Title

Impact of SARS-CoV-2 (COVID-19) Infections on Mental Health Diagnoses in Youth With Chronic Illness.

Authors

McVoy, Molly
Hung, Rina
Bransteter, Irina
et al.

Publication Date

2024-09-01

DOI

10.1016/j.jaacop.2023.12.004

Peer reviewed

NEW RESEARCH

Check for updates

Impact of SARS-CoV-2 (COVID-19) Infections on Mental Health Diagnoses in Youth With Chronic Illness

Molly McVoy, MD, Rina Hung, BA, Irina Bransteter, PhD, Jaime A. Perez, PhD, Tracy L. Segall, MSHS, Jessica O. Surdam, MPH, David W. Miller, MD, LAc, Jeffrey A. Dusek, PhD, Martha Sajatovic, MD

Objective: Stressors from the COVID-19 pandemic and limited availability of mental health care services have negatively impacted youth mental health in a significant way. In the first year of the pandemic, global prevalence of anxiety and depression increased by roughly 25% in pediatric populations. While the general trend is clear, this research aimed to explore the added mental health burden of acute COVID-19 on pediatric patients with chronic conditions and describe the differences in mental health outcomes between pediatric patients with 2 common chronic conditions (asthma and diabetes) to better understand specific factors that may increase susceptibility to mental health concerns.

Method: Using the TriNetX database, data were extracted for all pediatric patients (aged 5-17 years) with a positive SARS-CoV-2 infection (COVID-19) within a 1-year time frame (April 7, 2021, to April 6, 2022). These patients were divided into 4 cohorts based on the presence of chronic conditions before COVID-19 infection: diabetes (n = 1,587), asthma (n = 13,217), diabetes plus asthma (n = 626), and neither diabetes nor asthma (n = 104,427). For all cohorts, patients with other chronic illness and previous mental health diagnoses were excluded using relevant *ICD-10* codes. After matching for demographics, comorbid conditions, and body mass index, odds ratios (ORs) of the following outcomes were compared between cohorts after 6 months: new psychiatric diagnosis using relevant *ICD-10* codes, hospitalization within 1 week, and mortality.

Results: After matching, there were statistically significant differences in outcomes between patients with chronic illness and healthy controls after 6 months. Compared with healthy controls, the asthma cohort OR of developing a new psychiatric diagnosis was 1.4 (95% CI 1.15-1.71, $p < .001$), and the diabetes cohort OR was 1.81 (95% CI 1.11-2.94, $p = .015$). The new psychiatric diagnosis OR of the asthma cohort compared with the diabetes cohort was 0.62 (95% CI 0.39-0.99, $p = .045$), suggesting that patients in the diabetes cohort were particularly susceptible to additional mental health diagnoses after an acute COVID-19 infection.

Conclusion: Compared with healthy controls, pediatric patients with asthma and pediatric patients with diabetes experienced increased odds of developing a new psychiatric diagnosis after an acute COVID-19 infection.

Plain language summary: Adverse mental health outcomes have been reported in adults after a COVID-19 infection, but its effect on children with pre-existing chronic conditions is unclear. This study examined data from the TriNetX database, focusing on 5-to-17 year-old SARS-CoV-2 patients with pre-existing chronic conditions and without mental health diagnoses prior to infection, to identify factors associated with increased risk of mental health concerns. They studied 1,587 children with diabetes, 13,217 with asthma, 626 with both, and 104,427 with neither. Results showed that patients with asthma and diabetes had higher odds of developing new psychiatric diagnoses after COVID-19 infection compared to healthy individuals. These findings highlight the importance of tailored mental health support for this patient population.

Key words: chronic illnesses; COVID-19; mental illness; pediatrics

JAACAP Open 2024;2(3):180-187.

The COVID-19 pandemic caused an unprecedented disruption in the health care system, school systems, and social systems in general. Research has shown an increase in mental health challenges across the population since the onset of the pandemic,[1-3] and preliminary studies have demonstrated an increased incidence of mental health challenges among survivors of acute SARS-CoV-2 (COVID-19) infections.[4,5] However, much remains unclear about the specific psychiatric effects of an acute COVID-19 infection on vulnerable populations such as children with chronic health conditions.

Though there is minimal research on the psychiatric sequelae of acute COVID-19 infections in pediatric patients, evidence to date suggests that the pandemic at large has negatively affected the mental health of children.[1,6,7] A global meta-analysis of children and adolescents estimates that the prevalence of depression and anxiety symptoms has doubled compared with prepandemic estimates.[7] International data have demonstrated worsening symptoms of depression, sadness, and suicidality in adolescents during the pandemic.[8,9] In the United States, both the proportion and the number of mental health–related

emergency department visits increased for pediatric patients <18 years of age beginning in mid- to late 2020.[6] While these large-scale surveys describe an alarming trend, it is difficult to quantify the relative contributions of various social, economic, and personal factors during the global pandemic. For example, both in the United States and internationally, measures such as lockdowns and school closures have been associated with poor mental health outcomes in both children and adults.[10-12] There is growing research on the long-term sequelae of prolonged COVID-19 infection (long-COVID),[13,14] but, apart from a small study of 38 pediatric patients with COVID-19 in China that demonstrated a 2-fold increase in anxiety, no large cohort studies have been conducted to determine the psychological sequelae of acute COVID-19 infection itself on pediatric patients.[11]

Existing research on adult patients demonstrates a link between acute COVID-19 infection and increased psychiatric sequelae.[4,15,16] A large cohort study showed that adult patients without prior psychiatric histories experienced an increased incidence of first psychiatric diagnosis in the days following their infection compared with other common health events, especially for anxiety disorders, insomnia, and dementia.[4] Adults with certain chronic health conditions, such as respiratory, cardiovascular, and renal disease, also appear to experience increased mortality and morbidity from COVID-19 infection.[17,18] Severity of illness and acute disability associated with severe illness have been demonstrated to be associated with long-term increases in mental health morbidity in adults internationally.[19] We do not yet have data to confirm if this holds true for pediatric COVID-19 patients with chronic health conditions, but there is an urgent need to quantify the mental health burden for this vulnerable subgroup.

The studies that have investigated this population suggest that chronic illness may be overrepresented in severe pediatric COVID-19 cases. One review of 48 children admitted to pediatric intensive care units demonstrated that 83% had been diagnosed with preexisting conditions and that 8% had an existing diagnosis of type 1 diabetes.[20] Another retrospective chart review of 205 pediatric COVID-19 admissions found an association between type 1 diabetes and increased hospital stay and respiratory support.[21] Conversely, pediatric patients with asthma experienced comparably milder disease manifestations than adult patients with asthma, and asthma does not appear to be linked to worse outcomes of acute COVID-19 infections in children compared with healthy controls.[22,23] However, no large-scale studies have investigated the psychological sequelae of a COVID-19 infection in these populations.

This study aimed to address part of that knowledge gap. This retrospective chart review used a large electronic health record network to assess the odds ratios (ORs) of a new psychiatric diagnosis, mortality, and hospitalization in pediatric patients with COVID-19 and 2 representative chronic health conditions, diabetes and asthma, compared with healthy controls. Diabetes and asthma were chosen because they are 2 of the most common non-neurologic chronic health conditions in the pediatric population.[24] We hypothesized that participants with chronic conditions would experience an increased OR for all 3 outcomes compared with their healthy counterparts. Our aim was to quantify any added burden of acute COVID-19 on pediatric patients with chronic illness compared with healthy pediatric patients and to compare the difference in mental health outcomes between pediatric patients with diabetes and asthma.

METHOD

Data Source

We used TriNetX (TriNetX LLC, Cambridge, Massachusetts), a large national health care research network sourced from 58 health care organizations (HCOs) located in the United States and including more than 87 million patients (data accessed on April 6, 2022). TriNetX provides continuously aggregated clinical data directly from the electronic medical records of participating HCOs, including *ICD-10* codes, patient demographics, procedures, and laboratory measurements. Data are continually updated to ensure extensive data quality and accuracy. In compliance with legal and ethical guidelines, TriNetX does not provide institutional details of participating HCOs (such as number of pediatric hospitals included); however, a typical participating HCO includes a large academic or research-oriented health care center with inpatient, outpatient, and specialty care services. All data are deidentified and therefore exempt from institutional review board review. Using TriNetX, we created our cohorts after specifying our inclusion and exclusion criteria. We then matched the study participants for confounding variables and compared the outcomes of interest (Tables S1-S3, available online).

Participants

We identified all pediatric patients (aged 5-17 years) with a positive diagnosis of SARS-CoV-2 infection (as defined by *ICD-10* code U07.1 or a positive RNA test) from April 7, 2021, to April 6, 2022. These participants were further stratified by the presence of 2 common chronic illnesses before COVID-19 infection to create 4 cohorts: diabetes cohort, asthma cohort, asthma plus diabetes cohort, and

healthy controls (patients without any history of diabetes or asthma).[25] Patients with diabetes were defined with *ICD-10* codes E10, E11, and E13 (type 1 diabetes mellitus, type 2 diabetes mellitus, and other specified diabetes mellitus), and asthma patients were defined with *ICD-10* code J45. The asthma plus diabetes cohort required at least one positive *ICD-10* code from both categories.

For all cohorts, we excluded patients with preexisting chronic illnesses that may confound our findings, including respiratory conditions (chronic obstructive pulmonary disease, tuberculosis, cystic fibrosis), cardiovascular conditions (congenital malformations, arrhythmias), epilepsy, malignancies, autoimmune diseases, gastrointestinal diseases, and other systemic conditions (Table S4, available online) We also excluded any patients with prior mental health diagnoses so that any psychiatric diagnosis detected during our period of study would present a new concern and not an exacerbation of an existing condition.

Outcomes

We collected data on 3 clinical outcomes for each cohort: new psychiatric diagnosis occurring any time after COVID-19 infection during the time of investigation (April 7, 2021, to April 6, 2022), mortality occurring any time after COVID-19 infection, and all-cause hospitalization after 1 week of COVID-19 infection. A new psychiatric diagnosis was defined by the assignment of a new psychiatric disorder *ICD-10* code (depressive episode, anxiety disorder, attention-deficit/hyperactivity, or adjustment disorder) or a new psychiatric medication prescription (see full list in Table 1). Mortality was defined within the demographics section of TriNetX. All-cause hospitalization within 1 week of infection was defined as having either an inpatient encounter or a procedure code for critical care services within 1 week.

Statistical Analysis

We collected clinical data including patient demographics, comorbid conditions, body mass index (BMI), and clinical outcomes including a new psychiatric diagnosis or mortality any time after COVID-19 infection and all-cause hospitalization within 1 week of infection. To address potential confounders that could bias our results, we balanced cohorts using 1:1 greedy nearest-neighbor propensity score matching based on patient demographics, BMI ($\geq$26 kg/m^2), or a diagnosis of overweight/obesity.[26] All statistical tests were conducted within the TriNetX Advanced Analytics Platform.[26] For continuous data, we performed independent t tests. For categorical data (presented as frequencies and percentages), we performed χ^2 tests. For outcomes, we used ORs and 95% CIs to compare the risk of experiencing the outcome between cohorts. A two-sided p value $< .05$ was considered statistically significant. To safeguard protected health information, TriNetX rounds patient counts that are less than 10 up to 10. This rounding may affect our measures of association for variables with small patient counts.

TABLE 1 New Psychiatric Diagnosis or Prescription for Psychiatric Medication Following COVID-19 Diagnosis

Psychiatric Disorder Diagnosis	
UMLS *ICD-10-CM* code	**Disorder**
F32	Depressive episode
F41	Other anxiety disorders
F90	Attention-deficit/hyperactivity disorders
F43.2	Adjustment disorders
Psychiatric Medication Prescription	
NLM RxNORM code	**Medication**
4493	Fluoxetine
36437	Sertraline
32937	Paroxetine
2556	Citalopram
321988	Escitalopram
42347	Bupropion
72625	Duloxetine
6901	Methylphenidate
352372	Dexmethylphenidate
700810	Lisdexamfetamine
725	Amphetamine
6448	Lithium
40254	Valproate
28439	Lamotrigine
89013	Aripiprazole
51272	Quetiapine
35636	Risperidone
115698	Ziprasidone
679314	Paliperidone

Note: *NLM, National Library of Medicine; UMLS, United Medical Language System.*

RESULTS

We found 119,857 pediatric patients (aged 5-17 years) with a positive COVID-19 infection and stratified them into 4 cohorts: diabetes (n = 1,587), asthma (n = 13,217), asthma plus diabetes (n = 626), and healthy controls (n = 104,427). These cohorts were matched using patient demographics, BMI, and obesity measures.

TABLE 2 Outcomes in Asthma vs Healthy Control Cohorts After Propensity Score Matching

	Asthma		Healthy				
Outcome	**n**	**(%)**	**n**	**(%)**	**OR**	**(95% CI)**	***p***
Psychiatric diagnosis	234	(2)	168	(1)	1.40	(1.15, 1.71)	.00084
Mortality	52	(0.4)	22	(0.2)	2.37	(1.44, 3.9)	.00048
Hospitalization (1 wk)	183	(1)	100	(1)	1.84	(1.44, 2.35)	<.0001

Note: *OR = odds ratio.*

Chronic Illnesses vs Healthy Controls

The ORs comparing 1-week hospitalization, mortality, and new psychiatric diagnosis between chronic illness cohorts and the healthy control cohort are presented in Tables 2, 3, and 4. After matching, both the asthma cohort and the diabetes cohort experienced a statistically significant increase in OR of all 3 outcomes compared with their healthy controls. Patients with asthma experienced higher rates of 1-week hospitalization (OR = 1.84, $p < .0001$), mortality (OR = 2.37, $p = .00048$), and new psychiatric diagnosis (OR = 1.4, $p < .001$) (Table 2). In patients with diabetes, this OR increase in 1-week hospitalization (OR = 5.75, $p < .0001$), mortality (OR = 2.32, $p = .023$), and new psychiatric diagnosis (OR = 1.81, $p = .015$) was even more pronounced (Table 3), though the p values were considerably larger due to the smaller diabetes cohort.

Our asthma plus diabetes cohort yielded inconsistent results (Table 4). Compared with healthy controls, 1-week hospitalization was increased (OR = 1.51, $p = .31$) and new psychiatric diagnosis was decreased (OR = 0.63, $p = .25$), but the results were not statistically significant after matching. Mortality was statistically increased ($p = 0.001498$) for the asthma plus diabetes cohort.

Asthma Cohort vs Diabetes Cohort

The outcomes comparison between the asthma cohort and the diabetes cohort after propensity score matching is presented in Table 5. Patients with asthma experienced significantly improved outcomes in all 3 measures compared with patients with diabetes, with fewer 1-week hospitalizations (OR = 0.3, $p < .0001$), less mortality (OR = 0.43, $p = .022913$), and fewer new psychiatric diagnoses (OR = 0.62, $p = .045329$).

DISCUSSION

This is the first large cohort study to examine psychiatric sequelae of acute COVID-19 infections in youth. One small study in China found increased rates of anxiety after acute COVID-19 infection, and there are several case reports of flares of underlying neuropsychiatric issues in youth after COVID-19 infections.[27,28] This investigation used data from a large national health care network to compare cohorts of pediatric COVID-19 patients (aged 5-17) with chronic illnesses on 3 health outcomes: 1-week hospitalization, mortality, and new psychiatric diagnosis. We found that compared with previously healthy pediatric patients with an acute COVID-19 infection, patients who had either asthma or diabetes experienced significantly worse outcomes in all 3 areas. Our findings also indicated that patients with diabetes in particular had the worst outcomes than either patients with asthma or previous healthy youth.

After matching with healthy patients, 234 (2%) patients with asthma received a new psychiatric diagnosis within 6 months of COVID-19 infection compared with 168 (1%) of healthy controls (OR 1.4, $p < .001$). Among patients with diabetes, 46 (3%) received a new psychiatric diagnosis compared with only 26 (2%) participants in the healthy control cohort (OR = 1.81, $p = .015$). Importantly, both the asthma cohort and the diabetes cohort also experienced higher rates of 1-week hospitalization and mortality after infection. This opens up the possibility that the increased rate of new

TABLE 3 Outcomes in Diabetes vs Healthy Control Cohorts After Propensity Score Matching

	Diabetes		Healthy				
Outcome	**n**	**(%)**	**n**	**(%)**	**OR**	**(CI)**	***p***
Psychiatric diagnosis	46	(3)	26	(2)	1.81	(1.11, 2.94)	.015
Mortality	23	(1)	10	(1)	2.32	(1.1, 4.89)	.022914
Hospitalization (1 wk)	72	(5)	13	(1)	5.75	(3.17, 10.43)	<.0001

Note: *OR = odds ratio.*

TABLE 4 Outcomes in Diabetes and Asthma vs Healthy Controls After Propensity Score Matching

	Asthma and Diabetes		Healthy				
Outcome	**n**	**(%)**	**n**	**(%)**	**OR**	**(CI)**	***p***
Psychiatric diagnosis	10	(2)	16	(3)	0.63	(0.28, 1.4)	.25
Mortality	10	(2)	0		N/A		.0015
Hospitalization (1 wk)	15	(2)	10	(2)	1.51	(0.67, 3.39)	.31

Note: *N/A = not applicable; OR = odds ratio.*

psychiatric diagnoses is associated with COVID-19 disease severity or the length of stay in the hospital. It is also possible that, due to the existing chronic conditions, patients with asthma and diabetes were monitored more closely after COVID-19 infection and their psychiatric sequelae were overreported compared with their healthy counterparts, leading to a discovery bias in these findings. In addition, there were no consistent measures of pre-COVID diabetes or asthma severity in this dataset, and, consequently, patients with more severe diabetes and asthma may have different courses than their peers with less severe symptoms. Evidence is mixed regarding impact of asthma diagnosis, asthma severity, and its impact on COVID-19 outcomes, with some evidence suggesting that uncontrolled asthma leads to higher risk of severe COVID-19 acute infection.[29-31] Diabetes is a well-established risk factor for severe COVID-19 infection in adults,[32-34] and some early evidence suggests similar risks in pediatric COVID-19 infections.[35,36]

Of particular interest was the outcomes comparison between the asthma cohort and the diabetes cohort. Patients in the diabetes cohort consistently experienced worse outcomes after matching compared with patients with asthma. A new psychiatric diagnosis after infection was seen in 29 (2%) patients with asthma compared with 46 (3%) patients with diabetes (OR = 0.62, $p = .045$). The mortality rate for patients with diabetes was more than double the rate for patients with asthma (23 diabetes vs 10 asthma), and 1-week hospitalization was more than tripled (72 diabetes vs 22 asthma). It was expected that because COVID-19 infections and asthma both impact the respiratory system, patients with asthma would show more pronounced negative outcomes than patients with diabetes. However, our results suggest that youth with diabetes had higher risk of psychiatric sequelae and worse outcomes in general. Although no causation or mechanistic conclusions are possible with this correlational design, it is worth considering why youth with diabetes had such outcomes. Preexisting diabetes may have led to more severe COVID-19 infections in this sample, and, if so, our results are consistent with the previous hypothesis that the severity of the course of the COVID-19 disease corresponds with increased rates of new psychiatric concerns. A limited number of studies have shown a link between preexisting diabetes and increased COVID-19 complications such as kidney injury,[37,38] and it is possible that a preexisting diabetes diagnosis predisposes patients to psychiatric complications as well. The chronicity and daily impact of preexisting diabetes in youth may make them more vulnerable in general to poor outcomes when faced with additional disease burden, such as COVID-19, than youth with asthma, which is a more intermittent condition.[39-41]

Rates of mental health comorbidity are relatively well studied in pediatric asthma with 17% to 37% of pediatric patients with asthma reportedly having a diagnosis of a comorbid mental health disorder.[42-45] Mental health comorbidity is less well studied in pediatric diabetes, with rates ranging from 13% to 24% in type 1 diabetes and 11% to 68% in type 2 diabetes in youth.[46-50] The vulnerability of youth with a chronic, daily illness such as diabetes compared with youth with an intermittent illness such as asthma to psychiatric comorbidity is an area that requires further study, especially in light of studies such as this highlighting the risk for youth with diabetes.

TABLE 5 Outcomes in Diabetes vs Asthma After Propensity Score Matching

	Asthma		Diabetes				
Outcome	**n**	**(%)**	**n**	**(%)**	**OR**	**(CI)**	***p***
Psychiatric diagnosis	29	(2)	46	(3)	0.62	(0.39, 0.99)	.045
Mortality	10	(1)	23	(1)	0.43	(0.2, 0.91)	.023
Hospitalization (1 wk)	22	(1)	72	(5)	0.3	(0.18, 0.48)	<.0001

Note: *OR = odds ratio.*

In addition to the above findings, there has been a link between acute COVID-19 infections and the development of diabetes, and, perhaps pathophysiologic overlap between the diseases also leads to morbidity and more significant sequelae in patients with preexisting diabetes once infected with COVID-19.[51,52] Because of sample size limitations, patients with type 1 and type 2 diabetes were included together, which further limits mechanistic specific conclusions. Further studies investigating separate cohorts of type 1 and type 2 diabetes are warranted.

Our study strengths were the use of TriNetX to obtain a large national sample size and propensity score matching to account for patient demographics, BMI, and obesity. However, there are several limitations to note with our study. While demographic factors such as race, gender, and age were captured, TriNetX does not provide information on socioeconomic and insurance status, and we therefore could not match patients on these variables. Second, we could not account for the possibility that patients with prior chronic illnesses may have received more medical monitoring, potentially reflecting a cohort where a new psychiatric diagnoses and/or treatment would be inherently more likely due to more intensive medical engagement, a potential discovery bias. In addition, medication to treat more severe asthma, diabetes, and acute COVID-19 may have variable impact on mood (ie, corticosteroids and asthma exacerbations),[53,54] and this could be controlled for in this initial study.

Because we excluded all youth with prior comorbid mental health disorders, it is possible that the cohort skewed toward patients with milder symptoms of both asthma and diabetes, and more research is needed to further examine these relationships. We also do not have information on the initial severity of the COVID-19 infection, and it is possible that the chronic illness cohorts had different initial presentations compared with the healthy cohort. Because new psychiatric diagnoses were also not tightly temporally matched to the new COVID-19 infections specifically (ie, the new diagnosis was definitively added within 4 weeks of initial infection, rather than within 6 months), we also are not able to ensure that the new psychiatric diagnosis was caused by the initial infection and its experience. The way we defined new psychiatric diagnosis has some limitations. Because of the limits of a claims-based data analysis such as this, we used a new *ICD-10* code or a new psychiatric medication prescription. These criteria may have been too broad and led to overinclusion of patients without a true new psychiatric condition. Further longitudinal research would better identify these differences.

In addition, there is the possibility that the rapid changes in school closures, social policies, and COVID-19 surges may have affected our cohorts variably during our 1-year study period, and further research is needed. Importantly, the COVID-19 vaccine was available for 16- to 17-year-olds in December 2020 before our initial sample, but not until May 2021 for youth aged 12 to 15 and not until November 2021 for children 5 to 11 years old.[55] Availability of vaccine was variable over the course of the year of this dataset, and vaccination status was not one of the variables measured in this particular study because of variability in how it was recorded in the dataset. Vaccination status has been subsequently shown to impact disease severity,[56] and future research using databases such as this should incorporate vaccine status as a part of the variables measured. In addition, the generalizability of these findings is limited in part because this cohort was diagnosed before many of the emerging strains of COVID-19.

Given the large sample size, our findings have strong implications for the management of pediatric patients with COVID-19 and warrant further study. The increased odds of a new psychiatric diagnosis in patients with chronic illness, particularly for diabetes, is significant and can serve as a useful clinical alert for health care practitioners during follow-up monitoring and inpatient care. This review adds value and ought to be considered with future public health initiatives focused on mitigating the impact of COVID-19 in pediatric patients. While we broadly addressed 2 chronic conditions, asthma and diabetes, in this preliminary study, it would be useful for future research to investigate other illnesses or provide a more detailed picture of how COVID-19 affects children with a prior diagnosis of type 1 vs type 2 diabetes mellitus. In addition, most youth with COVID-19 experience mild or no symptoms and may not therefore be included in a database that requires a formal diagnosis. Further research taking this into account is warranted.[57] In summary, it is imperative that more studies focus on the association between the severity of COVID-19 and the psychiatric sequelae in children and distinguish between acute sequelae and the impact of long-COVID on the acquisition of new psychiatric diagnoses.

Accepted December 19, 2023.

Drs. McVoy, Bransteter, Miller, Dusek, and Sajatovic and Ms. Hung are with Case Western Reserve University School of Medicine, Cleveland, Ohio. Drs. McVoy, Bransteter, Perez, Miller, and Sajatovic, and Mss. Segall and Surdam are with University Hospitals Cleveland Medical Center, Cleveland, Ohio.

The authors have reported no funding for this work.

Dr. Perez served as the statistical expert for this research.

Author Contributions
Conceptualization: McVoy, Hung, Bransteter, Segall, Surdam, Miller, Dusek, Sajatovic
Data curation: McVoy, Perez

Formal analysis: McVoy, Perez
Investigation: McVoy, Hung, Bransteter, Perez, Segall, Surdam, Miller, Dusek, Sajatovic
Methodology: McVoy, Hung, Bransteter, Segall, Surdam, Miller, Dusek, Sajatovic
Project administration: McVoy, Hung
Resources: McVoy, Hung
Software: Perez
Supervision: McVoy
Validation: McVoy
Visualization: McVoy
Writing — original draft: McVoy, Hung
Writing — review and editing: McVoy, Hung, Bransteter, Perez, Segall, Surdam, Miller, Dusek, Sajatovic

Disclosure: Dr. McVoy has received royalties from the American Psychiatric Association and research funding from The Hartwell Foundation and the National Institute of Mental Health. Dr. Sajatovic has received funding from Merck, Otsuka, Alkermes, the International Society for Bipolar Disorders (ISBD), the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Patient-Centered Outcomes Research Institute (PCORI). She has been a consultant for Alkermes, Otsuka, Janssen, Lundbeck, Teva, and Neurelis and has received royalties from Springer Press, Johns Hopkins University Press, Oxford Press, and UpToDate. She has received compensation for preparation of/participation in CME activities: American Physician's Institute (CMEtoGo), Psychopharmacology Institute, American Epilepsy Society, Clinical Care Options, American Academy of Child and Adolescent Psychiatry, and Neurocrine. Drs. Bransteter, Perez, Miller, and Dusek and Mss. Hung, Segal, and Surdam have reported no biomedical financial interests or potential conflicts of interest.

Correspondence to Molly McVoy, MD, 10524 Euclid Avenue, Cleveland OH, 44106; e-mail: Molly.McVoy@uhhospitals.org

https://doi.org/10.1016/j.jaacop.2023.12.004

REFERENCES

1. Meherali S, Punjani N, Louie-Poon S, *et al*. Mental health of children and adolescents amidst COVID-19 and past pandemics: a rapid systematic review. Int J Environ Res Public Health. 2021;18(7):3432. https://doi.org/10.3390/ijerph18073432
2. Chadi N, Ryan NC, Geoffroy MC. COVID-19 and the impacts on youth mental health: emerging evidence from longitudinal studies. Can J Public Health. 2022;113(1):44-52. https://doi.org/10.17269/s41997-021-00567-8
3. Chavira DA, Ponting C, Ramos G. The impact of COVID-19 on child and adolescent mental health and treatment considerations. Behav Res Ther. 2022;157:104169. https://doi.org/10.1016/j.brat.2022.104169
4. Taquet M, Luciano S, Geddes JR, Harrison PJ. Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62 354 COVID-19 cases in the USA. Lancet Psychiatry. 2021;8(2):130-140. https://doi.org/10.1016/S2215-0366(20)30462-4
5. Mazza MG, De Lorenzo R, Conte C, *et al*. Anxiety and depression in COVID-19 survivors: role of inflammatory and clinical predictors. Brain Behav Immun. 2020;89:594-600. https://doi.org/10.1016/j.bbi.2020.07.037
6. Leeb RT, Bitsko RH, Radhakrishnan L, Martinez P, Njai R, Holland KM. Mental health-related emergency department visits among children aged <18 years during the COVID-19 pandemic—United States, January 1-October 17, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(45):1675-1680. https://doi.org/10.15585/mmwr.mm6945a3
7. Racine N, McArthur BA, Cooke JE, Eirich R, Zhu J, Madigan S. Global prevalence of depressive and anxiety symptoms in children and adolescents during COVID-19: a meta-analysis. JAMA Pediatr. 2021;175(11):1142-1150. https://doi.org/10.1001/jamapediatrics.2021.2482
8. Woo HG, Park S, Yon H, *et al*. National trends in sadness, suicidality, and COVID-19 pandemic-related risk factors among South Korean adolescents from 2005 to 2021. JAMA Netw Open. 2023;6(5):e2314838. https://doi.org/10.1001/jamanetworkopen.2023.14838
9. Saunders NR, Kurdyak P, Stukel TA, *et al*. Utilization of physician-based mental health care services among children and adolescents before and during the COVID-19 pandemic in Ontario, Canada. JAMA Pediatr. 2022;176(4):e216298. https://doi.org/10.1001/jamapediatrics.2021.6298
10. Singh S, Roy D, Sinha K, Parveen S, Sharma G, Joshi G. Impact of COVID-19 and lockdown on mental health of children and adolescents: a narrative review with recommendations. Psychiatry Res. 2020;293:113429. https://doi.org/10.1016/j.psychres.2020.113429
11. Liu D, Liu W, Rodriguez M, Zhang J, Zhang F. The mental health impacts of COVID-19 on pediatric patients following recovery. Front Psychol. 2021;12:628707. https://doi.org/10.3389/fpsyg.2021.628707
12. Aknin LB, Andretti B, Goldszmidt R, *et al*. Policy stringency and mental health during the COVID-19 pandemic: a longitudinal analysis of data from 15 countries. Lancet Public Health. 2022;7(5):e417-e426. https://doi.org/10.1016/s2468-2667(22)00060-3
13. Stephenson T, Pinto Pereira SM, Shafran R, *et al*. Physical and mental health 3 months after SARS-CoV-2 infection (long COVID) among adolescents in England (CLoCk): a national matched cohort study. Lancet Child Adolesc Health. 2022;6(4):230-239. https://doi.org/10.1016/s2352-4642(22)00022-0
14. Avittan H, Kustovs D. Cognition and mental health in pediatric patients following COVID-19. Int J Environ Res Public Health. 2023;20(6):5061. https://doi.org/10.3390/ijerph20065061
15. Halpin SJ, McIvor C, Whyatt G, *et al*. Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: a cross-sectional evaluation. J Med Virol. 2021;93(2):1013-1022. https://doi.org/10.1002/jmv.26368
16. Nalleballe K, Reddy Onteddu S, Sharma R, *et al*. Spectrum of neuropsychiatric manifestations in COVID-19. Brain Behav Immun. 2020;88:71-74. https://doi.org/10.1016/j.bbi.2020.06.020
17. Laires PA, Dias S, Gama A, *et al*. The association between chronic disease and serious COVID-19 outcomes and its influence on risk perception: survey study and database analysis. JMIR Public Health Surveill. 2021;7(1):e22794. https://doi.org/10.2196/22794
18. CDC COVID Response Team. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019—United States, February 12-March 28, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(13):382-386. https://doi.org/10.15585/mmwr.mm6913e2
19. Magnúsdóttir I, Lovik A, Unnarsdóttir AB, *et al*. Acute COVID-19 severity and mental health morbidity trajectories in patient populations of six nations: an observational study. Lancet Public Health. 2022;7(5):e406-e416. https://doi.org/10.1016/s2468-2667(22)00042-1
20. Buggs-Saxton C. Care of pediatric patients with diabetes during the coronavirus disease 2019 (COVID-19) pandemic. Pediatr Clin North Am. 2021;68(5):1093-1101. https://doi.org/10.1016/j.pcl.2021.05.014
21. Loomba RS, Villarreal EG, Farias JS, Bronicki RA, Flores S. Pediatric intensive care unit admissions for COVID-19: insights using state-level data. Int J Pediatr. 2020;2020:9680905. https://doi.org/10.1155/2020/9680905
22. Boechat JL, Wandalsen GF, Kuschnir FC, Delgado L. COVID-19 and pediatric asthma: clinical and management challenges. Int J Environ Res Public Health. 2021;18(3):1093. https://doi.org/10.3390/ijerph18031093
23. Chatziparasidis G, Kantar A. COVID-19 in children with asthma. Lung. 2021;199(1):7-12. https://doi.org/10.1007/s00408-021-00419-9
24. Miller GF, Coffield E, Leroy Z, Wallin R. Prevalence and costs of five chronic conditions in children. J Sch Nurs. 2016;32:357-364. https://doi.org/10.1177/1059840516641190
25. Torpy JM, Campbell A, Glass RM. JAMA patient page. Chronic diseases of children. JAMA. 2010;303(7):682. https://doi.org/10.1001/jama.303.7.682
26. Lee SW, Acharya KP. Propensity score matching for causal inference and reducing the confounding effects: statistical standard and guideline of Life Cycle Committee. Life Cycle. 2022;2:e18. https://doi.org/10.54724/lc.2022.e18
27. Bez Y, Kompella S, Summerson A, Coffey BJ. Management of COVID-19 infection-associated flare in an adolescent with pediatric acute neuropsychiatric syndrome and obsessive-compulsive disorder. J Child Adolesc Psychopharmacol. 2022;32(6):368-371. https://doi.org/10.1089/cap.2022.29224.bjc
28. Efe A. SARS-CoV-2/COVID-19 associated pediatric acute-onset neuropsychiatric syndrome a case report of female twin adolescents. Psychiatry Res Case Rep. 2022;1(2):100074. https://doi.org/10.1016/j.psycr.2022.100074
29. Abrams EM, Sinha I, Fernandes RM, Hawcutt DB. Pediatric asthma and COVID-19: the known, the unknown, and the controversial. Pediatr Pulmonol. 2020;55(12):3573-3578. https://doi.org/10.1002/ppul.25117

30. Palmon PA, Jackson DJ, Denlinger LC. COVID-19 infections and asthma. J Allergy Clin Immunol Pract. 2022;10(3):658-663. https://doi.org/10.1016/j.jaip.2021.10.072
31. Grandinetti R, Palazzolo E, Rizzo L, *et al*. Impact of SARS-CoV-2 infection in children with asthma and impact of COVID-19 vaccination: current evidence and review of the literature. Microorganisms. 2023;11(7):1745. https://doi.org/10.3390/microorganisms11071745
32. Kumar A, Arora A, Sharma P, *et al*. Is diabetes mellitus associated with mortality and severity of COVID-19? A meta-analysis. Diabetes Metab Syndr. 2020;14(4):535-545. https://doi.org/10.1016/j.dsx.2020.04.044
33. Lima-Martínez MM, Carrera Boada C, Madera-Silva MD, Marín W, Contreras M. COVID-19 and diabetes: a bidirectional relationship. Clin Investig Arterioscler. 2021; 33(3):151-157. https://doi.org/10.1016/j.arteri.2020.10.001
34. Zhou Y, Chi J, Lv W, Wang Y. Obesity and diabetes as high-risk factors for severe coronavirus disease 2019 (Covid-19). Diabetes Metab Res Rev. 2021;37(2):e3377. https://doi.org/10.1002/dmrr.3377
35. Woodruff RC, Campbell AP, Taylor CA, *et al*. Risk factors for severe COVID-19 in children. Pediatrics. 2022;149(1):e2021053418. https://doi.org/10.1542/peds.2021-053418
36. Fotea S, Ghiciuc CM, Stefanescu G, *et al*. Pediatric COVID-19 and diabetes: an investigation into the intersection of two pandemics. Diagnostics (Basel). 2023;13(14): 2436. https://doi.org/10.3390/diagnostics13142436
37. Feldman EL, Savelieff MG, Hayek SS, Pennathur S, Kretzler M, Pop-Busui R. COVID-19 and diabetes: a collision and collusion of two diseases. Diabetes. 2020;69(12):2549-2565. https://doi.org/10.2337/dbi20-0032
38. Hirsch JS, Ng JH, Ross DW, *et al*. Acute kidney injury in patients hospitalized with COVID-19. Kidney Int. 2020;98(1):209-218. https://doi.org/10.1016/j.kint.2020.05.006
39. Tallon EM, Ebekozien O, Sanchez J, *et al*. Impact of diabetes status and related factors on COVID-19-associated hospitalization: a nationwide retrospective cohort study of 116,370 adults with SARS-CoV-2 infection. Diabetes Res Clin Pract. 2022;194:110156. https://doi.org/10.1016/j.diabres.2022.110156
40. Kahkoska AR, Dabelea D. Diabetes in youth: a global perspective. Endocrinol Metab Clin North Am. 2021;50(3):491-512. https://doi.org/10.1016/j.ecl.2021.05.007
41. Panettieri RA Jr, Covar R, Grant E, Hillyer EV, Bacharier L. Natural history of asthma: persistence versus progression—does the beginning predict the end? J Allergy Clin Immunol. 2008;121(3):607-613. https://doi.org/10.1016/j.jaci.2008.01.006
42. Ye G, Baldwin DS, Hou R. Anxiety in asthma: a systematic review and meta-analysis. Psychol Med. 2021;51(1):11-20. https://doi.org/10.1017/s0033291720005097
43. Mrazek DA. Psychiatric symptoms in patients with asthma causality, comorbidity, or shared genetic etiology. Child Adolesc Psychiatr Clin N Am. 2003;12(3):459-471. https://doi.org/10.1016/s1056-4993(03)00028-2
44. Das RR, Gulla KM. Psychiatric and behavioral problems in childhood asthma: an opportunity for prevention. Indian J Pediatr. 2021;88(10):957-958. https://doi.org/10.1007/s12098-021-03925-z
45. Rajhans P, Sagar R, Patra BN, Bhargava R, Kabra SK. Psychiatric morbidity and behavioral problems in children and adolescents with bronchial asthma. Indian J Pediatr. 2021;88(10):968-973. https://doi.org/10.1007/s12098-021-03661-4
46. Akbarizadeh M, Naderi Far M, Ghaljaei F. Prevalence of depression and anxiety among children with type 1 and type 2 diabetes: a systematic review and meta-analysis. World J Pediatr. 2022;18(1):16-26. https://doi.org/10.1007/s12519-021-00485-2
47. Samuels S, Menand EV, Mauer EA, *et al*. Anxiety and type 1 diabetes management: guardian and child report in a pediatric endocrinology clinic. Psychosomatics. 2020; 61(3):231-237. https://doi.org/10.1016/j.psym.2019.11.006
48. Dybdal D, Tolstrup JS, Sildorf SM, *et al*. Increasing risk of psychiatric morbidity after childhood onset type 1 diabetes: a population-based cohort study. Diabetologia. 2018; 61(4):831-838. https://doi.org/10.1007/s00125-017-4517-7
49. Block WM, Putzer GJ, Jaramillo JR. Children with type 2 diabetes mellitus and the prevalence of psychiatric disorders. South Med J. 2010;103(12):1214-1218. https://doi.org/10.1097/SMJ.0b013e3181f96d5f
50. McVoy M, Hardin H, Fulchiero E, *et al*. Mental health comorbidity and youth onset type 2 diabetes: a systematic review of the literature. Int J Psychiatry Med. 2023;58(1): 37-55. https://doi.org/10.1177/00912174211067335
51. Wrona M, Skrypnik D. New-onset diabetes mellitus, hypertension, dyslipidaemia as sequelae of COVID-19 infection—systematic review. Int J Environ Res Public Health. 2022;19(20):13280. https://doi.org/10.3390/ijerph192013280
52. Pergolizzi J, LeQuang JAK, Breve F, Magnusson PM, Varrassi G. Exploring the implications of new-onset diabetes in COVID-19: a narrative review. Cureus. 2023;15(1): e33319. https://doi.org/10.7759/cureus.33319
53. Drozdowicz LB, Bostwick JM. Psychiatric adverse effects of pediatric corticosteroid use. Mayo Clin Proc. 2014;89(6):817-834. https://doi.org/10.1016/j.mayocp.2014.01.010
54. Cazzola M, Matera MG. Bronchodilators: current and future. Clin Chest Med. 2014; 35(1):191-201. https://doi.org/10.1016/j.ccm.2013.10.005
55. COVID-19 Vaccines. Accessed January 29, 2024. https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/covid-19-vaccines
56. Zhang JJ, Dong X, Liu GH, Gao YD. Risk and protective factors for COVID-19 morbidity, severity, and mortality. Clin Rev Allergy Immunol. 2023;64(1):90-107. https://doi.org/10.1007/s12016-022-08921-5
57. Pierce CA, Herold KC, Herold BC, *et al*. COVID-19 and children. Science. 2022; 377(6611):1144-1149. https://doi.org/10.1126/science.ade1675