

Risk Factors for COVID-19 Hospitalization in School-Age Children

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Abstract

Introduction: With the recent emergence of the Omicron variant, there has been a rapid and alarming increase in the number of COVID-19 cases among pediatric populations. Yet few US pediatric cohort studies have characterized the clinical features of children with severe COVID-19. The objective of this study was to identify those chronic comorbidities that increase the risk of hospitalization for pediatric populations with severe COVID-19.

Methods: A retrospective cohort study that utilized the Texas Inpatient Public Use Data file was conducted. The study included 1187 patients (ages 5 to 19) from 164 acute-care Texas hospitals with the primary or secondary ICD-10CM diagnosis code U07.1 (COVID-19, virus identified). The baseline comparison group included 38 838 pediatric patients who were hospitalized in 2020. Multivariable binary logistic regression, controlling for patient characteristics, sociodemographic factors, and health insurance, was used to estimate the adjusted risk of hospitalization for COVID-19.

Results: Obesity and type 1 diabetes increased the risk of hospitalization with COVID-19 among both children (5-12 years) and adolescents (13-19 years). Adolescents with morbid obesity were 10 times more likely to have severe COVID-19 ($p < 0.001$). Regardless of age, single-parent households (%) for the patient's zip code was associated with an increased risk of hospitalization with COVID-19 (AOR = 1.02, CI: 1.01-1.03, $p < 0.01$). Other risk factors included chronic kidney disease ($p < 0.05$), male gender ($p < 0.001$), Medicaid ($p < 0.001$), and charity care ($p < 0.001$).

Conclusion: Pediatric providers and public health officials should consider the need to tailor clinical management and mitigation efforts for pediatric populations with identifiable risk factors for severe COVID-19. These findings can be used to improve risk communication with families of children with underlying medical conditions and to prioritize prevention measures, including vaccinations.

Keywords

COVID-19 infection, hospitalization, children, adolescents, comorbidities, single-parent households

Introduction

Coronavirus Disease 2019 (COVID-19) was newly identified in January 2020 and was soon thereafter declared a global pandemic. The United States has been one of the countries most severely affected by COVID-19, with more than 77.5 million cases and 921 984 deaths reported by February 18, 2022.¹

Whereas COVID-19 affects all age groups, children have had markedly different outcomes than adults. During the early months of the pandemic, reports of severe forms of

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COVID-19 among pediatric populations were rare. However, the clinical course of COVID-19 in children has since been found to encompass a wide spectrum of disease, from asymptomatic infection to severe complications, including acute respiratory distress syndrome, myocarditis, acute renal failure, multisystem organ failure, and multisystem inflammatory syndrome in children.² Early data on COVID-19 were mostly from older adults with multiple comorbidities. Several authors argued against extrapolating results derived from adults that may not be valid for children.^{3,4} Many early reports on “diabetes” and COVID-19 failed to distinguish between type 1 and type 2.³

In a recent systematic review of asthma and COVID-19 in children, Castro-Rodriguez and Forno (2020) concluded that there is a paucity of evidence on whether childhood asthma is a risk factor for severe complications and hospitalization due to COVID-19.⁵ Likewise, in a systematic review and meta-analysis of pediatric comorbidities and their impact on COVID-19 severity, Tsankov and colleagues (2021) reported that obesity, chronic respiratory disease, and cardiovascular disease increased the risk of hospitalization due to COVID-19.⁶ Another recent study found that type 1 diabetes and obesity increased the likelihood of hospitalization for COVID-19 among pediatric populations.⁷ Although medically complex children were found to be more likely to have serious complications from COVID-19, few studies have examined specific risk factors in more detail.²

Since the start of the pandemic, there have been 11.4 million COVID-19 cases reported among children, and these represent almost one-fifth (18.6%) of total cases within the US.⁸ In December, 2021, the Omicron variant of the SARS-CoV-2 virus emerged and this caused a dramatic rise in the number of childhood COVID-19 cases. In the most recent two-week period, from January 13-27, 2022, there were 1.96 million COVID-19 cases among children. Pediatric populations are more susceptible to COVID-19 because they comprise a significant percentage of the unvaccinated population. As of February 2, 2022, fifty-five percent of adolescents age 12-17 were fully vaccinated.⁹ However, only 22% of children 5-11 years were fully vaccinated.⁹ These immunization rates are in sharp contrast to the rates of greater than 95% for routine pediatric vaccinations.¹⁰ Note there are currently no FDA-approved vaccines for children under five. Whereas most children with COVID-19 experience mild symptoms, about 0.7% of these cases require hospitalization.⁸

Hence there is an urgent need for an unbiased and targeted approach to guide policy makers and to mitigate potential harms, by identifying those children who are most at risk for severe complications from COVID-19. In the present study, we seek to address this void in the literature by identifying the risk factors for hospitalization for COVID-19 among pediatric populations using data from Texas hospitals. Moreover, we seek to illuminate the broader context and to identify the root causes of these comorbid conditions in terms of the social determinants of health (SDOH).^{11,12} The context for this study will be germane for planners and policy makers because Texas is a diverse state in terms of clinical, socioeconomic, and sociodemographic characteristics.

Methods

Study Participants and Inclusion

The data for this study came from the 2020 Texas Inpatient Public Use Data File (TIPUDF), an administrative data set maintained by the Texas Department of State Health Services.¹³ This database contained one principal and twenty-four secondary diagnosis codes for each discharge. This is a comprehensive database that includes 93% to 97% of all hospital discharges statewide.

Starting with a database of more than 1.4 million inpatient discharges, the study included all patients who are: (i) school-age children and (ii) who tested positive for SARS-CoV-2 ($n = 1652$). Of these patients, only females who were admitted for labor and delivery ($n = 465$) were excluded from further analysis.¹⁴ The remaining study subjects included 1187 patients (ages 5 to 19) from 164 acute-care hospitals who were hospitalized from April to September, 2020, with SARS-CoV-2 infection. The associated diagnosis code, based on the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM), was U07.1 (COVID-19, virus identified) for either the principal diagnosis or any of 24 secondary diagnosis codes.¹⁵ The study subjects included 488 children (ages 5-12) and 699 adolescents (age 13-19) who were hospitalized with COVID-19. The baseline comparison group included all pediatric patients, ages 5-19, who were admitted to a Texas hospital from January to March, 2020, for any reason. There were ($n = 38\,838$) patients in the baseline group.

The patient's 5-digit zip code was used to derive several economic indicators and factors related to the SDOH. The data source was the US Census's American Community Survey.¹⁶ These factors included the following: unemployment rate, proportion of adults with at least a high school diploma or equivalent, proportion of households with children that are single-parent, and proportion of households living below the poverty line.

Variable Definitions

The comorbidities were selected from the 30 comorbidities in the Elixhauser comorbidity index and were selected based on having a prevalence of at least 1% among the study subjects and that were consistent with previous studies. We used the Healthcare Cost and Utilization Project's Clinical Classifications Software to obtain the most current definitions of the comorbidities.¹⁷ Seven chronic comorbidities were selected for study. These included: asthma, diabetes (type 1 and 2), hypertension, kidney disease, obesity, and morbid obesity. Obesity was defined as a Body Mass Index (BMI) of 30-39. Morbid obesity was defined as a BMI of 40 or greater.¹⁸ Payer type was based on both the patient's primary and, if applicable, secondary source of payment. There were three payer categories: Medicaid, Charity care (eg, indigent or self-pay), and Commercial insurance (eg, Blue Cross/Blue Shield). Patients were categorized by Hispanic ethnicity and then by race (Asian, Black, White, and other).

For clarity, the term “White” (and other races) shall hereafter refer to Whites who are other than Hispanic ethnicity,

Analysis

Logistic regression models were used to predict the likelihood of hospital admission with COVID-19. Predictor variables included patient characteristics (race/ethnicity, age, sex, and health insurance) and chronic comorbidities. Separate analyses were done for children (ages 5-12) and adolescents (ages 13-19). Fixed effects by public health region were included to account for regional variation in hospitalization rates for COVID-19. For a variable to be included in the final model, the stepwise procedure was used with a threshold for statistical significance of alpha = 0.05. Significant differences between the groups were identified using chi-square tests for categorical variables and t-tests for ordinal variables. All statistical analyses were performed using SPSS software version 27 (IBM, Armonk, NY, 2020).

Results

As shown in Table 1, pediatric patients with COVID-19 were more than three times more likely to require intensive care, as

Table 1. Patient Characteristics of Pediatric Patients (Age 5-19) Compared to Baseline Group Of Pediatric Patients Without Covid-19.

Patients	Hospitalized	Hospitalized	Ratio	P-value
	Patients	Patients		
	Baseline	Covid-19	Covid-19/ Baseline	
Race/Ethnicity				
Asian	1.4%	0.7%	0.48	0.036
Black	14.6%	15.9%	1.09	0.198
Hispanic	38.4%	51.5%	1.34	0.000
White, NH	38.8%	27.0%	0.70	0.000
Other race	6.9%	5.0%	0.72	0.011
Source of Payment				
Medicaid	49.2%	57.9%	1.18	0.000
Charity	9.0%	13.9%	1.55	0.000
Commercial	41.7%	29.5%	0.71	0.000
Hospital Stay				
Children’s Hospital	46.6%	74.8%	1.61	0.000
Emer. Dept. Admit	36.8%	75.0%	2.04	0.000
Intensive Care	11.8%	35.6%	3.01	0.000
Length of Stay	6.27	8.41	1.34	0.000
Comorbidities				
Asthma	14.0%	12.6%	0.90	0.150
Diabetes, Type 1	2.4%	6.0%	2.47	0.000
Diabetes, Type 2	1.2%	5.0%	4.21	0.000
Hypertension	2.0%	5.9%	2.98	0.000
Kidney Disease	0.9%	2.1%	2.37	0.009
Obesity	6.6%	18.6%	2.84	0.000
Obesity, Morbid	0.3%	3.5%	11.42	0.000
I + Comorbid.	24.4%	41.9%	1.72	0.000

compared to the baseline group (35.6% vs 11.8%, p < 0.0001). In addition, pediatric patients with COVID-19 had a longer length of stay (8.41 days vs 6.27 days, p < 0.001). Seventeen percent of COVID-19 patients had a length of stay of 10 days or longer. Moreover, COVID-19 patients were more than twice as likely to have hypertension (5.9% vs 2.0%, p < 0.0001), more than four times as likely to have type 2 diabetes (5.0% vs 1.2%, p < 0.0001), more than twice as likely to be obese (18.6% vs 6.6%, p < 0.0001) and more than eleven times likely to be morbidly obese (3.5% vs 0.3%, p < 0.0001). Asthma prevalence was not higher among pediatric patients with COVID-19, as compared to the baseline group (12.6% vs 14%; p = 0.15). In terms of source of payment, sixty-eight percent of COVID-19 patients were recipients of either Medicaid (58%), charity care (14%) or both (2%).

More than one-half of all COVID-19 patients were Hispanic (52%), as shown in Table 2. More than one-third (35.6%) of pediatric patients required intensive care, and seventy-five percent were admitted through the emergency department. Over four-in-ten (42%) of the pediatric patients with COVID-19 had one or more chronic comorbidities. For children

Table 2. Characteristics of Pediatric Patients Hospitalized with Covid-19 (n = 1187).

	Children (n = 488) Age 5-12	Adolescents (n = 699) Age 13-19	Total*
Gender			
Female	46%	49%	48%
Male	51%	39%	44%
Race/Ethnicity			
Asian	0.8%	0.6%	0.7%
Black	14.3%	17.0%	15.9%
Hispanic	53.9%	49.8%	51.5%
White, NH	26.6%	27.2%	27.0%
Other race	4.3%	5.4%	5.0%
Source of Payment			
Medicaid	68.2%	50.6%	57.9%
Charity	9.4%	17.0%	13.9%
Commercial	25.4%	32.3%	29.5%
Hospital Stay			
Children’s Hospital	89.0%	65.0%	74.8%
Emer. Dept. Admit	75.2%	74.8%	75.0%
Intensive Care	35.7%	35.6%	35.6%
Length of Stay	863.0%	825.0%	841.0%
Comorbidities			
Asthma	13.9%	11.6%	12.6%
Diabetes, Type 1	5.5%	6.3%	6.0%
Diabetes, Type 2	2.1%	7.0%	5.0%
Hypertension	4.5%	6.9%	5.9%
Kidney Disease	2.3%	2.0%	2.1%
Obesity	14.8%	21.3%	18.6%
Obesity, Morbid	0.4%	5.7%	3.5%
I + Comorbid.	36.7%	45.5%	41.9%

* Information on patient gender was missing for 92 patients.

ages 5-12, the most common comorbidities were obesity (15%), asthma (14%), and type 1 diabetes (6%). Twenty-seven percent of the 13- to 19-year-old patients with COVID-19 had either obesity or morbid obesity. More than one-third (34%) of adolescents with COVID-19 had either diabetes or obesity or both (5.9%).

Among children (5-12 years), type 1 diabetes was associated with an increased risk for hospitalization with COVID-19 (AOR = 1.83, CI: 1.21-2.76; $p < 0.01$), as shown in Table 3. Children with obesity were three times (AOR = 3.23, CI: 2.42-4.30; $p < 0.001$) more likely to be hospitalized with COVID-19. Children with asthma were less likely to be hospitalized with COVID-19 (AOR = 0.64; CI: 0.49-0.83, $p = .001$). Being Hispanic was associated with an increased risk for COVID-19 hospitalization (AOR = 1.51, CI: 1.23-1.84, $p < 0.001$). Having either Medicaid (AOR = 2.05, CI: 1.63-2.58, $p < 0.001$) or charity care (AOR = 2.27, CI: 1.59-3.25 $p < 0.001$) was associated with a greater risk for severe COVID-19. In terms of the SDOH, an increase in adults with a high school diploma (%) was associated with a lower risk of severe COVID-19 (AOR = 0.98, CI: 0.97-0.99, $p = 0.001$).

As shown in Table 3, adolescents who were morbidly obese were 9.8 times (CI: 6.47, 14.98, $p < 0.001$) more likely to be hospitalized with COVID-19. Both type 1 diabetes (AOR = 2.44; CI: 1.73-3.45, $p < 0.001$) and type 2 diabetes (AOR = 1.78; CI: 1.22-2.65, $p < 0.01$) were associated with a greater risk of severe COVID-19. Hypertension was associated with a 1.56 (CI: 1.08, 2.27, $p = .018$) greater odds of hospitalization with COVID-19. Other covariates that were associated with increased risk of COVID-19 hospitalization included: male gender (AOR = 1.91, CI: 1.61-2.27, $p < 0.001$; and having charity care (AOR = 1.70, CI: 1.36-2.13, $p < 0.001$). Regardless of age, single-parent households (%) was associated with an increased risk of hospitalization with COVID-19 (AOR = 1.02, CI: 1.01-1.03, $p < 0.01$). The R-squared measure was 8% for the children's model and 10% for the adolescent model.

Discussion

Two of the major findings of this study concerned obesity and diabetes. Obesity was found to be the most significant risk factor for hospitalization due to COVID-19 for both age groups. The risk of obesity and morbid obesity also increased with age. The risk of obesity appeared to be dose-dependent, in that the risk was two to three times higher for those with morbid obesity. Among adolescents, obesity ($p < 0.01$) and morbid obesity ($p = 0.001$) were also risk factors for more severe disease, as indicated by ICU admission. Rates of childhood obesity have also been found to be higher among children from single-parent households.¹¹ Childhood obesity has also increased during the pandemic due to various factors, such as school closures and lack of exercise.¹⁹

For children (age 5-12), type 1 diabetes was a greater risk factor for severe COVID-19 than type 2 diabetes. For adolescents (age 13-19), the relative risk was slightly higher for

type 1 than for type 2 diabetes. For both children and adolescents, hospitalized patients with type 1 diabetes were more than twice as likely to be admitted to the ICU. This is consistent with two previous studies, which found similar relationships.^{2,7} Children with diabetes may also be more vulnerable to various stressors caused by the pandemic, especially during lockdown periods, such as anxiety, lack of exercise, weight gain, and a lack of access to primary care.³ These stressors may also cause poor glycemic control.²⁰

With reference to the baseline group of children without COVID-19, obesity and type 2 diabetes were found to be positively correlated with numerous SDOH indicators, including unemployment, single parent households, proportion of adults with no high school diploma, and proportion of households living below the poverty line. In other words, our pediatric cohort mirrored other studies which found that children from poorer households were more likely to be obese and have type 2 diabetes.

Childhood asthma was not associated with a greater risk of hospitalization due to COVID-19. Among children (5-12 years), asthma was associated with a reduced risk for COVID-19 hospitalization, and this may reflect a lower threshold for hospital admission. The evidence regarding the correlates between asthma and risk for hospitalization for COVID-19 among children is mixed and may depend on other factors, such as age and type of asthma (eg, type 2).²¹ Consistent with these findings, a recent study found that asthma was not a risk factor for severe COVID-19 among children, except among those aged 12 to 18 years.⁷ Though the prevalence of kidney disease was low (about 2%), kidney disease was a serious risk factor for adolescents for both COVID-19 hospitalization ($p < 0.05$) and ICU admission ($p < 0.05$).

Hispanic ethnicity ($p < 0.001$) was associated with a greater risk of hospitalization for COVID-19 among children (5-12 years). Surprisingly, Hispanic ethnicity did not meet the threshold ($p = 0.06$) as a risk factor for hospitalization among adolescents, even though Hispanics comprised half of all adolescents in our COVID-19 cohort. Moreover, several previous studies reported that Hispanic children are at greater risk for hospitalization and death due to COVID-19.^{2,22} When "single-parent households" was omitted from the model, both Hispanic ethnicity ($p < 0.001$) and Black race ($p < 0.01$) were found to be significant predictors for COVID-19 hospitalization. This demonstrates that the "obvious" linkage between Hispanic ethnicity and COVID-19 was greatly attenuated, once SDOH factors are taken into control, such as single-parent households. Among adolescents, Asians ($p = 0.04$) and Whites ($p < 0.001$) had a lower risk of COVID-19 hospitalization, as shown in Table 3. Within the baseline group, Asians also had lower obesity rates than non-Asians ($p < 0.001$). Among patients hospitalized with COVID-19, neither black race nor Hispanic ethnicity were risk factors for ICU admission. The only significant predictors for ICU admission were the underlying medical conditions mentioned previously.

This study included a large sample of 1187 school-age children from 164 acute-care hospitals who were hospitalized with

Table 3. Logistic Regression Models Predicting Risk of Hospitalization with COVID-19.

Type	Variable	Children (n = 488) Age 5-12			Adolescents (n = 699) Age 13-19		
		Odds Ratio	Confidence Limits	P-value	Odds Ratio	Confidence Limits	P-value
Comorbid.	Asthma	0.636	(0.49, 0.83)	0.001	N/S	N/S	N/S
Comorbid.	Diabetes, Type 1	1.828	(1.21, 2.76)	0.004	2.441	(1.73, 3.45)	< 0.001
Comorbid.	Diabetes, Type 2	N/S	N/S	N/S	1.799	(1.22, 2.65)	0.003
Comorbid.	Hypertension	1.828	(1.14, 2.94)	0.013	1.565	(1.08, 2.27)	0.018
Comorbid.	Kidney Disease	N/S	N/S	N/S	1.909	(1.06, 3.45)	0.032
Comorbid.	Obesity	3.231	(2.43, 4.3)	< 0.001	3.179	(2.57, 3.94)	< 0.001
Comorbid.	Obesity, Morbid	7.442	(1.49, 37.2)	0.014	9.849	(6.48, 14.98)	< 0.001
Sex	Male	N/S	N/S	N/S	1.913	(1.61, 2.27)	< 0.001
Race	Asian	N/S	N/S	N/S	0.129	(0.02, 0.93)	0.042
Ethnicity	Hispanic	1.506	(1.23, 1.84)	< 0.001	N/S	N/S	N/S
Race	White, NH	N/S	N/S	N/S	0.697	(0.57, 0.85)	< 0.001
Insurance	Charity	2.269	(1.59, 3.25)	< 0.001	1.704	(1.36, 2.14)	< 0.001
Insurance	Medicaid	2.050	(1.63, 2.58)	< 0.001	N/S	N/S	N/S
SDOH	High School Grad (%)	0.985	(0.98, 0.99)	0.001	N/S	N/S	N/S
SDOH	Single Parent House (%)	1.025	(1.01, 1.04)	0.004	1.019	(1.01, 1.03)	0.007

COVID-19 in 2020. The explanatory variables included race, ethnicity, clinical comorbidities, and SDOH attributes. To our knowledge, this is one of the first studies that have included both clinical comorbidities with SDOH indicators to identify the risk factors for COVID-19 hospitalization among children. This is also the first study to identify single-parent households (%) as a risk factor for hospitalization for COVID-19 among children.

At the time of this writing, the Omicron variant has caused an unprecedented surge in COVID-19 hospitalizations among children and has placed significant stress on the health care system.⁸ The data from this study are from 2020, prior to when vaccines first became available for school-age children in fall, 2021. At present children under five are ineligible to receive the COVID-19 vaccine. Hence the results of this study represent the baseline case prior to when vaccines became available.

We acknowledge a few limitations to this study. First, because COVID-19 did not exist prior to 2020, a cross-sectional approach was adopted to study these risk factors. Therefore, causal relationships could not be established. Second, some comorbidities, eg, obesity, may be undercoded in the patient's medical record, which would lead to the misclassification of cases.⁷ Third, the scope of this study was limited to seven pediatric comorbidities and excluded children younger than five. Other studies have found other chronic conditions to be risk factors for severe COVID-19 in children, including neurological, psychological, and cardiovascular diseases.^{6,7} Fifth, even though we identified several race-specific disparities, we cannot rule out ascertainment bias and residual confounding in this cohort study.²³ Sixth, information on patient sex was missing for 8% of the study subjects with COVID-19. Seventh, zip code data derived from the U.S. census are known to provide biased proxies for SDOH measures at the household level.²⁴

Finally, due to data limitations, we did not have more specific clinical detail on certain comorbidities, eg, asthma and diabetes, that would indicate whether the disease was controlled through medical management. Primary care plays a critical role in supporting children with these chronic conditions and thereby reducing the long-term risk of infectious disease, such as COVID-19. For example, the use of steroid inhalers among asthmatic children may have a protective effect against SARS-CoV2 infection.²⁵ A recent study reported that school-age children with uncontrolled or untreated asthma had significantly greater risk for COVID-19 hospitalization than children with controlled asthma.²⁶ If access to primary care is disrupted, this may exacerbate their underlying conditions, which may in turn increase the risk of serious complications from COVID-19.

Conclusions

This study found that obesity, diabetes, hypertension, and kidney disease are risk factors for hospitalization with COVID-19. These results also suggest that school-age children living in single-parent households may be at greater risk for severe illness due to COVID-19. Findings from this study can be used to improve risk communication with families of children with underlying medical conditions and to prioritize prevention measures, including vaccinations.


Declaration of Conflicting Interests

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References

1. United States of America: WHO Coronavirus Disease (COVID-19) dashboard with vaccination data [Internet]. Cited February 21, 2022. <https://covid19.who.int>
2. Graff K, Smith C, Silveira L, et al. Risk factors for severe COVID-19 in children. *Pediatr Infect Dis J*. 2021;40(4): e137-e145.
3. DiMeglio LA, Albanese-O'Neill A, Muñoz CE, Maahs DM. COVID-19 and children with diabetes—updates, unknowns, and next steps: first, do No extrapolation. *Diabetes Care*. 2020;43(11):2631-2634.
4. Schuster JE, de St Maurice A. COVID-19 in children—not just little adults. *JAMA Netw Open*. 2021;4(6):e2111441.
5. Castro-Rodriguez JA, Forno E. Asthma and COVID-19 in children: a systematic review and call for data. *Pediatr Pulmonol*. 2020;55(9):2412-2418.
6. Tsankov BK, Allaire JM, Irvine MA, et al. Severe COVID-19 infection and pediatric comorbidities: a systematic review and meta-analysis. *Int J Infect Dis*. 2021;103:246-256.
7. Kompaniyets L, Agathis NT, Nelson JM, et al. Underlying medical conditions associated with severe COVID-19 illness among children. *JAMA Netw Open*. 2021;4(6):e2111182.
8. American Academy of Pediatrics. Children and COVID-19: state-level data report [Internet]. Cited February 21, 2022. <http://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report/>
9. American Academy of Pediatrics. Children and COVID-19 vaccination trends [Internet]. Cited February 21, 2022. <http://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-vaccination-trends/>
10. Edwards KM. Sparing of severe COVID-19 in vaccinated adolescents. *N Engl J Med*. 2022;386(8):789-790.
11. Yusuf ZI, Dongarwar D, Yusuf RA, Bell M, Harris T, Salihu HM. Social determinants of overweight and obesity among children in the United States. *Int J MCH AIDS*. 2019;9(1):22-33.
12. Hill-Briggs F, Adler NE, Berkowitz SA, et al. Social determinants of health and diabetes: a scientific review. *Diabetes Care*. 2020; 44(1): 258–279.
13. Texas Department of State Health Services [Internet]. Cited February 21, 2022. <https://www.dshs.texas.gov/>
14. Sutton D, Fuchs K, D'Alton M, Goffman D. Universal screening for SARS-CoV-2 in women admitted for delivery. *N Engl J Med*. 2020;382(22):2163-2164.
15. Kadri SS, Gundrum J, Warner S, et al. Uptake and accuracy of the diagnosis code for COVID-19 among US hospitalizations. *JAMA*. 2020;324(24):2553.
16. United States Census Bureau. "B01001 SEX BY AGE." 2019 American Community survey 5-year estimates. U.S. Census Bureau, American Community Survey Office. Web. December 10, 2020. <ftp.census.gov>.
17. Agency for Healthcare Research and Quality. Chronic Condition Indicator (CCI) for ICD-10-CM (beta version). Accessed August 13, 2021. https://www.hcup-us.ahrq.gov/toolssoftware/chronic_icd10/chronic_icd10.jsp
18. Rodgers GP, Gibbons GH. Obesity and hypertension in the time of COVID-19. *JAMA*. 2020;324(12):1163-1165. doi:10.1001/jama.2020.16753
19. Rundle AG, Park Y, Herbstman JB, Kinsey EW, Wang YC. COVID-19 Related school closings and risk of weight gain among children. *Obesity (Silver Spring)*. 2020;28(6):1008-1009.
20. Singh AK, Khunti K. Assessment of risk, severity, mortality, glycemic control and antidiabetic agents in patients with diabetes and COVID-19: a narrative review. *Diabetes Res Clin Pract*. 2020;165:108266.
21. Skevaki C, Karsonova A, Karaulov A, et al. SARS-CoV-2 infection and COVID-19 in asthmatics: a complex relationship. *Nat Rev Immunol*. 2021;21(4):202-203.
22. McCormick DW, Richardson LC, Young PR, et al. Deaths in children and adolescents associated with COVID-19 and MIS-C in the United States. *Pediatrics*. 2021;148(5): e2021052273.
23. Saatci D, Ranger TA, Garriga C, et al. Association between race and COVID-19 outcomes among 2.6 million children in England. *JAMA Pediatr*. 2021;175(9):928-938.
24. Krieger N, Waterman P, Chen JT, Soobader M-J, Subramanian SV, Carson R. Zip code caveat: bias due to spatiotemporal mismatches between zip codes and US census-defined geographic areas—the public health disparities geocoding project. *Am J Public Health*. 2002;92(7):1100-1102.
25. Broadhurst R, Peterson R, Wisnivesky JP, et al. Asthma in COVID-19 hospitalizations: an overestimated risk factor? *Annals ATS*. 2020;17(12):1645-1648.
26. Shi T, Pan J, Katikireddi SV, et al. Risk of COVID-19 hospital admission among children aged 5-17 years with asthma in Scotland: a national incident cohort study. *Lancet Respir Med*. 2022;10(2):191-198.

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