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**Original Research Article**

# Multiple sclerosis incidence in Al-Madinah Al-Munawwarah in Saudi Arabia before and after the COVID-19 pandemic: a retrospective cross-sectional study

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## ABSTRACT

**Background:** Many people have suffered from coronavirus 2019 (COVID-19) which was declared pandemic in 2020. More than a year ago, vaccination against COVID-19 offered hope of controlling this pandemic. Recent studies have reported that COVID-19 vaccine can boost immune responses, However, it triggers several neurological diseases such as multiple sclerosis (MS). However, there is insufficient data on COVID-19 infections as a risk factor for MS. Therefore, in this study our aim is to assess the incidence rate of MS before and after COVID-19 Pandemic and the associated findings that appeared in MS patients.
**Methods:** A retrospective cross-sectional study had been conducted using data of patients admitted with COVID-19 infection at King Fahad hospital, Al-Madinah Al-Munawwarah, Saudi Arabia from 2020 to 2024. The collected data had been analyzed using SPSS version 20 using data from medical reports.
**Results:** The overall number of all MS cases that we have collected were 383, the cases before COVID-19 pandemic were 125 cases while 147 cases were during and after COVID-19 pandemic. The brain and spinal lesions was higher than the cases before COVID-19 also, there was a statistically significant difference between the cases that had ataxia before MS before COVID-19 are lower than after COVID- with statistically significant difference.
**Conclusions:** The incident of cases increased after COVID-19, the mean age before COVID-19 was higher than the mean age of cases after COVID-19 with statistical significance difference.

**Keywords:** MS, COVID-19, Pandemic, Demyelinating disorders

## INTRODUCTION

The first incidence of unexplained pneumonia was discovered in December 2019 in Wuhan, China. The coronavirus was discovered to be the cause shortly after that.[1] The outbreak was declared a global pandemic on 27 February 2020.[2] It is a viral infection that have a wide range of severity and prognosis. This disease was characterized by the symptoms; fever, fatigue, dry cough, myalgia, dyspnea, sputum production, headache, hemoptysis, and /or diarrhea. Some patients are completely asymptomatic. However, some of these symptoms are uncommon. The vast majority of the critically ill patients with respiratory failure, septic shock, and/or multiple organ failure already have chronic illnesses such diabetes and hypertension.[3]

Recent studies have demonstrated that the present COVID-19, like all HCoV family, has the ability to directly infect the central nerve system (CNS) and cause

neurological symptoms such as neuroinvasive, neurotropic, and neurovirulent symptoms.[4] One of the CNS demyelination diseases that has been linked with COVID-19 is MS, which defines as chronic autoimmune disease attacks the protective sheath (myelin) that covers nerve fibers and lead to severe neurological symptoms in young adults.[5] Unpredictably, COVID-19 has been linked to MS since their mainstream emergence.[4] Since then, numerous researchers have been trying to investigate the potential causative link between COVID-19 and MS.[4]

There are some cases of MS relapse after COVID-19 infection but with no evidence if it is due to the COVID-19 infection itself.[6,7] Unfortunately, only few cases of new onset MS after COVID-19 infection were reported.[8-11] In October 2021, a case report study was done for a 47-year-old female known case of DM who had a blurry vision and numbness three weeks after COVID-19 infection. Neurological assessment showed that she also had an afferent pupillary defect in her left eye, and mild inflammation of the optic disc. Hyperreflexia was noted in the lower limb, more in the left side with numbness in the upper limb and mild sensory loss. Interestingly, MRI scan showed multiple brain lesions in the periventricular area in both left and right hemisphere, and she was diagnosed with MS.[8] Another case report of a 28-year-old male, who presented with binocular diplopia in the last two days, he developed anosmia, myalgia and headache two weeks prior presentation, three days ago he developed vertigo that exacerbated by head movement and walking. One day after he reported that he could not watch TV, or work on his computer due to involuntary eye movements. Neurological assessment was notable for vertical nystagmus in all gaze directions. White matter lesions in juxtacortical, periventricular and infratentorial locations were found on MRI scan.[9] Additional case report in December 2021, reported a 36-year-old male known case of idiopathic generalized epilepsy well controlled, started to have gait instability, incoordination and dizziness 2 months after COVID-19 infection. Neurological assessment showed that he had mild intention tremor and dysdiadochokinesia on his left side with reduced superficial sensation all over the left side. MRI scan showed multiple hyper-intense white matter lesions involving the juxtacortical and periventricular in both cerebral hemispheres and cerebellum. He diagnosed with MS as he fulfilled the diagnostic criteria of MS.[10] Another report in October 2020, described a 29-year-old female with negative neurological history developed decreased visual acuity in her right eye associated with continuous retro ocular pain exacerbated by eye movements. On neurological assessment she also had signs of pyramidal tract dysfunction and hyperreflexia in the lower limb more in the right side. MRI scan showed optic nerve lesion and spares supratentorial periventricular demyelinating lesions.[11] Based on those previous reports, the aim of this study is to assess whether COVID-19 infections could trigger the onset of MS.

### *Objectives*

Primary objectives were to assess the frequency rate of MS in Al-Madinah Al-Munawwarah, before and after COVID-19 pandemic. Secondary objectives were to assess symptoms associated with MS disease in patients before and after COVID-19 (visual impairment**,** motor function impairments in upper and lower limbs, muscle stiffness and lesion prevalence and changes on MRI).

### *Research questions*

Is there a relation between COVID-19 infection and onset of MS in males and females.

## METHODS

### *Study design*

Study design for this current research had been a retrospective cross-sectional study. Data collected by using medical records from King Fahad hospital.

### *Study area/setting*

In this study we used patients' data from King Fahad hospital in Al-Madinah Al-Munawwarah, Saudi Arabia.

### *Study time*

This data had been collected from March 2024 to December 2024.

### *Study population/subjects*

Males and females above the age of 18 years who are affect by MS disease at King Fahad hospital.

### *Sample size*

Our population consist of patients who have been admitted at King Fahad hospital due to MS disease before and after COVID-19.

The estimated sample size is 384 patients using OpenEpi software, version 3, using the equation (Sample size n=[DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)] ). The sample size was calculated based on the confidence level of 95%, a significant margin of 5%, and population proportion 50%.[12]

### *Inclusion criteria*

Males and females who have MS disease and age between 18 years old and above were included.

### *Exclusion criteria*

Male and female who doesn't have MS disease and age under 18 years old were excluded.

***Data collection, management and analysis plan***

This retrospective study of census data (total coverage) had been conducted from January 2014 through May 2023. Data collected from medical records in King Fahad hospital in Al-Madinah Al-Munawwarah and had been statistically described in terms of mean±SD, or frequencies (number of cases) and percentages when appropriate. The comparison of numerical variables between the studied groups was done using independent sample t test. For comparing categorical data, Chi-square (C2) test was performed. Two-sided p values less than or equal 0.05 was considered statistically significant. All statistical calculations were done using computer program IBM SPSS (Statistical package for the social science; IBM Corp, Armonk, NY, USA) release 25 for Microsoft Windows. A value of 0.05 had been considered as the value of statistical significance for all statistical tests in the study.

***Ethical consideration***

This proposal has been submitted to the research ethical committee at Al-Rayan colleges for approval. The confidentiality of the data had been ensured.

## RESULTS

The overall number of all MS cases that we have collected were 383, 109 cases were excluded from 2022:2013, and include the MS cases within 5 years before and after COVID-19, the cases before COVID-19 pandemic were 125 cases while 147 cases were during and after COVID-19 pandemic.

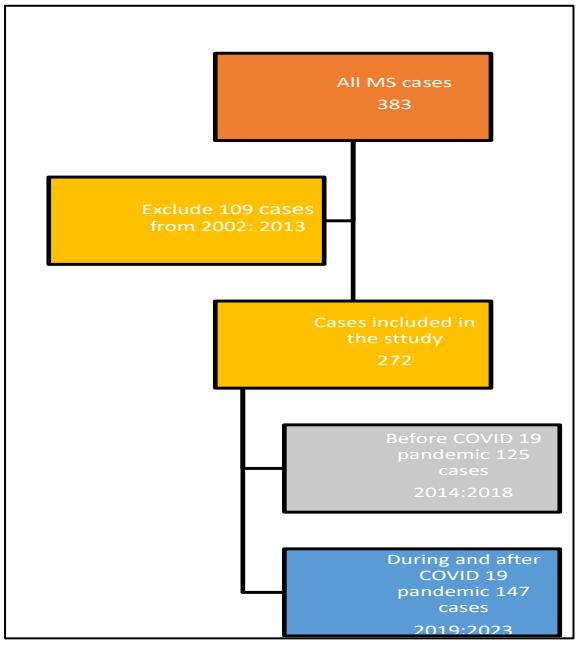


**Figure 1 : Number of MS case collected from King Fahad Hospital in Al-Madinah Al-Munawwarah, Saudi Arabia.**

**Table 1: New diagnosed cases of MS in King Fahad hospital in Al-Madinah Al Munawwarah, Saudi Arabia.**

| Variables | N | Percentage (%) |
|---|---|---|
| **Before COVID 19 (2014-2018)** | 125 | 45.6 |
| **After COVID 19 (2019-2023)** | 149 | 54.4 |

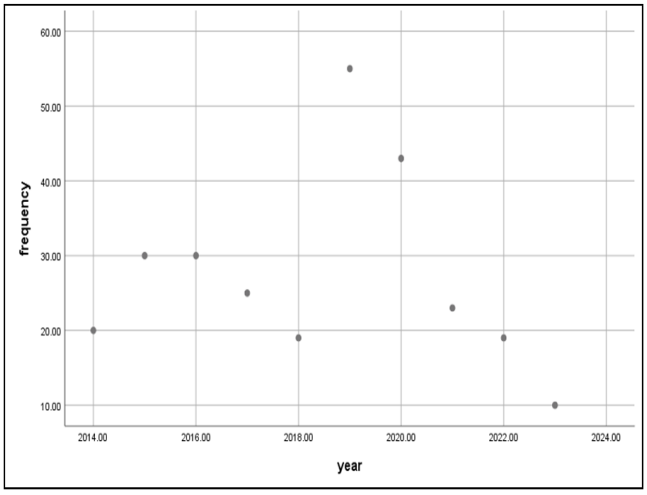


**Figure 2: Trend analysis of MS in King Fahad hospital in Al-Madinah Al Munawwarah, Saudi Arabia (2014-2023).**

The figure showed the number of MS cases within 5 years before and 5 years after COVID-19 pandemic, there was an increase in the number of MS cases during the pandemic years.

Regarding the gender, before COVID-19 76.0% of cases were females and 24.0% of cases were males. However, after COVID-19 69.1%of cases were females and 30.9% of cases were males. Without statistically significant difference p=0.206.

As regard of age, the mean age before COVID-19 was 36.76%±8.7 and that was higher than the mean age of cases after COVID-19 which was 34.61±8.8 with statistically significant difference, p=0.004.

Before COVID 19, the most used drugs were monoclonal antibodies and steroids (30.4%), (30.4%) respectively, however (36.9%) of cases after COVID-19 used monoclonal antibodies with statistically significance difference, p=0.030.

Before COVID-19 74.4% of cases had no history of chronic illness, however 81.9% of cases after COVID-19 had no history of chronic illnesses without statistically significant difference. Diabetes mellitus (DM) was the most common disease among the cases before and after COVID-19 as 74.4% of cases with chronic illness before

COVID-19 had DM, and 81.9% of cases after COVID-19 who had chronic illness had DM.

There was no statistically significant difference as regard numbness, unsteady gait, limb weakness and ophthalmic symptoms before MS diagnosis either before or after COVID-19, p=(0.401,0.553,0.052,0,578) respectively, however there was a statistically significant difference as regard ataxia before MS diagnosis as 1.6% of cases had ataxia before COVID-19, and 6.7% of cases had ataxia after COVID-19 with statistically significant difference p=0.039 (Table 4).

As regards clinical symptoms of MS of studied patients 14.1% of cases after COVID-19 had numbness, however 20% of cases had numbness before COVID-19 without statistically significant difference p=0.193. As regard stiffness before COVID-19, 3.2% of cases had stiffness, however after COVID-19 2.7% of cases had stiffness without any statistically signifiant difference (Table 5).

As regarding MRI findings, 5.4% of cases after COVID-19 had a new lesion however, 3.2% of cases had new lesions before COVID-19 without statistically significant difference (Table 6).

**Table 2: Sociodemographic characteristics of the studied patients.**

| Variables | | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|---|
| **Gender** | Female | N | 95 | 103 | 198 | 0.206(1) |
| | | % | 76.0 | 69.1 | 72.3 | |
| | Male | N | 30 | 46 | 76 | |
| | | % | 24.0 | 30.9 | 27.7 | |
| **Age (in years)** | Min-Max | | 22-67 | 18-64 | 18-67 | 0.044*(2) |
| | Mean±SD | | 36.76±8.7 | 34.61±8.8 | 35.6±8.8 | |

*Statistically significant at p≤0.05, (1) Chi square test (2) Independent sample T test, SD: standard deviation

**Table 3: MS medication among the studied patients.**

| Medication | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|
| **No** | N | 1 | 6 | 7 | 0.030* |
| | % | 0.8 | 4.0 | 2.6 | |
| **Monoclonal antibodies** | N | 38 | 55 | 93 | |
| | % | 30.4 | 36.9 | 33.9 | |
| **Sphingosine 1-phosphate** | N | 5 | 2 | 7 | |
| | % | 4.0 | 1.3 | 2.6 | |
| **DMT** | N | 4 | 8 | 12 | |
| | % | 3.2 | 5.4 | 4.4 | |
| **Nrf2 activators** | N | 9 | 20 | 29 | |
| | % | 7.2 | 13.4 | 10.6 | |
| **Cytokines** | N | 30 | 19 | 49 | |
| | % | 24.0 | 12.8 | 17.9 | |
| **Steroids** | N | 38 | 39 | 77 | |
| | % | 30.4 | 26.2 | 28.1 | |

*Statistically significant at p≤0.05, Chi square test, DMT: Disease modifying therapy.

**Table 4: Medical history of the studied patients before MS diagnosis.**

| Variables | | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|---|
| **History of chronic illness** | No | N | 93 | 122 | 215 | 0.134 |
| | | % | 74.4 | 81.9 | 78.5 | |
| | Yes | N | 32 | 27 | 59 | |
| | | % | 25.6 | 18.1 | 21.5 | |
| **Type of chronic illness** | DM | N | 93 | 122 | 215 | 0.628 |
| | | % | 74.4 | 81.9 | 78.5 | |
| | HTN | N | 6 | 7 | 13 | |
| | | % | 4.8 | 4.7 | 4.7 | |
| | Thyroid dysfunction | N | 5 | 3 | 8 | |
| | | % | 4.0 | 2.0 | 2.9 | |
| | Epilepsy | N | 4 | 5 | 9 | |
| | | % | 3.2 | 3.4 | 3.3 | |
| | Others | N | 8 | 5 | 13 | |
| | | % | 6.4 | 3.4 | 4.7 | |

Continued.

| Variables | | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|---|
| **History of numbness before MS diagnosis** | No | N | 98 | 122 | 220 | 0.401 |
| | | % | 78.4 | 82.4 | 80.6 | |
| | Yes | N | 27 | 26 | 53 | |
| | | % | 21.6 | 17.6 | 19.4 | |
| **History of unsteady gait before MS diagnosis** | No | N | 118 | 138 | 256 | 0.553 |
| | | % | 94.4 | 92.6 | 93.4 | |
| | Yes | N | 7 | 11 | 18 | |
| | | % | 5.6 | 7.4 | 6.6 | |
| **History of limb weakness before MS diagnosis** | No | N | 94 | 126 | 220 | 0.052 |
| | | % | 75.2 | 84.6 | 80.3 | |
| | Yes | N | 31 | 23 | 54 | |
| | | % | 24.8 | 15.4 | 19.7 | |
| **History of ataxia before MS diagnosis** | No | N | 123 | 139 | 262 | 0.039* |
| | | % | 98.4 | 93.3 | 95.6 | |
| | Yes | N | 2 | 10 | 12 | |
| | | % | 1.6 | 6.7 | 4.4 | |
| **History of ophthalmic symptoms before MS diagnosis** | No | N | 111 | 129 | 240 | 0.578 |
| | | % | 88.8 | 86.6 | 87.6 | |
| | Yes | N | 14 | 20 | 34 | |
| | | % | 11.2 | 13.4 | 12.4 | |

*Statistically significant at p≤0.05, chi square test.

**Table 5: Clinical symptoms of MS of the studied patients.**

| Variables | | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|---|
| **Numbness** | No | N | 100 | 128 | 228 | 0.193 |
| | | % | 80.0 | 85.9 | 83.2 | |
| | Yes | N | 25 | 21 | 46 | |
| | | % | 20.0 | 14.1 | 16.8 | |
| **Stiffness** | No | N | 121 | 145 | 266 | 0.801 |
| | | % | 96.8 | 97.3 | 97.1 | |
| | Yes | N | 4 | 4 | 8 | |
| | | % | 3.2 | 2.7 | 2.9 | |
| **Ophthalmic symptoms** | No | N | 82 | 87 | 169 | 0.221 |
| | | % | 65.6 | 58.4 | 61.7 | |
| | Yes | N | 43 | 62 | 105 | |
| | | % | 34.4 | 41.6 | 38.3 | |
| **Limb weakness and gait disturbance** | No | N | 211 | 123 | 334 | 0.260 |
| | | % | 85.8 | 82.5 | 87.2 | |
| | Yes | N | 35 | 24 | 49 | |
| | | % | 14.2 | 17.5 | 12.8 | |
| **Urinary symptoms** | No | N | 226 | 121 | 347 | 0.254 |
| | | % | 91.9 | 88.3 | 90.6 | |
| | Yes | N | 20 | 16 | 36 | |
| | | % | 8.1 | 11.7 | 9.4 | |

*Statistically significant at p≤0.05. Chi square test

**Table 6: MRI finding of the studied patients.**

| Variables | | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|---|
| **New lesion** | No | N | 121 | 141 | 262 | 0.382 |
| | | % | 96.8 | 94.6 | 95.6 | |
| | Yes | N | 4 | 8 | 12 | |
| | | % | 3.2 | 5.4 | 4.4 | |

Continued.

| Variables | | | Before COVID 19 | After COVID 19 | Total | P value |
|---|---|---|---|---|---|---|
| **Number of lesions** | No lesion | N | 59 | 48 | 107 | 0.009* |
| | | % | 47.2 | 32.2 | 39.1 | |
| | Single lesion | N | 11 | 6 | 17 | |
| | | % | 8.8 | 4.0 | 6.2 | |
| | Multiple brain or multiple spinal | N | 36 | 67 | 103 | |
| | | % | 28.8 | 45.0 | 37.6 | |
| | Multiple brain and spinal | N | 19 | 28 | 47 | |
| | | % | 15.2 | 18.8 | 17.2 | |
| **Enhancement** | No | N | 118 | 130 | 248 | 0.044* |
| | | % | 94.4 | 87.2 | 90.5 | |
| | Yes | N | 7 | 19 | 26 | |
| | | % | 5.6 | 12.8 | 9.5 | |

*Statistically significant at p≤0.05. Chi square test.

The 4.0% of cases after COVID-19 had a single lesion and 45.0% had multiple brain or multiple spinal lesions, 18.8% had multiple brain and spinal lesions which was higher than the multiple brain and spinal lesions in cases before COVID-19 which was 28.8% and 15.2% respectively with statistically deference, p=0.009.

## DISCUSSION

MS is a chronic, immune-mediated disease of the CNS characterized by focal demyelination and neurodegeneration. The etiopathogenesis of MS is multifactorial, and environmental factors have been shown to have a considerable impact on susceptible individuals.[19] Among triggers, viral infections have been associated with an increased risk of developing MS.[18]

The recent COVID-19 pandemic and the subsequent vaccination campaign have raised a new debate on the mutual relations between viral infections, vaccinations, and MS. In this regard we conducted this study to assess the frequency rate of MS in Al-Madinah Al-Munawwarah, before and after COVID-19 pandemic.

In the present study number of newly diagnosed MS cases after COVID was slightly increased than those before COVID. In accordance to our findings a previous study showed that the frequency of new-onset MS did not differ significantly between COVID-19 positive and COVID-negative individuals (in- and outpatients combined), nor separately across in- and outpatients.[24]

In the present study there was no significant difference between newly diagnosed MS cases after COVID than those before COVID regarding gender distribution as, before COVID-19: 76.0% of cases were females and 24.0% of cases were males and after COVID-19: 69.1% of cases were females and 30.9% of cases were males. However, we noted that in both conditions, females represented higher percentage than males. In accordance to our findings a previous study reported a female preponderance of MS.[25] The gender gradient in this study is confirmed from the Saudi registry of MS, which has established a 2:1 female:male ratio of MS in the country.[26] This difference could be explained by inherent differences in genetics and in physiological responses to other proposed risk factors, such as environmental and medical risk factors. It has also been proposed that the female preponderance of MS could be related to changes in environmental interactions rather than genetic factors.[27]

In the present study we found that the mean age of patients of MS cases after COVID was significantly decreased than those before COVID as the mean age before COVID-19 was 36.76%±8.7 and that was more than the mean age of cases after COVID-19 which was 34.61±8.8 with statistically significant difference. In accordance to our findings a previous study showed a shift in peak incidence was found to be shifted from those aged 40 to 49 years to those aged 30 to 34 years. This is likely attributable to the 2010 McDonald diagnostic criteria for MS, which facilitates earlier diagnosis.[28]

In the present study we found that there was significant difference between MS cases after COVID and those before COVID regarding medication and we noted that usage of monoclonal antibodies was significantly increased in the after COVID group as before COVID-19, the most used drugs were monoclonal antibodies and steroids (30.4%), (30.4%) respectively, however (36.9%) of cases after COVID-19 used monoclonal antibodies with statistically significance difference. Our findings are supported with recent study which reported that there is global trend for using monoclonal antibodies for treatment of MS as monoclonal antibodies are currently taking a leading role among high efficacy therapies for MS.[29]

In the present study, DM was the most common disease among the cases before and after COVID-19 as 74.4% of cases with chronic illness before COVID-19 had DM, and 81.9% of cases after COVID-19 who had chronic illness had DM.

In accordance to our finding, a previous study reported the coexistence of type 1 DM.[16] which is in line with a

case-control approach based on Danish registries found a 3-fold-high incidence rate for MS in the population with DM type 1.[15] This may be due to MS been negatively linked with pancreatic isle cell function, resulting in higher blood glucose levels and ultimately the manifestation of DM.[13] Also, T1D and MS are T-cell-mediated disorders.[17]

Our study showed that, hypothyroidism represented 4% and 2% of cases with chronic illness among before COVID-19 and after COVID-19, respectively. A previous study revealed that hypothyroidism had a significant association with MS risk. The reason for this association might be due to the autoimmunity base of both diseases or the application of different disease-modifying therapies.[20]

In the current study we found that there was no significant difference between MS cases after COVID and those before COVID regarding Clinical symptoms of MS but we noted that both groups showed high presence of ophthalmic symptoms as it represented 34.4% and 41.6% among cases before COVID and those after COVID, respectively. In accordance to our finding Salama et al reported that visual neuritis was the most prevalent presenting symptom at the time of illness initiation.

Also, according to Zakaria et al the most prevalent presenting symptoms were visual, followed by sensory and finally motor symptoms.

In the present study, there was no significant difference between the 2 groups regarding Limb weakness and gait disturbance before and after COVID-19 as it represented 14.2% and 17.5% among cases before COVID and those after COVID, respectively. In accordance to our finding a previous study showed that MS sufferers may also suffer from a cerebellar sign called dysmetria, frequently accompanied by ataxia, tremor and uncoordinated movements in the extremities. Lesions in the cerebellum play an essential part in the manifestation of symptoms, especially for limb coordination and motor performance.[14]

In the present study as regard MRI findings, we found that number of lesions and MRI enhancement were significantly increased in new cases after COVID group than new cases before COVID group as 4.0% of cases after COVID-19 had a single lesion and 45.0% had multiple brain or multiple spinal lesions 18.8% had multiple brain and spinal lesions which was higher than the multiple brain and spinal lesions in cases before COVID-19 28.8% and 15.2% respectively with Statistically deference.

A literature review for demyelinating disorders showed very few reports, mostly observing new MRI demyelinating lesions and an-optical neuritis after SARS-CoV2 infection.[30-32] Another study reported MS worsening occurring in three patients after COVID-19 infection without a clear confirmation of a preceding relapse. The authors concluded that MS worsening could be attributable to pseudo-relapses associated to acute infection.[33]

Recent clinical studies of COVID-19 disease have investigated the role of extracellular vesicles (EVs), already known to be involved in cell-to-cell communication, also between components of the blood–brain barrier (BBB). Microvesicles (MVs) and exosomes are involved both in viral infection and antiviral response. Recent evidence suggests a role of exosomes in SARSCoV-2 infection due to their ability to transfer the ACE2 receptor to cells exposed to viral docking, supporting virus internalization and infection spread.[34] Furthermore, evidence regarding neuroinflammation highlighted that MVs would promote BBB injury through co-involvement of tumor necrosis factor-α (TNF-α) and interleukin-6 (IL-6) which have been reported as increased during COVID-19 infection.[35]

A limitation of the study is the data was collected from only one hospital which made it difficult to collect data and we were limited in the number of patients. We could not cover all the years before COVID-19 to avoid bias in the study.

This study has some limitations should be considered when evaluating the results. the data was collected from one hospital, which may limit the findings to other hospitals. The practices, patient, and resources may differ from other hospitals, influencing the study results.

## CONCLUSION

Our study showed increase in the incidence of MS during covid-19 pandemic. The mean age decreased after COVID-19, also there is a significant difference in the medications that were used before and after COVID-19. Also, the patients after covid-19 were more likely to have ataxia before MS diagnosis. MRI findings showed that the MS cases after COVID-19 mostly having multiple lesions and few cases are having single lesions.

### *Recommendations*

In our study we used medical records as a methodology, but it was not sufficient for our study aim and we couldn't reach the full history information that we need. Also, we couldn't reach the records of COVID-19 infection of the MS cases that was included in the study. For future research it is better to collect the information using different method rather than medical records such as interviews to avoid the previous limitations.

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## REFERENCES


1. Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown etiology in Wuhan, China: The mystery and the miracle. J Med Virol. 2020;92:4:401-2.
2. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: Implications for virus origins and receptor binding. The Lancet. 2020;395:10224:565-74.
3. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Eng J Med. 2020;382:8:727-33.
4. Lima M, Aloizou AM, Siokas V, Bakirtzis C, Liampas I, Tsouris Z, et al. Coronaviruses and their relationship with multiple sclerosis: Is the prevalence of multiple sclerosis going to increase after the COVID-19 pandemia? Rev Neurosci. 2022;33(7):703-20.
5. Ghasemi N, Razavi S, Nikzad E. Multiple sclerosis: Pathogenesis, symptoms, diagnoses and cell-based therapy Cell J. 2017;19(1):1-10.
6. Assunta B, Gabriele DS, Francesca C, Valeria DA, Alessandra C, Paola DG, et al. Clinical onset and multiple sclerosis relapse after SARS-COV-2 infection. Neurology Int. Int J Mol Sci. 2024;25(8):4556.
7. Finsterer J. SARS-COV-2 triggered relapse of multiple sclerosis. Clin Neurol Neurosurg. 2022;215:107210.
8. Sobia S, Sylvette R, Alaa SM, Enitare O, Rihanat AA, Ahmed A, et al. Multiple sclerosis following SARS-COV-2 infection: A case report and literature review. Cureus. 2021;13(10):e19036.
9. Moore L, Ghannam M, Manousakis G. A first presentation of multiple sclerosis with concurrent COVID-19 infection. e Neurological Sci. 2020;22:100299.
10. Ismail II, Al-Hashel J, Alroughani R, Ahmed SF. A case report of multiple sclerosis after COVID-19 infection: Causality or coincidence? Neuroimmunol Rep. 2021;1:100008.
11. Palao M, Fernández-Díaz E, Gracia-Gil J, Romero-Sánchez CM, Díaz-Maroto I, Segura T, Multiple sclerosis following SARS-COV-2 infection. Mult Scler Relat Disord. 2020:45:102377.
12. OpenEpi epidemiologic-statistics (no date) OpenEpi Epidemiologic Statistics. Available at: http://www.OpenEpi.com/. Accessed on 23 April 2024.
13. Giannopapas V, Palaiodimou L, Kitsos D, Papagiannopoulou G, Stavrogianni K, Chasiotis A, et al. The Prevalence of Diabetes Mellitus Type II DMII in the Multiple Sclerosis Population: A Systematic Review and Meta-Analysis. J Clin Med. 2023;1215:4948.
14. Elzamarany E, Afifi L, El-Fayoumy NM, et al. Motor cortex rTMS improves dexterity in relapsing-remitting and secondary progressive multiple sclerosis. Acta Neurol Belg. 2016;1162:145-50.
15. Magyari M, Koch-Henriksen N, Pfleger CC, Sørensen PS. Gender and autoimmune comorbidity in multiple sclerosis. Mult Scler J. 2014;20:1244-51.
16. Tettey P, Simpson S, Taylor BV, Van Der Mei IAF. The co-occurrence of multiple sclerosis and type 1 diabetes: shared aetiologic features and clinical implication for MS etiology. J Neurol Sci. 2015;348:126-31.
17. Pozzilli V, Grasso EA, Tomassini V. Similarities and differences between multiple sclerosis and type 1 diabetes Diabetes. Metab Res Rev. 2022;38:1.
18. Frau J, Coghe G, Lorefice L, Fenu G, Cocco E. Infections and Multiple Sclerosis: From the World to Sardinia, from Sardinia to the World. Front Immunol. 2021;12:728677.
19. Haki M, Al-Biati HA, Al-Tameemi ZS, Ali IS, Al-Hussaniy HA. Review of multiple sclerosis: Epidemiology, etiology, pathophysiology, and treatment. Med Baltimore. 2024;1038:e37297.
20. Maroufi H, Moghadasi AN, Rezaei-Aliabadi H, Sahraian MA, Eskandarieh S. Medical history risk factors in primary progressive multiple sclerosis: A case-control study. Curr J Neurol. 2020;20:86-94.
21. Han H, Ma Q, Li C, Liu R, Zhao L, Wang W, et al. Profiling serum cytokines in COVID-19 patients reveals IL-6 and IL-10 are disease severity predictors Emerg. Microbes Infect. 2020;9:1123-30.
22. Lima M, Siokas V, Aloizou A-M, Liampas I, Mentis A-FA, Tsouris Z, et al. Unraveling the possible routes of SARS-COV-2 invasion into the central nervous system. Curr Treat Options Neurol. 2020;11:37.
23. Zarifkar P, Peinkhofer C, Benros ME, Kondziella D. Frequency of Neurological Diseases After COVID-19, Influenza A/B and Bacterial Pneumonia. Front Neurol. 2022;13:904796.
24. Waubant E, Lucas R, Mowry E, Graves J, Olsson T, Alfredsson L, et al. Environmental and genetic risk factors for MS: an integrated review. Ann Clin Transl Neurol. 2019;6:1905-22.
25. Al Jumah M, Bunyan R, Al Otaibi H, Al Towaijri G, Karim A, Al Malik Y, et al. Rising prevalence of multiple sclerosis in Saudi Arabia, a descriptive study. BMC Neurol. 2020;20:49.
26. Etemadifar M, Nourian SM, Nourian NS, Abtahi SH, Sayahi F, Saraf Z, et al. Early-onset multiple sclerosis in Isfahan, Iran: report of the demographic and clinical features of 221 patients. J Child Neurol 2016; 31: 932–937.
27. Tian DC, Zhang C, Yuan M, Yang X, Gu H, Li Z et al.Incidence of multiple sclerosis in China: A nationwide hospital-based study. Lancet Reg Health West Pac. 2020;1:100010.
28. Van Kempen ZL, Toorop AA, Sellebjerg F, Giovannoni G, Killestein J. Extended dosing of monoclonal antibodies in multiple sclerosis. Multiple Scler J. 2022;28(13):2001-9.
29. Meppiel E, Peiffer-Smadja N, Maury A, Bekri I, Delorme C, Desestret et al. Neurologic

manifestations associated with COVID-19: A multicentre, registry. Clin Microbiol Infect. 2021;27:458.
30. Palao M, Fernández-Díaz E, Gracia-Gil J, Romero-Sánchez CM, Díaz-Maroto I, Segura T. Multiple sclerosis following SARS-CoV-2, infection. Mult Scler Relat Disord. 2020;45:102377.
31. Zanin L, Saraceno G, Panciani PP, Renisi G, Signorini L, Migliorati K, Fontanella M. SARS-CoV-2 can induce brain and spine demyelinating lesions. Acta Neurochir. 2020;162:1491-4.
32. Kataria S, Tandon M, Melnic V, Sriwastava S. A case series and literature review of multiple sclerosis and COVID-19: Clinical characteristics, outcomes and a brief review of immunotherapies. eNeurological Sci. 2020;21:100287.
33. Machhi J, Shahjin F, Das S, Patel M, Abdelmoaty MM, Cohen JD, et al. A Role for Extracellular Vesicles in SARS-CoV-2 Therapeutics, Prevention. J Neuroimmune Pharmacol. 2021;16:270-88.
34. Rochfort KD, Collins LE, McLoughlin A, Cummins PM. Tumour necrosis factor-α-mediated disruption of cerebrovascular endothelial barrier integrity *in vitro* involves the production of proinflammatory, interleukin-6. J Neurochem. 2016;136:564-72.
35. Zakaria M, Zamzam D, Hafeez M, Swelam M, Khater S, Fahmy M, et al. Clinical characteristics of patients with multiple sclerosis enrolled in a new registry in Egypt. Mult Scler Rel Disord. 2016;10:30-5.
36. Salama S, Marouf H, Ihab Reda M, Mansour AR, El Kholy O, Levy M. Clinical and radiological characteristics of neuromyelitis optica spectrum disorder in the North Egyptian Nile Delta. J Neuroimmunol. 2018;15;324:22-5.

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