do you think the coronavirus poses a risk to people in Australia?	3.9	0.9
To what extent do you think the coronavirus poses a risk to you personally?	3.6	1.1
I am worried about catching Covid-19	6.9	2.6
I believe that Covid-19 would be a mild illness for me	2.6	2.6
We are all responsible for reducing the spread of the coronavirus	9.0	1.7
I believe I am immune to Covid-19	1.2	2.4
The coronavirus pandemic has had a big impact on my life	6.8	2.6
I trust the Federal government to manage the coronavirus pandemic in Australia	4.5	3.2
I trust the State government to manage the coronavirus pandemic in Australia	5.8	2.9
I trust the Australian healthcare system to manage the coronavirus pandemic in Australia	6.6	2.6
<b>Attitudes and beliefs about a COVID-19 vaccination</b>		
A coronavirus vaccination should be made mandatory for everyone who is able to have it.	6.6	3.2
Without a coronavirus vaccine, I am likely to catch Covid-19	6.4	2.7
If I get a coronavirus vaccination, I will be protected against coronavirus	5.3	2.7
A coronavirus vaccination could give me coronavirus	0.9	1.8
I would be worried about experiencing side effects from a coronavirus vaccination	4.8	3.2
I might regret getting a coronavirus vaccination if I later experienced side effects from the vaccination.	4.1	3.4
A coronavirus vaccination will be too new for me to be confident about getting vaccinated	3.4	3.3
Most Australians will get a coronavirus vaccination	6.3	2.1
Other people like me will get a coronavirus vaccination	7.0	2.0
In general, vaccination is a good thing	8.8	1.4
If I were vaccinated, I would not need to follow social distancing and other coronavirus restrictions	2.4	2.5
<b>Vaccination intentions</b>		
When a coronavirus vaccination becomes available to you, how likely is it that you will have one?	3.0	1.6
As far as you know, would your employer want you to have the coronavirus vaccination?	7.2	3.0
<b>Knowledge Sufficiency</b>		
I do not know enough about the coronavirus ILLNESS to make an informed decision about whether to get vaccinated.	1.8	2.5
I do not know enough about the coronavirus VACCINE to make an informed decision about whether to get vaccinated.	2.6	3.0
I do not know enough about the coronavirus vaccine's interaction with my MS medications to make an informed decision about whether to get vaccinated.	4.0	3.5

concerned about vaccine side effects (mean 5.3 versus 3.1/10;  $p < .001$ ) (Fig. 1). While 55% of respondents reported they would not regret getting the vaccine if they later experienced side effects, unvaccinated people anticipated significantly greater regret (mean 4.9 versus 2.9/10;  $p < .001$ ). Although agreement was very low overall, unvaccinated people agreed to a greater extent that the vaccine could give them COVID-19 illness (1.8 versus 1.3/10;  $p = .004$ ). Unvaccinated people agreed significantly more highly that the COVID-19 vaccine was “too new for me to be confident about getting vaccinated” (mean 4.7 versus 2.1/10;  $p < .001$ ).

**3.4. Subjective norms**

Almost all respondents (96.1%) agreed to some extent that “we are all responsible for reducing the spread of the coronavirus,” with people experiencing extended strict lockdown in Melbourne agreeing to a significantly greater extent. This perception did not vary according to vaccination status. Respondents agreed more highly that people like themselves (5.5/10) would get vaccinated, compared to most Australians (4.9/10), and there was no difference by vaccination status, but the

**Table 3**

Descriptive results for ordinal and categorical items.

Perception Of Health Risk	Response	n	%	
To what extent do you think the coronavirus poses a risk to people in Australia?	No Risk	1	0.1	
	Minor Risk	44	29.1	
	Moderate Risk	62	41.1	
	Considerable Risk	44	29.1	
	Major Risk	0	0.0	
To what extent do you think the coronavirus poses a risk to you personally?	Do not Know	0	0.0	
	No Risk	6	4.0	
	Minor Risk	62	41.1	
	Moderate Risk	51	33.8	
	Considerable Risk	31	20.5	
Major Risk	0	0.0		
	Missing	1	0.7	
	<b>Vaccination Beliefs</b>			
	Did you have a flu vaccination in 2019 (before the pandemic)?	Yes	30	19.9
		No	118	78.1
Do not Remember		2	1.3	
Missing	1	0.7		
	<b>Social Norms</b>			
	As far as you know, would your employer want you to have the coronavirus vaccination?	No	5	3.3
Yes		75	49.7	
Not Sure		25	16.6	
Not Applicable	46	30.5		
	<b>Communication and Information Seeking</b>			
	Has the healthcare professional who primarily manages your Multiple Sclerosis discussed vaccination with you?	No	47	31.1
Yes		98	64.9	
Not Sure		5	3.3	
Not Applicable	1	0.7		
	Have you asked your MS doctor about the coronavirus vaccination?	No	51	33.8
		Yes	98	64.9
Not Sure		1	0.7	
Missing	1	0.7		
	Have you read any information about coronavirus vaccinations for people with Multiple Sclerosis?	No	53	35.1
		Yes	93	61.6
Not Sure		5	3.3	
Multiple Sclerosis Australia	49	32.5		
	MS Society UK	7	4.6	
	Several Sources	24	15.9	
I can not remember	10	6.6		
	Prefer not to say	2	1.3	
	Missing	59	39.1	
<b>The extent to which respondents agreed (0=strongly disagree to 10= strongly agree)</b>				
I found the information easy to understand	93	5.9	0.9	
The information was applicable to my situation	92	5.6	1.2	
The information helped me make a decision regarding my own coronavirus vaccination	93	5.2	1.6	

average agreement scores indicated that participants were generally non-committal, overall.

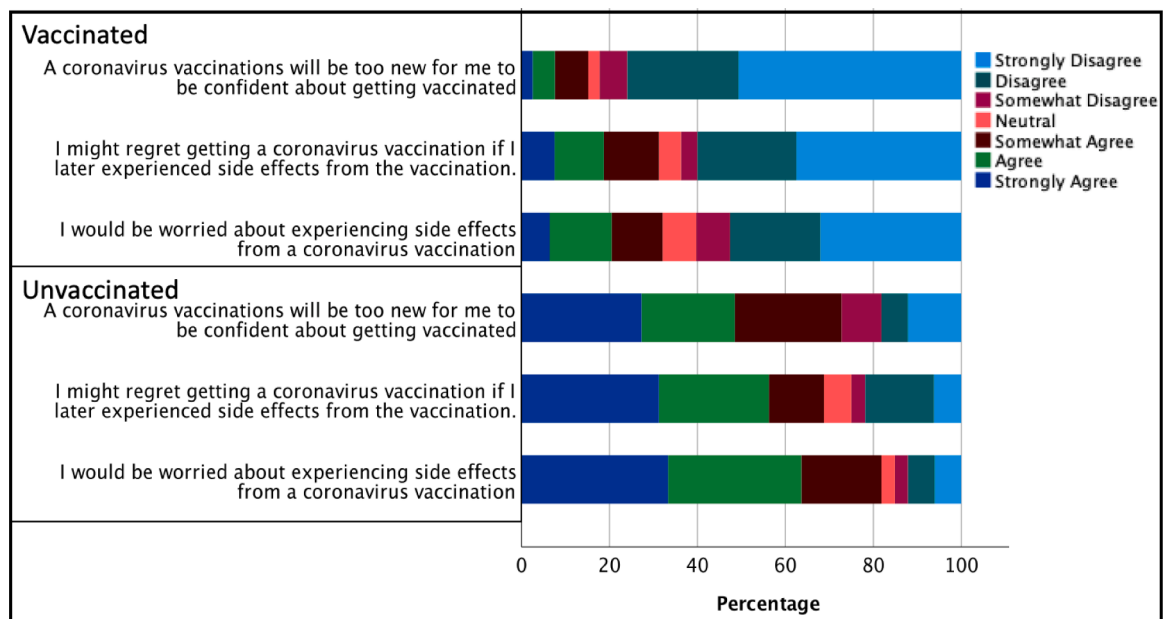
Vaccinated people responded more positively to the statement that “in general, vaccinations are a good thing” (mean 6.6 versus 6.3;  $p = .003$ ) and that “COVID-19 vaccination should be mandatory” (mean 5.6 versus 4.1;  $p = .001$ ).

**3.5. Context, communication and trust**

Australian State and Territory Governments’ primary roles are

**Table 4**  
Univariate analysis – 11-point scale.

Grouping variable:	Vaccinated (n = 81)			Unvaccinated (n = 33)			Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
	Median	Q 25	Q75	Median	Q 25	Q75			
To what extent do you think the coronavirus poses a risk to people in Australia?	3	3	4	3	2	3	1019	-2.123	<b>0.034</b>
To what extent do you think the coronavirus poses a risk to you personally?	3	2	3	3	2	3.8	1293.5	-0.017	0.987
I am worried about catching Covid-19	6	5	6.5	6	5	7	1213.5	-0.796	0.426
I believe that Covid-19 would be a mild illness for me	2	1	3	2	1	3	1245	-0.602	0.547
We are all responsible for reducing the spread of the coronavirus	7	7	7	7	6	7	1114	-1.648	0.099
I believe I am immune to Covid-19	1	1	2	1	1	1	1114.5	-1.603	0.109
The coronavirus pandemic has had a big impact on my life	6	5	7	6	3	6	1028.5	-1.99	<b>0.047</b>
I trust the Federal government to manage the coronavirus pandemic in Australia	4	2	6	2	2	5.5	1152	-1.08	0.28
I trust the State government to manage the coronavirus pandemic in Australia	6	3	6	4	2	6	993	-2.119	0.034
I trust the Australian healthcare system to manage the coronavirus pandemic in Australia	6	4	7	5	2.5	6	997	-2.185	<b>0.029</b>
A coronavirus vaccination should be made mandatory for everyone who is able to have it.	6	5	7	5	1.5	7	951.5	-2.4	0.016
Without a coronavirus vaccine, I am likely to catch Covid-19	6	5	7	4.5	2	6	692	-3.835	<b>0</b>
If I get a coronavirus vaccination, I will be protected against coronavirus	5	3	6	3	1.5	5.5	942	-2.516	<b>0.012</b>
A coronavirus vaccination could give me coronavirus	1	1	1	1	1	2.5	948.5	-3.176	<b>0.001</b>
I would be worried about experiencing side effects from a coronavirus vaccination	2	1	5	6	5	7	541.5	-4.941	<b>0</b>
I might regret getting a coronavirus vaccination if I later experienced side effects from the vaccination.	2	1	5	6	3.25	7	614.5	-4.436	<b>0</b>
A coronavirus vaccinations will be too new for me to be confident about getting vaccinated	1	1	2	5	3	7	454.5	-5.681	<b>0</b>
Most Australians will get a coronavirus vaccination	5	4	6	5	5	6	1333.5	-0.02	0.984
Other people like me will get a coronavirus vaccination	6	5	6	6	4.5	6	1120.5	-1.436	0.151
In general, vaccination is a good thing	7	6	7	6	6	7	912	-2.962	<b>0.003</b>
If I were vaccinated, I would not need to follow social distancing and other coronavirus restrictions	2	1	3.75	2	1	3	1213	-0.71	0.478
I do not know enough about the coronavirus ILLNESS to make and informed decision about whether or not to get vaccinated.	1	1	2	2	1	5	734.5	-4.211	<b>0</b>
I do not know enough about the coronavirus VACCINE to make and informed decision about whether or not to get vaccinated.	1	1	2	5	2	6	520.5	-5.513	<b>0</b>
I do not know enough about the coronavirus vaccine's INTERACTION WITH MY MS MEDICATIONS to make an informed decision about whether or not to get vaccinated.	2	1	4	6	2.5	7	530	-5.121	<b>0</b>
Think about the article or resource you most remember about coronavirus vaccination for people with MS.									
I found the information easy to understand	6	6	6	6	5	6	323	-2.364	<b>0.018</b>
The information was applicable to my situation	6	6	6	6	4	6	342.5	-2.008	<b>0.045</b>
The information helped me make a decision regarding my own coronavirus vaccination	6	5	6	4	2	6	294	-2.776	<b>0.006</b>



**Fig. 1.** Response scales for concerns regarding COVID-19 vaccination, stratified by COVID-19 vaccination status. Item statements are presented on the y-axis with color-coded Likert-type scale. Items ordered by proportion of strong disagreement.

managing healthcare, state border closures, hotel quarantine and all public health restrictions. The Federal Government's primary roles relating to the pandemic are obtaining vaccines and vaccine roll-out, and international border closures. More people (62.3%) trusted their state governments to manage the pandemic than did not (29.2%). Conversely, fewer people (43%) trusted the Federal government to manage the pandemic than did not (49%). Almost three-quarters (73.5%) trusted the Australian healthcare system to manage the pandemic. Half (50%) thought their employer would want them to have the vaccination. There was no statistically significant difference in trust in government or healthcare according to vaccination status.

### 3.6. Information sources and knowledge

Over 61% the respondents reported having read information about COVID-19 vaccinations for people with MS. Those who had read information did not demonstrate a significant difference in vaccine uptake or intention. Over a third (38-39%) did not respond to further questions about the information sources. Of those who did respond, almost one third read information from MS Australia (32.5%) followed by the MS Society UK (4.6%), while 15.9% consulted several sources, and 6.6% reported not remembering the source. Most respondents agreed that the information was easy to understand (67.6%) and applicable to their situation (53.6%). However, less than half (47.8%) agreed that the information helped them make a personal decision regarding COVID-19 vaccine uptake.

Over two-thirds (64.9%) of respondents had discussed vaccinations with their healthcare provider, 31.1% had not and 3.3% were unsure if they had done so. Overall, while the mean reported levels of knowledge were moderately high, people felt significantly more uninformed about the interactions between DMTs and the COVID-19 vaccine (3.4/10) compared to information concerning the vaccine itself (2.5/10) or the COVID-19 disease (2.0/10), which might have been relevant to making a decision about vaccination uptake. Only 11.2% agreed to some extent (5/10 or higher) that they lacked enough knowledge about the COVID-19 illness to make a decision about pursuing vaccination. People who had not discussed COVID-19 vaccination with their MS clinician reported being significantly more uninformed about the interactions of the vaccine with MS medications (mean 3.9 versus 2.9/10;  $p = .044$ ) and reported significantly lower intention of vaccine uptake than those who had discussed it (mean 5.8 versus 7.9/10;  $p = .009$ ) (Fig. 2).

### 3.7. Personal, environmental and clinical factors

People who had at least one dose of COVID-19 vaccine were slightly older (51 versus 46;  $p = .06$ ). We found no difference in educational level, disease burden (PDSS), body mass index or perception of personal risk from COVID-19 between vaccinated and unvaccinated people. Those who experienced extended lockdown measures, were keyworkers, or lived in urban areas, were not more likely to be vaccinated, and if not vaccinated, did not have a higher vaccination intent. Vaccinated people reported significantly higher impact of COVID-19 pandemic on their lives (2.8 versus 2.1/10;  $p = .015$ ).

Although vaccination rates and willingness to be vaccinated were generally high, only 53.3% of people on DMTs were vaccinated, compared to 75% of those who were not. People on ocrelizumab therapy ( $n = 35$ ) had a lower vaccination rate (39%) than those on other medications ( $n = 86$ , 59%), but the difference was not statistically significant. Vaccination intent was significantly lower in those on DMTs (mean 9.1 versus 10.2/11,  $p = .013$ ), who also reported significantly greater lack of knowledge about the vaccine (mean 2.7 versus 1.6/10;  $p = .022$ ) and about the vaccine's interaction with MS medications (mean 3.7 versus 2.2/10;  $p < .001$ ). People on DMTs were slightly more likely to have sought information from printed sources, but the incidence of information seeking was low overall, and the difference was not significant.

### 3.8. Factors associated with vaccination willingness in the unvaccinated

In those who were eligible, but not yet vaccinated there was no difference in hesitancy by sex, age or disability level. Vaccine willingness in those who were unvaccinated was not higher among those who experienced extended lockdown measures or those living in urban areas. Vaccine willingness in the unvaccinated was most highly correlated with knowledge regarding the vaccine ( $r_s^2 = .709$ ), agreement with the statement that COVID-19 vaccination is "too new for me to be confident about getting vaccinated" ( $r_s^2 = .709$ ), anticipation of regret due to side effects of vaccination ( $r_s^2 = .642$ ), and lack of knowledge regarding interactions between COVID-19 vaccines and MS medications ( $r_s^2 = .570$ ), in addition to other moderate correlations (Table 5). Unvaccinated people ( $n = n = 41/151$ ) who had spoken with their HCW about the vaccine reported higher vaccine willingness ( $n = 25$ , 7/10) than those that had not ( $n = 14$ , 5.8/10).

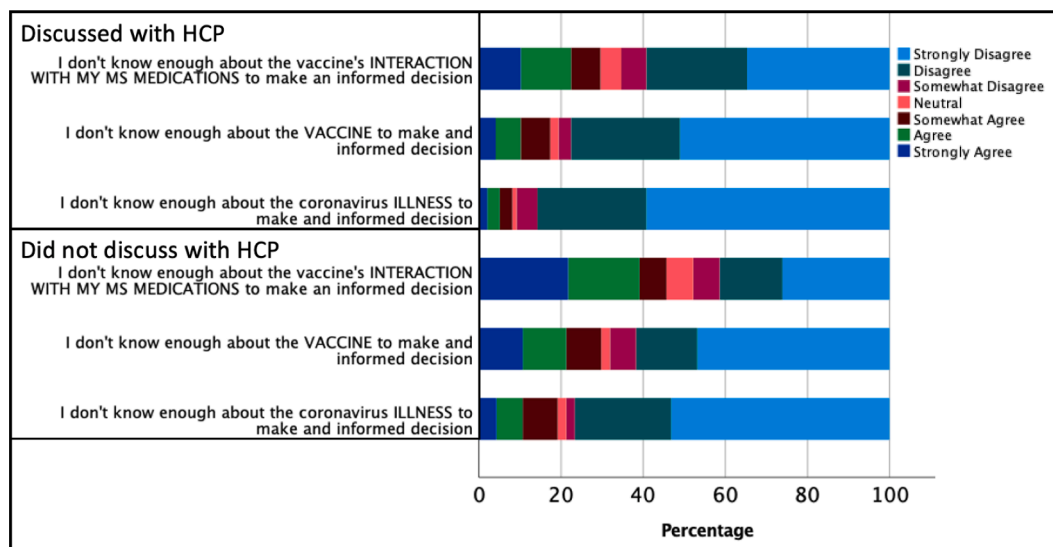


Fig. 2. Response scales for knowledge regarding COVID-19 illness, vaccination, and interaction between the vaccine and multiple sclerosis (MS) medications, stratified by whether respondents had discussed COVID-19 vaccination with their healthcare professional (HCP). Item statements are presented on the y-axis with color-coded Likert-type scale. Items ordered by proportion of strong disagreement.

**Table 5**  
Associations with vaccination intention.

Survey Item	Spearman's rho	p-value
To what extent do you think the coronavirus poses a risk to people in Australia?	0.267	<.001
To what extent do you think the coronavirus poses a risk to you personally?	0.085	0.152
I am worried about catching Covid-19	0.041	0.311
I believe that Covid-19 would be a mild illness for me	-0.167	0.021
We are all responsible for reducing the spread of the coronavirus	0.067	0.207
I believe I am immune to Covid-19	0.218	0.004
The coronavirus pandemic has had a big impact on my life	0.165	0.022
I trust the Federal government to manage the coronavirus pandemic in Australia	0.060	0.233
I trust the State government to manage the coronavirus pandemic in Australia	0.153	0.031
I trust the Australian healthcare system to manage the coronavirus pandemic in Australia	0.154	0.030
A coronavirus vaccination should be made mandatory for everyone who is able to have it.	0.319	<.001
Without a coronavirus vaccine, I am likely to catch Covid-19	0.402	<.001
If I get a coronavirus vaccination, I will be protected against coronavirus	0.260	0.001
A coronavirus vaccination could give me coronavirus	-0.281	<.001
I would be worried about experiencing side effects from a coronavirus vaccination	-0.467	<.001
A coronavirus vaccinations will be too new for me to be confident about getting vaccinated	-0.565	<.001
Most Australians will get a coronavirus vaccination	0.064	0.217
Other people like me will get a coronavirus vaccination	0.264	0.001
In general, vaccination is a good thing	0.303	<.001
If I were vaccinated, I would not need to follow social distancing and other coronavirus restrictions	0.110	0.090
I do not know enough about the coronavirus ILLNESS to make an informed decision about whether or not to get vaccinated.	-0.409	<.001
I do not know enough about the coronavirus VACCINE to make an informed decision about whether or not to get vaccinated.	-0.549	<.001
I do not know enough about the coronavirus vaccine's INTERACTION WITH MY MS MEDICATIONS to make an informed decision about whether or not to get vaccinated.	-0.526	<.001

#### 4. Discussion

In Australians with MS, surveyed April-September 2021, just over half reported being fully or partially vaccinated, while 13.2% reported having no intention to vaccinate or being unsure. This rate of vaccine hesitancy is lower than reported in several countries at a similarly early stages of vaccine accessibility (20–40%) (Diem et al., 2021; Ehde et al., 2021; Xiang et al., 2021; Serrazina et al., 2021). We found no effect of age, sex or educational level on attitudes, which was similar to some reports (Ehde et al., 2021; Serrazina et al., 2021; Yap et al., 2021) but not others (Ehde et al., 2021; Xiang et al., 2021; Ghadiri et al., 2021; Huang et al., 2021; Uhr and Mateen, 2021). Our findings were consistent with evidence, except for one early paper, that lockdowns do not decrease hesitancy (Caserotti et al., 2021; Cascini et al., 2021). On the other hand, our data were not consistent with previous evidence that people in rural areas were more hesitant. (Cascini et al., 2021) This may be influenced by the on-line distribution of this survey, where the rural people in our sample may have better engagement with internet sources of information than rural people in the other countries (International Telecommunication, 2020).

In our study, the most prevalent barriers to vaccine uptake were lack of knowledge about the vaccine, including fear of side effects, and lack of personally relevant understanding around the interaction of vaccination with DMTs. Correspondingly, we found that those on any DMT

were less likely to be vaccinated. This contrasts with the UK, where people on DMTs were 1.7 times more likely to take up the vaccine, perhaps because they were at a later stage in their vaccine roll-out. (Huang et al., 2021) Misinformation and lack of knowledge have been reported as barriers to COVID-19 vaccination for PwMS globally (Ehde et al., 2021; Ghadiri et al., 2021; Huang et al., 2021; Loomba et al., 2021).

MS society organizations have provided information on the COVID-19 vaccines geared towards both healthcare workers and lay audiences. While two-third of our respondents had accessed these publications and found them easy to understand, only half considered the information personally applicable, and fewer reported the publications helped them make personal vaccination decisions. We found that communication with MS clinicians had considerable influence on vaccine willingness, but only two thirds of respondents had discussed vaccination with their MS clinician. This proportion might have been affected by the relative infrequency with which PwMS see their clinicians, however given, the survey was initiated one year after the start of the pandemic, most people would have seen their practitioner once or twice. This mirrors the lack of general vaccine promotion by healthcare professionals reported in the UK (Yap et al., 2021).

As the pandemic evolves, global pressures to vaccinate immunocompromised populations have increased, in light of reports where highly-mutated SARS-CoV-2 variants of concern preferentially emerged during prolonged infections in immunosuppressed hosts (Choi et al., 2020; Corey et al., 2021). The ability of the most recent variant of concern, Omicron, to evade immunity from currently available vaccines, (Cao et al., 2021) and the relative effectiveness of “booster” doses, (Yang et al., 2022) highlights the continuing complexity involved in gaining immunity in the population generally, as well as the medical management of PwMS.

#### 4.1. Recommendations

Provision of ongoing individualised management and advice is critical, including optimal timing and choice of available vaccine (Sormani et al., 2021) and potentially including serial measurement of SARS-CoV-2 antibodies for some PwMS (Baker et al., 2022; Ozakbas et al., 2022; Türkoğlu et al., 2022). Our results suggest that personalised counselling is needed and should focus on those who are on DMTs, especially ocrelizumab and fingolimod, who are at greater relative risk for COVID-19 infection without appropriate timing (Garjani et al., 2022). For PwMS on a B-cell-depleting DMT, where an adequate humoral response to COVID-19 vaccination requires a delay in DMT administration, fears surrounding possible disease relapse must be assuaged and relative risk with respect to increased complications with COVID-19 infection should be addressed in a personalised manner by the MS clinician (Huang et al., 2021; Baker et al., 2021; Karussis et al., 2021).

Risk-mitigation regarding any escalating risk from new variants depends on timely transparent communication. Potential solutions might involve a team approach. MS-trained nursing staff could be engaged to disseminate appropriate and timely information to patients regarding vaccination recommendations and facilitate the resolution of individual questions as needed using a patient-centered approach (Burden et al., 2021), potentially employing individually-timed ‘nudges’ to increase vaccine confidence and uptake (Reñosa et al., 2021).

#### 4.2. Limitations

The main limitation in this study is the relatively small sample size. The respondent cohort may not reflect the MS population as a whole, as socioeconomic status, ethnic background, and physical disability can all affect access to reliable internet and social media resources. Our cohort reported a relatively low PDDS, despite a relatively mature age of 48, and thus these findings may not be directly applicable to people with



PDDS > 4, or with more severe disease phenotypes.

## 5. Conclusion

Our study highlights that vaccination efforts should focus on educating those who are managed with DMTs, and include individual recommendations related to specific DMTs, how the vaccines work, expectations regarding potential side-effects, potential exacerbation of MS symptoms, likelihood of recovery from any exacerbation, and the relative risks of side effects versus COVID-19 infection. Furthermore, we found that personal education delivered directly from MS clinicians is more influential than information from websites or other publications, even if they are evidence-based, MS-specific and easily understood. This is important, in light of reports of low prevalence of vaccine promotion from healthcare practitioners in the UK (Yap et al., 2021).

## Funding

This study received no funding support.

## Data

The data that support the findings of this study are available from the corresponding author, [MGP], upon reasonable request.

## CRedit authorship contribution statement

**M.G. Panisset:** Conceptualization, Investigation, Project administration, Data curation, Formal analysis, Writing – original draft. **T. Kilpatrick:** Conceptualization, Writing – review & editing. **L.E. Cofré Lizama:** Conceptualization, Writing – review & editing. **M.P. Galea:** Supervision, Conceptualization, Writing – review & editing.

## Declaration of Competing Interest

The Authors declare that there is no conflict of interest.

## Acknowledgments

The authors acknowledge the participants for their involvement in the study.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.msard.2022.103933.

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