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Factors Associated with COVID-19 Vaccination Status in Adolescents Diagnosed With Epilepsy

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WHAT IS ALREADY KNOWN ON THIS TOPIC?

- *Adolescents with chronic conditions, including epilepsy, may have lower COVID-19 vaccination rates compared to the general population due to concerns about vaccine safety and interactions with medications.*
- *Parental hesitancy, influenced by misinformation, fear of seizure exacerbation, and lack of provider recommendations, can significantly impact vaccination decisions.*
- *Factors such as socioeconomic status, healthcare access, and prior vaccination history play a role in determining vaccine uptake among adolescents.*

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ABSTRACT

Objective: This study investigates coronavirus disease 2019 (COVID-19) vaccination status in adolescents diagnosed with epilepsy, focusing on its relationship with psychiatric comorbidities.

Methods: Between December 2020 and June 2023, 214 adolescents aged 12-18 with epilepsy were enrolled in 2 pediatric neurology clinics. Data were collected from legal guardians and patient records.

Results: Among the 214 patients, 112 (52.3%) were male, and 170 (79.4%) attended formal education. Mental illness was present in 108 patients (50.5%), with 73 (34.1%) having autism spectrum disorder or intellectual disability (ID). Eighty patients (37.4%) received the COVID-19 vaccine, predominantly mRNA vaccines (85%). Vaccinated individuals were older, had more siblings, had higher maternal education levels, and had lower rates of treatment-resistant epilepsy ($P < .05$ for each). There was no significant association found between the presence and number of comorbid mental health diagnoses and COVID-19 vaccination status in adolescents with epilepsy. Family preference was the main reason for vaccination (68.4%), while concerns about epilepsy worsening were the primary reason for non-vaccination.

Conclusion: Factors associated with COVID-19 vaccination in adolescents with epilepsy include age, number of siblings, maternal education level, history of COVID-19 in the patient, vaccination among family members, perceived vaccine efficacy, duration of protection of the vaccine, and healthcare professionals' opinions. Importantly, no significant association was observed between the presence and number of comorbid mental health diagnoses and COVID-19 vaccination status, underscoring that mental health conditions in this population are not barriers to vaccination. Parents have concerns about vaccine safety and the exacerbation of epilepsy, necessitating the dissemination of accurate information by healthcare professionals, especially targeting parents with lower education levels, unvaccinated parents without prior COVID-19 infection, and adolescents.

Keywords: Children, COVID-19, epilepsy, vaccination

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WHAT THIS STUDY ADDS ON THIS TOPIC?

- *This study highlights that factors such as age, number of siblings, and mothers' education level (high school or above) are significantly associated with higher COVID-19 vaccination rates in adolescents diagnosed with epilepsy.*
- *Recommendations from healthcare professionals are critical for shaping parental attitudes and improving COVID-19 vaccination rates in adolescents.*
- *The most common reason for vaccine refusal among parents was the concern that COVID-19 vaccines might exacerbate epilepsy, emphasizing the need for targeted education and reassurance about vaccine safety.*

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a newly emerged infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), characterized by high mortality rates.[1] The World Health Organization (WHO) officially declared it a global pandemic on March 11, 2020.[1] The prevalence of SARS-CoV-2 in the pediatric population is lower.[2] Severe acute respiratory syndrome coronavirus 2 is a virus that specifically binds to angiotensin-converting enzyme 2 (ACE2) receptors, which are present in the lower respiratory tract as well as in various organs, including the brain.[3] The clinical manifestations associated with SARS-CoV-2 infection are diverse and may encompass respiratory symptoms (such as dyspnea, chest pain, and cough), gastrointestinal symptoms (including diarrhea and vomiting), and musculoskeletal symptoms (such as muscle and joint pain).[3] Moreover, neurological symptoms, including headache, dizziness, anosmia, and dysgeusia, are also acknowledged as potential manifestations of COVID-19.[3] Compared to adults, children have a milder course of acute COVID-19.[2]

Furthermore, considering the relationship between epilepsy and COVID-19 is crucial. Patients with epilepsy are at risk of recurrent seizures despite medical treatment and intervention.[4] Increased stress, difficulty accessing doctors and medications, and the potential for mask-induced hyperventilation during the early months when healthcare services were restricted may have made seizure control more challenging during acute COVID-19.[3]

Mass vaccination programs against COVID-19 have been initiated in many countries, including Türkiye, as of December 2020. In Türkiye, approval for vaccination has been granted to children aged 12 and over since September 2021.[5] As of January 2023, over 152 million doses have been administered in Türkiye and over 13 billion doses worldwide.[6] Despite the benefits of vaccination, concerns about adverse reactions, including local pain, fever, dizziness, tachycardia, muscle pain, allergic reactions, and rarer complications such as Guillain–Barré syndrome, have led to increased vaccine hesitancy in certain segments of the population.[7] However, in many studies, no significant difference in adverse reactions has been observed between the group of patients diagnosed with epilepsy and the general population after vaccination.[8,9] Nonetheless, an increase in seizure frequency and rare epilepsy-related issues such as status epilepticus following COVID-19 vaccination have been suggested.[9]

Vaccine hesitancy is defined as a reluctance to accept or a delay in the decision to vaccinate, despite the availability of vaccines, whereas vaccine resistance refers to an individual's outright opposition to vaccination.[10] One of the most common concerns contributing to vaccine hesitancy is the risk of seizure exacerbation.[8,11] Several studies have reported vaccine hesitancy among patients diagnosed with epilepsy.[10,11] Several societal surveys have found that vaccine hesitancy and refusal are more likely to occur in younger individuals, females, those with lower income and education levels, lower perceived severity of COVID-19, lower exposure to COVID-19, lower trust in the government, and individuals residing in disadvantaged areas.[12,13] Similarly, factors associated with COVID-19 vaccine refusal include beliefs that children's immune systems are overwhelmed by the quantity of vaccines received, perception that the vaccine is more dangerous than the disease, religious beliefs, distrust in public health systems, concerns about side effects, and misinterpretation of vaccine components.[14]

Based on the scientific literature, there is a limited number of studies examining COVID-19 vaccination status in adolescents diagnosed with epilepsy. In light of all these studies, this study aims to investigate factors associated with COVID-19 vaccination status in adolescents diagnosed with epilepsy and explore their relationship with psychiatric comorbidities.

MATERIAL AND METHODS

Study Design

This study included 178 adolescents aged 12-18 years diagnosed with epilepsy who were under regular follow-up at the Pediatric Neurology Clinic of İstanbul University, Faculty of Medicine, Department of Neurology, Division of Child Neurology, and 36 adolescents aged 12-18 years diagnosed with epilepsy who were under regular follow-up at the Pediatric Neurology Clinic of Bursa Uludağ University, Faculty of Medicine. Regular follow-up refers to patients who attended at least 80% of the follow-up appointments recommended by their doctor, as confirmed through their records. The study was conducted by reviewing patient records between December 2020, when COVID-19 vaccines were introduced in our country, and June 2023, and by inviting patients who met the inclusion criteria and their legal guardians to the hospital to collect information. Previous patient data and current patient data were reviewed retrospectively as part of the study.

Participants were informed about the study's objectives and procedures, and written consent was obtained during face-to-face interviews. For those unable to attend the hospital, verbal consent was obtained via phone, and the questionnaire was completed. Written consent from these legal guardians was collected during their subsequent clinic visits. The data collection and interview process with patients and their legal guardians took place between August 15, 2023, and December 15, 2023. Patients and legal guardians who refused to participate at any stage of the study were excluded.

Inclusion criteria were a diagnosis of epilepsy according to the International League Against Epilepsy (ILAE) criteria and verbal and written consent from the legal guardian.[17] Exclusion criteria were not meeting the age range, not having epilepsy, and lack of consent from the legal guardian. The ethical approval for this study was obtained from the Noninvasive Clinical Research Ethics Committee of Bursa Uludağ University (Approval no: 2023-16/45, Date: August 1, 2023).

Data Collection Tools

Structured patient files from the Pediatric Neurology Clinic of İstanbul University Faculty of Medicine, Department of Neurology, Division of Child Neurology and the Pediatric Neurology Clinic of Bursa Uludağ University Faculty of Medicine. A form created by the researchers based on literature and filled out by questioning the legal guardian face-to-face and/or by phone and checking the patient file. This form includes sociodemographic information, presence of comorbid diseases, presence of psychiatric illness, duration of epilepsy, seizure type, number and dosage of antiepileptic drugs, treatment-resistant epilepsy, level of compliance with pandemic hygiene rules, history of COVID-19 infection (according to PCR results), whether they experienced any side effects during the acute period, long-COVID symptoms (long-COVID refers to the persistence or emergence of symptoms beyond the acute phase of COVID-19, typically lasting at least 2 months and occurring 3 months after the initial SARS-CoV-2 infection, as defined by the WHO),[15] vaccination status, type of vaccine received, number of doses received, whether they experienced any side effects after vaccination (local or systemic reactions), reasons for not getting vaccinated if they did not, vaccination plans, and criteria considered important in vaccine selection. Treatment-resistant epilepsy was defined by the ILAE as patients who experienced seizures despite receiving adequate treatment with two or more antiepileptic drugs.[16]

Procedure

Patients and their legal guardians were invited to participate in the study and provided consent. Consent was obtained face-to-face from those who attended, and oral consent was obtained via phone, and the questionnaire was completed. Written consent from absent parents was obtained when they came for their next appointment. Patients and legal guardians who refused to participate at any stage were excluded from the study.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA). Descriptive data are presented as numbers, percentages, means, and standard deviations. Chi-square tests were used to compare categorical variables between individuals who received the COVID-19 vaccine (group 1) and those who did not (group 2). The normality of the distribution of continuous variables was assessed using the Kolmogorov–Smirnov test. For group comparisons, independent samples *t*-tests were applied for normally distributed continuous variables, while Mann–Whitney *U* tests were used for non-normally distributed continuous variables. Pearson correlation tests were used to evaluate relationships between normally distributed continuous variables, and Spearman correlation tests were applied for non-normally distributed continuous variables.

The significance of univariate analyses was assessed using binary logistic regression analysis. In the binary logistic regression analysis, the effect of each independent variable on the likelihood of receiving the COVID-19 vaccine was examined. Regression coefficients (B), standard errors (SE), Wald statistics, odds ratios (OR), and 95% CI were calculated. The Hosmer–Lemeshow test was used to evaluate model fit.

A significance level of $P < .05$ was considered statistically significant in all analyses.

RESULTS

There were 214 patients diagnosed with epilepsy aged 12-18 years who met the inclusion and exclusion criteria in this study. Of these patients, 112 (52.3%) were male, and 170 (79.4%) were attending formal education. Eighty (37.4%) of these patients had received the COVID-19 vaccine, with 68 (85%) of them receiving mRNA vaccines.

When compared in terms of sociodemographic data, in group 1, the mean age, number of siblings, and the proportion of mothers with high school education or above were significantly higher than in group 2 (each with $P < .05$). Sociodemographic data are shown in Table 1.

When compared in terms of epilepsy characteristics, in group 1, the rate of treatment-resistant epilepsy was lower than in group 2 ($P < .05$) (Table 2).

When comparing the data related to COVID-19 in patients and families, in group 1, the history of COVID-19 in patients was significantly higher compared to group 2 ($P < .05$). It was found that 28.5% of patients who had experienced COVID-19 had symptoms lasting longer than 3 months, including fatigue and exhaustion (56.3%), concentration and attention problems (31.3%), shortness of breath and difficulty breathing (25%), loss of taste and smell (25%), joint and muscle pain (18.8%), chest pain (12.5%), language and speech problems (6.3%), palpitations (6.3%), anxiety (6.3%), and depression (6.3%). Data related to COVID-19 in patients and families are shown in Table 3.

Among the 80 individuals who received the COVID-19 vaccine, 68 (85%) received mRNA vaccines, and 12 (15%) received inactivated vaccines. The mean number of COVID-19 vaccine doses was 2.04 ± 0.74. Nineteen (23.8%) of those vaccinated experienced post-vaccination side effects, including fatigue (36.8%), pain, swelling, or redness at the injection site (36.8%), fever (21.1%), headache (15.8%), muscle or joint pain (10.5%), and worsening of epilepsy (5.3%).

When comparing data related to COVID-19 vaccination, in group 1, the rates of COVID-19 vaccination among mothers, fathers, and siblings, as well as the importance given to protective characteristics, duration of protection, and healthcare workers' opinions in vaccine selection, were significantly higher compared to group 2 ($P < .05$). The rate of COVID-19 vaccination for children was higher

Table 1. Comparison of Sociodemographic Data Between Groups

	Total	Group 1 n (%)	Group 2 n (%)	X^2/Z	*P*
Total	214	80 (37.4)	134 (62.6)		
Patient age (mean ± SD) (years)		15.73 ± 1.74	14.47 ± 1.76	−4.769	**<.001***
Patient gender (male)	112	44 (55.0)	68 (50.7)	0.363	.547
Patient education level	–	–	–	–	–
Continuing formal education	170	65 (82.3)	105 (78.94)	0.538	.910
Not continuing formal education	13	4 (5.1)	9 (6.76)		
Only attending special education	13	4 (5.1)	9 (6.8)		
Attending special education class	16	6 (7.6)	10 (7.5)		
Number of siblings of patient		2.71 ± 0.80	2.36 ± 0.80	−2.897	**.004***
Ranking of patient among siblings		1.95 ± 1.21	2.01 ± 1.17	−0.668	.504*
Mother's education level (high school or higher)	73	34 (42.5)	39 (29.1)	3.999	**.046**
Father's education level (high school or higher)	67	37 (46.3)	54 (40.3)	0.726	.394
Mother's occupation (employed)	73	30 (37.5)	43 (32.1)	0.652	.419
Father's occupation (employed)	199	76 (95.1)	123 (91.3)	1.516	.469
Average monthly income level of family					
Below minimum wage	26	8 (10.0)	18 (13.5)	0.582	.747
Minimum wage	104	40 (50.0)	64 (48.1)		
Above minimum wage	83	32 (40.0)	51 (38.3)		
Additional chronic physical illness in patient (present)	78	33 (41.3)	45 (33.6)	1.272	.259
Mental illness in patient (present)	108	41 (51.3)	67 (50.0)	0.031	.860
2 or more mental illnesses in patient (present)	28	8 (10.0)	20 (14.9)	1.410	.494
Patient diagnosed with ASD or ID (present)	73	26 (32.5)	47 (35.1)	0.328	.567
Mental illness in family (present)	34	9 (11.3)	25 (18.7)	2.056	.152
Patient's ability to adhere to hygiene rules during pandemic					
None	13	5 (6.2)	8 (6.0)	3.431	.488
Some	11	4 (5.0)	7 (5.2)		
Moderate	13	4 (5.0)	9 (6.7)		
Good	73	22 (27.5)	51 (38.1)		
Almost perfect	104	45 (56.3)	59 (44.0)		

Group 1: received the COVID-19 vaccine; Group 2: not received the COVID-19 vaccine. *P*-values in bold indicate statistically significant results ($P < .05$).
Mean ± SD, mean ± standard deviation.
*Mann–Whitney *U* test.

when parents had a higher mean number of vaccine doses ($P < .05$). The vaccination rate and mean number of vaccine doses for mothers were higher compared to fathers and siblings ($P < .05$). The reasons for vaccination in group 1 were family desire (68.4%), physician recommendation (17.7%), school recommendation (8.9%), and legal requirement (travel, etc.) (5.1%). The reasons for not being

Table 2. Comparison of Epilepsy Characteristics of Patients

	Total	Group 1 n (%)	Group 2 n (%)	X^2/Z	*P*
Total	214	80 (37.4)	134 (62.6)		
Type of epilepsy in patient					
Focal	55	20 (25.0)	35 (26.1)	0.719	.698
Generalized	149	55 (68.8)	94 (70.1)		
Undetermined	10	5 (6.3)	5 (3.7)		
Patient has treatment-resistant epilepsy (present)	35	6 (7.5)	29 (21.6)	7.323	**.007**
Duration of epilepsy (mean ± SD) (years)		9.03 ± 4.82	8.18 ± 4.35	−1.324	**.185***

Group 1: received the COVID-19 vaccine; Group 2: not received the COVID-19 vaccine. *P*-values in bold indicate statistically significant results ($P < .05$).
Mean ± SD, mean ± standard deviation.
*Mann–Whitney *U* test.

Table 3. Comparison of Patients' and Families' COVID-19 Related Data

	Total	Group 1 n (%)	Group 2 n (%)	X^2	*P*
Total	214	80 (37.4)	134 (62.6)		
History of COVID-19 in patient (present)	56	29 (36.3)	27 (20.1)	6.721	**.010**
History of COVID-19 in family (present)	137	46 (57.5)	91 (67.9)	2.357	.125
Symptoms lasting more than 3 months in patients who had COVID-19 (present)	16	10 (34.5)	6 (22.2)	1.030	.310

Group 1: received the COVID-19 vaccine; Group 2: not received the COVID-19 vaccine. *P*-values in bold indicate statistically significant results ($P < .05$).

vaccinated in group 2 were the possibility of triggering epileptic seizures (32.3%), possible side effects of the vaccine (23.8%), other reasons (16.9%), the child's young age (11.5%), lack of information about vaccinating children (9.2%), physician not recommending the vaccine (3.8%), and the possibility of interaction with medications (2.3%). Data related to COVID-19 vaccination are shown in Table 4.

The dataset was subjected to a binary logistic regression analysis model. The variable group in the model explained a portion of the variance related to vaccination status, ranging from 28.5% (Cox and Snell R square) to 38.9% (Nagelkerke R square). According to the model, as the patient's age increases, the likelihood of vaccination increases significantly by 1.5 times. Moreover, as the number of siblings of the patient increases, the likelihood of vaccination significantly decreases. Additionally, an increase in epilepsy resistance significantly leads to an increase in vaccination likelihood, while a history of COVID-19 in siblings significantly decreases the likelihood of vaccination. The binary logistic regression analysis model is presented in Table 5.

DISCUSSION

In this study, it was found that approximately one-third of adolescents diagnosed with epilepsy had received the COVID-19 vaccine, with the majority of these vaccines being mRNA-based. Furthermore, among those who were vaccinated, the average age, number of siblings, mothers' education level of high school or above, history of COVID-19 in the patient, vaccination rate of first-degree relatives of patients, protective characteristics sought in the vaccine selection, duration of protection, and importance given to the opinions of healthcare workers were significantly higher compared to those who were not vaccinated,while the rate of treatment-resistant epilepsy was lower. The most common reason for vaccination was family preference, while the most common reason for not getting vaccinated was the possibility of exacerbating epilepsy.

Similar to findings in the scientific literature, approximately one-third of patients in our study had received the COVID-19 vaccine.[17] Consistent with Wang et al[17], our results also showed that parents preferred mRNA vaccines more often. In vaccinated adolescents, the average age, number of siblings, and mothers' education level of high school or above were significantly higher. Similar findings have been reported in other studies, showing higher vaccination rates in older children and in children of parents with higher education levels.[18] However, some studies have found no difference or even lower vaccination rates in children of highly educated parents.[19,20] This finding may be attributed to several factors. Highly-educated parents may have greater access to diverse sources of information,

Table 4. Data Related to COVID-19 Vaccination

	Total	Group 1 n (%)	Group 2 n (%)	X^2	*P*
Total	214	80 (37.4)	134 (62.6)		
History of COVID-19 vaccination in mother	186	78 (97.5)	108 (80.6)	12.585	**<.001**
History of COVID-19 vaccination in father	181	73 (92.4)	108 (80.6)	5.428	**.020**
History of COVID-19 vaccination in sibling	74	51 (64.6)	46 (34.6)	17.936	**<.001**
Criteria considered in vaccine selection	193	76 (95.0)	117 (87.3)	3.344	.095
Characteristics sought in the vaccine selection					
Produced in Türkiye	42	13 (16.3)	29 (21.6)	0.923	.337
Produced in foreign countries	16	9 (11.3)	7 (5.2)	2.630	.105
Protectiveness	188	55 (68.8)	63 (47.0)	9.567	**.002**
Duration of protection	61	34 (42.5)	27 (20.2)	12.279	**<.001**
Absence of temporary side effects	44	14 (17.5)	30 (22.4)	0.733	.392
Absence of permanent side effects	57	20 (25.0)	37 (27.6)	0.175	.676
Low or no additives	26	10 (12.5)	16 (12.1)	0.007	.935
Public opinion	45	17 (21.3)	28 (20.9)	0.004	.951
Opinions in the media	37	16 (22.6)	21 (12.1)	0.656	.418
Opinions of official institutions	61	28 (35.0)	33 (24.6)	2.645	.104
Opinions of healthcare workers	69	39 (48.8)	30 (22.4)	15.935	**<.001**

Group 1: received the COVID-19 vaccine; Group 2: not received the COVID-19 vaccine. *P*-values in bold indicate statistically significant results ($P < .05$).

Table 5. Binary Logistic Regression Analysis for COVID-19 Vaccination Status

Independent Variables	*B*	SE	Wald	*P*	OR	95% CI
Patient's age	0.406	0.101	16.170	**.000**	1.500	1.23-1.83
Number of siblings of the patient	−5.613	1.734	10.479	**.001**	0.004	0.21-0.95
Duration of epilepsy	0.044	0.038	1.359	.244	1.045	0.97-1.13
History of COVID-19 vaccination in siblings	−1.038	0.385	7.253	**.007**	0.354	0.17-0.75
Protective efficacy of the vaccine	−0.574	0.406	1.996	.158	0.564	0.25-1.25
Duration of vaccine protection	−0.608	0.422	2.074	.150	0.544	0.24-1.25
Treatment-resistant epilepsy in the patient	1.255	0.569	4.866	**.027**	3.507	1.15-10.70

Model $X^2 = 0.285$; Pseudo $R^2 = 0.389$; Hosmer and Lemeshow test $X^2 = 11.263$ (DF = 8 ; $P = 0.187$). *P*-values in bold indicate statistically significant results ($P < .05$).
OR, odds ratio; SE, standard error.

including misinformation, which could increase vaccine hesitancy. Additionally, such parents may have a heightened sense of control over health-related decisions and may critically evaluate potential risks associated with vaccines, potentially leading to lower vaccination rates.[21] Additionally, while our study found no difference, many studies have reported parallelism between socioeconomic status and vaccination rates.[22,23] The differences in the relationship between sociodemographic factors and vaccination observed in our study compared to the literature may not only be related to the small sample size but also to contextual factors such as cultural norms, regional disparities, and access to healthcare. Cultural beliefs about vaccines and their safety may significantly influence parental decisions. Regional disparities, including differences in healthcare infrastructure and the availability of vaccines, could also affect vaccination rates. Furthermore, unequal access to healthcare services, especially in rural or underserved areas, may play a critical role.[24] These factors, in combination with individual and familial considerations, highlight the complexity of vaccination decisions in this population and may explain some of the discrepancies observed in our study.

There was no significant association found between the presence and number of comorbid mental health diagnoses and COVID-19 vaccination status in adolescents with epilepsy. There is no study in the literature examining this relationship. Khoodoruth et al[23] reported that about two-thirds of parents of children with autism spectrum disorder refused or were unsure about vaccinating their children. In another study, although parents of disabled adolescents reported a higher intention to vaccinate their adolescents, the vaccination rate was found to be lower in disabled adolescents compared to non-disabled adolescents.[25,26] Overall, vaccination rates in individuals with mental illnesses have been reported similarly.[26] However, parents of unvaccinated disabled adolescents reported significant difficulty in accessing COVID-19 vaccines.[25] Furthermore, a survey on SARS-CoV-2 vaccine perceptions in the community of individuals with intellectual and developmental disabilities in New York State indicates concerns about side effects and the speed of vaccine development.[27] The lack of an effect of comorbid mental health disorders on vaccination rates in adolescents with epilepsy suggests that comorbid mental health issues may not be significant in vaccination preferences in the presence of a physical illness like epilepsy.

When compared in terms of epilepsy characteristics, vaccinated adolescents had a lower rate of treatment-resistant epilepsy compared to those who were not vaccinated, with no significant differences in epilepsy type and duration. Similarly, a study on adults found that the vaccination rate was lower in patients diagnosed with treatment-resistant epilepsy and those with higher seizure frequencies.[28]

In our study, while there were more patients with a history of COVID-19 among the vaccinated group, there was no difference in the history of COVID-19 in the family. In contrast to our findings, Temple et al[29] found that a history of COVID-19 in healthy children did not significantly affect COVID-19 vaccination. In the study by Ceannt et al,[22] knowing that someone close had COVID-19 was significantly associated with a decrease in parental vaccine hesitancy. In light of this information, it can be speculated that while a history of COVID-19 may increase the tendency to vaccinate in healthy children, it may not be a significant factor in epilepsy cases.

When compared in this study, the rate of COVID-19 vaccination among mothers, fathers, and siblings of patients, protective characteristics sought in the vaccine selection, duration of protection, and importance given to the opinions of healthcare workers were significantly higher in those who were vaccinated compared to those who were not vaccinated. More than half of the parents in the study stated that they would consult a healthcare worker first to receive information about COVID-19 vaccines, suggesting that being correctly informed by a healthcare worker about the effectiveness and safety of COVID-19 vaccines could lead to changes in vaccination attitudes among parents. Similarly, in other studies, the most important reason for parents to vaccinate their children was the belief that the vaccine would protect them from the disease.[30] Given that more than half of the parents in our study would consult a healthcare worker for information about COVID-19 vaccines, it is essential for healthcare workers to provide accurate information about the possible side effects, potential impacts on existing physical or mental illnesses, and the duration of protection and its efficacy.

The safety of SARS-CoV-2 vaccines has been shown to be good among children and adolescents, with the rate of side effects being within normal limits. In our study, the most common side effects reported were pain, swelling, or redness at the injection site and fatigue, consistent with other studies.[20,31] The frequency of side effects after the second dose of vaccination is usually higher.[32]

Long-COVID is characterized by multi-organ involvement, with common symptoms including fatigue, weakness, dyspnea, cognitive impairment, and general malaise.[33] While the etiology and pathogenesis of these symptoms remain uncertain, a combination of viral infection, comorbidities, immunological response, and psychological and emotional factors is likely implicated.[34] Neurological features such as brain fog, memory deficits, and sleep disturbances are prevalent at the 3-month mark, while acute symptoms like anosmia and headache tend to improve over time.[33,34] In this study, it was found that 28.5% of patients who had experienced long-COVID symptoms. About one-quarter of patients who had contracted COVID-19 reported long COVID symptoms, most commonly fatigue and exhaustion. These findings are consistent with previous studies reporting a wide range of long COVID symptoms in children with fatigue.[35,32] However, our study found no significant difference in long COVID symptoms between the vaccinated and unvaccinated groups. Parents may disregard long COVID symptoms when vaccinating adolescents with epilepsy. It is essential to inform families about these symptoms for the follow-up of children.

The results should be interpreted considering some limitations. Firstly, the study being only 2-centered, the small sample size, limited options in the questionnaire, and the absence of a healthy control group limit the generalizability of the results. Secondly, due to the retrospective nature of the data, some information may be missing. Thirdly, psychiatric diagnoses were not evaluated with a diagnostic interview tool, and cases clinically or by imaging suspected of COVID-19 but tested negative may have affected the relationship between history and vaccination. Fourthly, the lack of clarity about the timing of vaccination and COVID-19 contraction may have affected the results in terms of clinical data timing. Additionally, the side effects associated with each dose of the vaccine were not separately analyzed. Fifthly, the lack of a standardized scale to measure side effects may have led to a lack of standardization. However, the study's strengths include the investigation of the relationship between vaccination and epilepsy in adolescents, siblings, long COVID symptoms, characteristics sought in vaccines, and comorbid mental illnesses.

In conclusion, vaccination is one of the most crucial components of public health. Factors affecting COVID-19 vaccination in adolescents diagnosed with epilepsy, such as age, number of siblings, mothers' education level, history of COVID-19 in the patient, vaccination of first-degree relatives of patients, protective characteristics sought in the vaccine, duration of protection, and importance given to the opinions of healthcare workers highlight the importance of the vaccination. The fact that results similar to those in healthy adolescents were obtained in adolescents diagnosed with epilepsy in the scientific literature, and the absence of a relationship between comorbid physical or mental illnesses and vaccination, is remarkable. Families have significant concerns that COVID-19 vaccines may exacerbate epilepsy seizures. Data on the safety of COVID-19 vaccination in adolescents diagnosed with epilepsy are essential. Especially parents with lower education levels, those who have not been vaccinated, and those who have a child with epilepsy and COVID-19 should be informed by a healthcare worker about the effectiveness and safety of COVID-19 vaccines. Detailed guidelines should be developed for specific patient populations. Also, multicenter and larger studies are needed to investigate factors influencing vaccination in these populations.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: The ethical approval for this study was obtained from the Noninvasive Clinical Research Ethics Committee of Bursa Uludağ University (Approval no: 2023-16/45, Date: August 1, 2023).

Informed Consent: Written informed consent was obtained from the patients/patient who agreed to take part in the study.

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