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Short communication

Childhood immunization during the COVID-19 pandemic in Texas

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ABSTRACT

In 2020, the state of Texas implemented coronavirus disease 2019 (COVID-19) social distancing guidelines in order to prevent surges at Texas hospital emergency rooms and in intensive care units. As noted in other states, an unintended consequence of these activities was significant declines in childhood immunizations. After analyzing state-wide immunization register data for Texas, we observed a 47% relative decline in immunization rates between 2019 and 2020 among 5-month-olds and a 58% decline among 16-month-olds. We observed a small decline (5%) among 24-month-olds, and no decline in vaccines received at birth (Hepatitis B). Declines were larger in rural counties compared to urban. These declines are superimposed on increases in state vaccine exemptions over the last five years due to an aggressive anti-vaccine movement in Texas. There are concerns that continued declines in childhood immunization coverage due to COVID-19 could lead to co-endemics of measles and other vaccine preventable diseases.

1. Introduction

Since the first confirmed case of the respiratory illness caused by a newly discovered coronavirus (SARS-CoV-2) virus in the United States (US) on January 20, 2020 [1], Texas has accounted for almost 10% of the more than 30 million total confirmed cases nationwide, and has the second highest number of positive coronavirus cases in the US, and as of April 8, 2021 approximately 49,000 Texans have also died from coronavirus disease 2019 (COVID-19) [2]. Measures to mitigate the risks of COVID-19 have included limiting personal contact and social distancing in several states, together with expanded testing, contact tracing, and wearing face masks [3,4]. Nationally, on March 13, 2020 the US government declared a national emergency and, beginning on March 31, 2020, Texas announced further measures to control the spread of COVID-19 through mandated shelter-in-place orders, and social distancing [5]. These measures were implemented for a period of almost one month, with phased reopening in Texas beginning on April 27, 2020.

Despite the recommendation on March 24 from the US Centers for Disease Control and Prevention (CDC) to issue guidelines for continuing vaccinations for children less than 2 years of age [6], calls for social distancing have produced reductions in the availability and utilization of routine childhood vaccinations in several states [7–9]. State-sponsored shelter-in-place mandates in some states, including Texas, have resulted in reductions in uptake of routine childhood vaccination, in part due to closing of vaccination sites and parental fears of disease risk from pediatrician visits [7,8]. For example, Massachusetts reported a 68% decline in vaccine doses administered in the first two weeks of April in 2020, in comparison with the same period in 2019 [8]. Other states, including Minnesota and Michigan, have also reported a decrease in the uptake of measles vaccination [8,9]. Additionally, New York City reported a 63% decline in the number of vaccine doses

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administered to children during a six-week period in the pandemic lockdown [10].

Nationally, the CDC has noted significant declines in childhood vaccination rates in association with social distancing mandates. This includes more than 50% decline in measles-containing vaccinations (MCV) for young children, as well significant declines in other non-influenza vaccines [6]. Data for routine pediatric vaccines from Vaccines for Children Program (VFC) and Vaccine Safety Datalink (VSD) from January 6–April 19, 2020, found the sharpest decline in measles immunization uptake in the US following the week after the national emergency declaration on March 13, 2020 [6].

Any disruption to immunization services, even for a short duration, can result in an increased number of vaccine-preventable disease infections, contributing to childhood morbidity and mortality due to vaccine-preventable diseases [11]. We examine the impact of the preventive measures implemented to combat the SARS-CoV-2 pandemic on children's vaccination coverage in Texas and provide recommendations to address the challenges.

2. Methods

We analyzed data from the Texas Immunization Registry (ImmTrac2) to assess changes in children's recommended vaccination coverage over a 10-year period, encompassing before and during the SARS-CoV-2 pandemic. ImmTrac2 is an opt-in registry that obtains and stores vaccine records from different sources including health care providers, the Texas Department of State Health Services (DSHS), and Vital Statistics Unit (VSU). Because this was a secondary data analysis, the Texas A&M University Institutional Review Board deemed it exempt from human subject research.

Immunization data were extracted in September 2020 on immunizations administered from May 2010 through May 2020. Data at the county level were provided for May 2019 and May 2020 for comparison by rurality. We assessed the vaccination status of children at four time points: 1, 5, 16 and 24 months old.

Up-to-date status for individual vaccines and combined vaccine series recommended by the Advisory Committee for Immunization Practices (ACIP) were assessed at the point in time (1 May 2020) and compared with 1-month cohorts for points in time May 2010 to May 2019.

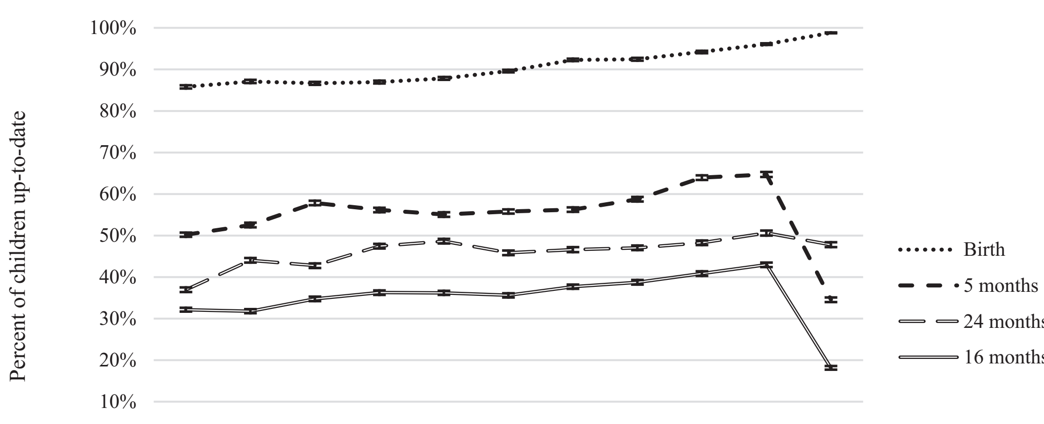
- 3 month-old children: The first dose of hepatitis B (HepB) within 3 days of birth.
- 5-month-old children: received all doses in the recommended vaccine series, including 2 HepB, 2 Rotavirus (Rota), 2 DTaP, 2 Hib, 2 PCV13, and 2 Polio.
- 16-month-old children: received all doses in the recommended vaccine series, including 3 DTaP, 2 Polio, 1 MMR, 3 or 4 doses of Hib, 2 HepB, 1 Varicella and 4 PCV13.
- 24-month-old children received all doses in the recommended vaccine series, including 4 DTaP, 3 Polio, 1 MMR, 3 or 4 doses of Hib, 3 HepB, 1 Varicella, and 4 PCV13.

We calculated the percent of children who were "up-to-date" as of 1 May each year and corresponding 95% confidence intervals using exact methods. We additionally estimated the percent change in the number of doses administered for the month of May in 2019 and the month of May in 2020 in rural and urban counties. We used chi-squared tests to determine whether the percent change was significantly different for urban and rural counties (α = 0.05).

4. Results

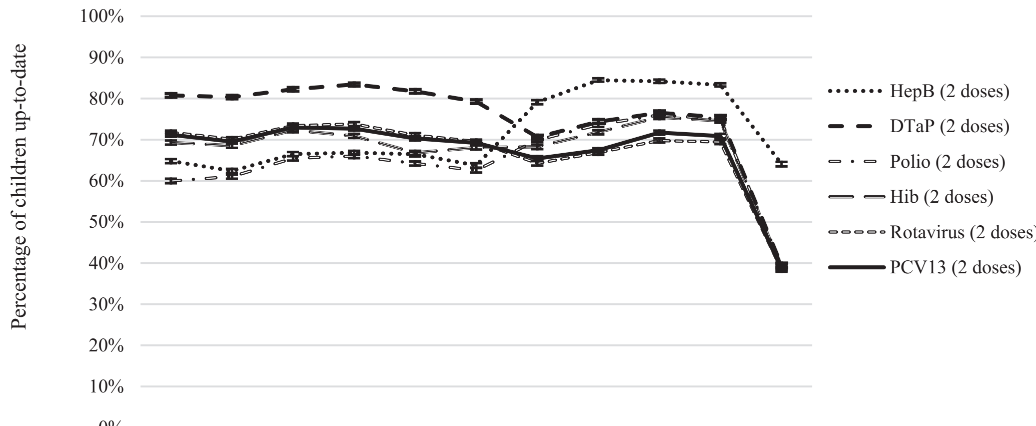
Information on immunizations administered in Texas between 2010 and 2020 was extracted for 325,922 children at birth, 342,906 5-month-old children, 364,611 16-month-old children, and 336,442 24-month-old children. The percent of children who were "up-to-date" at birth, 5 months, 16 months, and 24 months increased from 2010 to 2019 (Fig. 1). However, between 2019 and 2020, we observed a 47–58% decline in immunization coverage for 5- and 16-month-olds (Fig. 1). In 2019, 64.7% (95% CI 64.1, 65.3%) of children 5 months of age were recorded as fully immunized as compared to 34.6% (95% CI 34.0, 35.1%) in 2020; 43.0% (95% CI 42.4, 43.5%) of children 16 months of age were fully immunized in 2019 compared to 18.1% (95% CI 17.7, 18.6%) in 2020. In contrast, we observed a smaller decline (5%) in the percent of 24-month-old children who were fully immunized and a 2% increase in the percent of infants who received a birth dose of Hepatitis B.

When we considered administration of specific recommended vaccines, among children 5 months of age, we observed a 44–



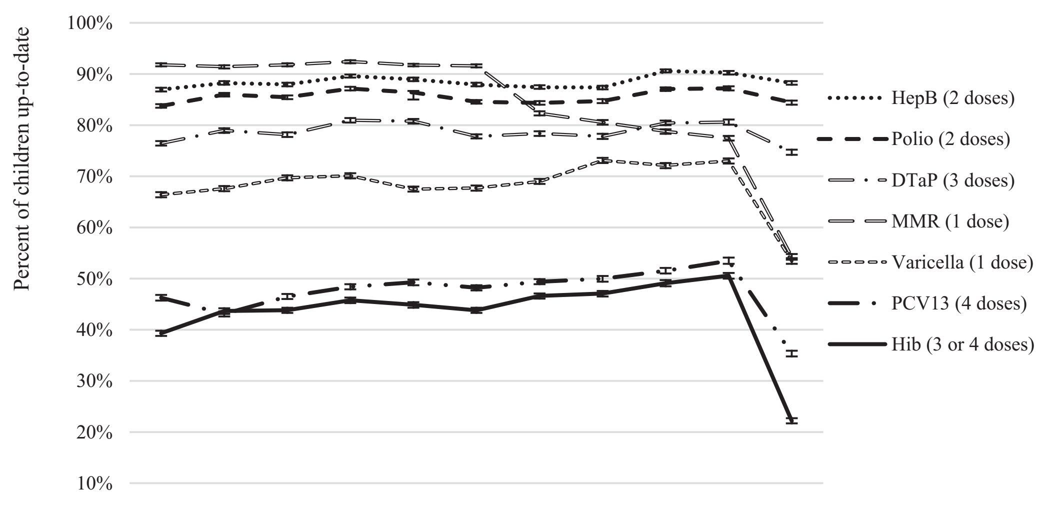
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Birth	85.8%	87.1%	86.7%	87.0%	87.8%	89.6%	92.3%	92.5%	94.2%	96.1%	98.8%
5 months	50.2%	52.5%	57.8%	56.2%	55.1%	55.8%	56.2%	58.7%	64.0%	64.7%	34.6%
24 months	36.9%	44.0%	42.8%	47.5%	48.6%	45.9%	46.6%	47.0%	48.3%	50.6%	47.8%
16 months	32.1%	31.8%	34.7%	36.3%	36.2%	35.6%	37.7%	38.7%	40.9%	43.0%	18.1%

Fig. 1. Percent of children up-to-date with recommended childhood vaccines at 1 May between 2010 and 2020, by age group – Texas, ImmTrac2, May 2010 to May 2020.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
HepB (2 doses)	64.8%	62.4%	66.5%	66.8%	66.5%	63.7%	79.1%	84.5%	84.2%	83.3%	64.1%
DTaP (2 doses)	80.8%	80.3%	82.2%	83.4%	81.7%	79.3%	70.6%	74.4%	76.5%	75.4%	39.4%
Polio (2 doses)	60.0%	61.0%	65.5%	66.0%	64.2%	62.6%	69.9%	73.6%	76.0%	75.0%	39.2%
Hib (2 doses)	69.3%	68.6%	72.3%	70.9%	66.8%	68.1%	68.3%	71.8%	75.4%	74.6%	38.9%
Rotavirus (2 doses)	71.8%	70.1%	73.4%	73.8%	71.1%	69.6%	64.2%	66.9%	69.8%	69.4%	38.4%
PCV13 (2 doses)	71.2%	69.5%	73.0%	72.7%	70.3%	69.2%	65.4%	67.4%	71.7%	70.9%	38.6%

Fig. 2. Percent of 5-month-old children up-to-date with recommended childhood vaccines at 1 May between 2010 and 2020, by vaccine – Texas, ImmTrac2, May 2010 to May 2020. **Abbreviations**: DTaP, ditheria-tetanus-acellular pertussis vaccine; MMR, measles-mumps-rubella vaccine; Hib, *Haemophilus influenzae B*; PCV13, pneumococcal conjugate-13 vaccine.

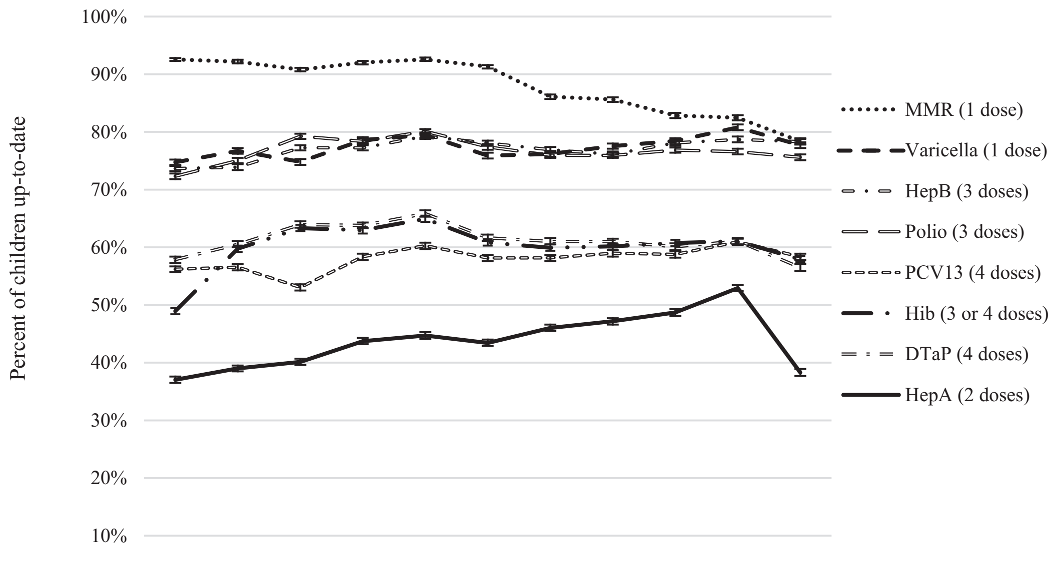


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
HepB (2 doses)	87.0%	88.2%	88.0%	89.6%	88.9%	87.9%	87.4%	87.4%	90.6%	90.3%	88.2%
Polio (2 doses)	83.8%	86.0%	85.5%	87.2%	86.4%	84.6%	84.4%	84.7%	87.1%	87.2%	84.4%
DTaP (3 doses)	76.4%	79.0%	78.2%	81.0%	80.8%	77.8%	78.4%	77.8%	80.4%	80.6%	74.7%
MMR (1 dose)	91.8%	91.4%	91.8%	92.4%	91.8%	91.6%	82.3%	80.5%	78.8%	77.4%	54.3%
Varicella (1 dose)	66.4%	67.6%	69.7%	70.1%	67.5%	67.7%	69.0%	73.1%	72.1%	73.0%	53.4%
PCV13 (4 doses)	46.3%	43.1%	46.5%	48.4%	49.3%	48.2%	49.4%	50.0%	51.5%	53.5%	35.3%
Hib (3 or 4 doses)	39.3%	43.7%	43.8%	45.8%	44.9%	43.8%	46.6%	47.1%	49.1%	50.6%	22.2%

Fig. 3. Percent of 16-month-old children up-to-date with recommended childhood vaccines at 1 May between 2010 and 2020, by vaccine – Texas, ImmTrac2, May 2010 to May 2020. **Abbreviations**: DTaP, ditheria-tetanus-acellular pertussis vaccine; MMR, measles-mumps-rubella vaccine; Hib, *Haemophilus influenzae B*; PCV13, pneumococcal conjugate-13 vaccine.

47% reduction in receipt of each of the major recommended vaccines between 2019 and 2020, with exception to Hepatitis B (Fig. 2). Hepatitis B vaccination among 5-month-olds declined by 23%. Among children 16 months of age, we observed a 27–56% reduction in administration of individual scheduled vaccines between 2019 and 2020 (Fig. 3). Hepatitis B, DTaP and polio vaccination rates among 16-month-olds declined by 2–7%. Among children 24 months of age, we observed less than a 7% reduction in scheduled vaccines between 2019 and 2020 (Fig. 4) although Hepatitis A coverage declined 27%.

In urban counties during May 2019, 10,049 vaccination doses were administered to children 5 months of age, 7,210 doses were



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MMR (1 dose)	92.6%	92.2%	90.8%	92.0%	92.6%	91.3%	86.1%	85.6%	82.9%	82.5%	78.4%
Varicella (1 dose)	74.7%	76.7%	74.8%	78.6%	79.5%	75.9%	76.2%	77.5%	78.4%	80.8%	77.7%
HepB (3 doses)	73.6%	73.9%	77.3%	77.3%	79.3%	78.1%	76.9%	76.1%	78.1%	78.7%	78.3%
Polio (3 doses)	72.3%	75.0%	79.3%	78.4%	80.1%	77.4%	76.0%	75.9%	76.8%	76.6%	75.6%
PCV13 (4 doses)	56.2%	56.6%	53.0%	58.4%	60.3%	58.2%	58.2%	59.0%	58.8%	61.0%	58.4%
Hib (3 or 4 doses)	48.9%	59.7%	63.3%	63.0%	64.9%	60.8%	59.9%	60.2%	60.7%	61.1%	57.9%
DTaP (4 doses)	57.9%	60.5%	63.9%	63.8%	65.9%	61.6%	61.0%	61.0%	60.1%	61.1%	56.5%
HepA (2 doses)	37.0%	39.0%	40.1%	43.7%	44.7%	43.4%	46.0%	47.2%	48.7%	52.9%	38.3%

Fig. 4. Percent of 24-month-old children up-to-date with recommended childhood vaccines at 1 May between 2010 and 2020, by vaccine – Texas, ImmTrac2, May 2010 to May 2020. **Abbreviations**: DTaP, ditheria-tetanus-acellular pertussis vaccine; MMR, measles-mumps-rubella vaccine; Hib, *Haemophilus influenzae B*; PCV13, pneumococcal conjugate-13 vaccine.

administered to children 16-months of age, and 6,146 doses were administered to children 24-months of age. In comparison, during the same period in 2020, 143 fewer doses were administered among 5-month-olds, 1,312 fewer doses among 16-month-olds, and 2,688 fewer doses among 24-month-olds. In rural counties in May 2019, 901 doses were administered to 5-month-olds, 332 doses were administered to 16-month-olds, and 334 doses were administered to 24-month-olds. During the same time period in May 2020, 258 fewer doses of childhood vaccines were administered among 5-month-olds, 40 fewer doses were administered to 16-month-olds, and 130 fewer doses were administered to 24-month-olds. The percent of decline in doses administered to children 5 months of age comparing May 2019 to May 2020 was 27.2% (95% CI 24.3, 30.2%) greater in rural counties (-28.6%; 95% CI −31.7%, −25.7%) than urban counties (−1.4%; 95% CI −1.7, −1.2%). The percent decline in doses administered to children 16 months of age was slightly greater (6.2%; 95% CI 1.8, 10.0%) in urban counties (-18.2%; 95% CI −19.1, −17.3%) compared to rural counties (-12.1%; 95% CI −15.5, −8.5%). There was no difference in the decline in doses administered to children 24 months of age in rural compared to urban areas (4.8%; 95% CI −0.7, 10.0%).

5. Discussion

Our findings indicate that the emergence of SARS-CoV-2 in Texas coincided with significant declines in childhood immunizations, similar to what has been noted nationally and in multiple other states [8–10]. The declines were greatest for routine immunizations among the 5-month and 16-month aged groups, and were lowest for vaccines administered at birth. Analysis of data by county shows that 5-month-old children in rural areas may experience more disruption to immunization services than 5-month-old children in urban areas.

These declines in childhood immunization rates appear to overlay existing issues in maintaining uptake of certain vaccines. Although uptake of most vaccines appeared to increase prior to the pandemic between May 2010 and May 2019, MMR coverage appears to have declined in Texas since 2015, reaching 77% among 16-month-olds and 82% among 24-month-olds by 2019. During the pandemic, MMR coverage appears to have declined further. Whether the declining trend in MMR acceptance would have continued without the pandemic is unknown. Regardless, high coverage of MMR is required to avoid the occurrence of outbreaks, indicating the already low level of measles vaccination coverage, exacerbated by the pandemic could have substantial public health consequences.

Hepatitis B immunizations are administered in the hospital after birth. Since we did not observe declines in administration of Hepatitis B birth dose, this may indicate that immunizations requiring a clinic or in-office visit are solely impacted by the COVID-19 pandemic [9]. The larger declines in doses administered we observed in rural counties of Texas may indicate that disruptions to childhood immunization are further exacerbated by barriers to immunization experienced prior to the COVID-19 pandemic in rural communities, including affordability and more limited geographic access to immunization services [12].

These results suggest that strategies to mitigate transmission of SARS-CoV-2 may have had unintended consequences in terms of reductions in vaccination among children in Texas. Our findings, in conjunction with those of previous studies, suggest that immunization and other preventive health services requiring in-person visits have been adversely impacted by the COVID-19 pandemic [5–9]. Declines in vaccination coverage below 90–95% put herd immunity at risk for children in Texas, potentially resulting in the increase of vaccine preventable diseases. The situation may be aggravated when coupled with the effects of COVID-19, thereby significantly taxing the already stressed healthcare system [13].

The CDC recommends continued administration of routine immunization during the pandemic to prevent transmission of other preventable infectious diseases [14]. According to the American Academy of Pediatrics (AAP), while telehealth visits are recommended, in-person visits, especially for vaccination, should not be discontinued unless community circumstances require the limitation of in-person visits, in which case curbside or drive-through vaccination can be implemented by clinics to limit patient-provider contact [14]. Healthcare providers, especially in communities with low immunization rates, will have to provide catch-up immunizations and have effective recall programs in place that provide timely reminders to parents when vaccinations are scheduled.

The use of an opt-in registry for our study presents several strengths and limitations. As ImmTrac2 is an opt-in registry, data may not necessarily reflect general population estimates. ImmTrac2 data used in the study might not reflect the true vaccination coverage at the population level and result in the underestimation of routine immunizations administered in Texas. However, the registry has several strengths. ImmTrac2 collects data from multiple sources, including healthcare providers, pharmacies, public health clinics, Medicaid claims administrators, Texas Department of State Health Services (DSHS), Vital Statistics Unit (VSU) and other organizations, which increases the accuracy of the reported data. Furthermore, the data are useful for evaluating trends in immunization over time, which was the primary aim of this study. Although our analysis provides a rapid evaluation of trends in childhood vaccination during the COVID-19 pandemic, future evaluation of trends in childhood immunization coverage using population-based estimates from representative surveys such as National Immunization Survey would be useful for confirming our findings.

Considering the ongoing SARS-CoV-2 transmission in the United States, it is paramount that healthcare providers continue to adhere to established preventive COVID-19 care protocols in order to avoid two successive years of low immunization coverage. There is an urgent need to address gaps in accessing immunization services, including possible increases in vaccine hesitancy resulting during the pandemic [15]. Survey data have indicated significant levels of COVID-19 vaccine hesitancy, especially among underrepresented minority populations [16]. It is therefore critical to build vaccine confidence and to reduce barriers to immunization where possible by disseminating clear health messages, improving accessibility, implementing culturally responsive strategies (e.g., messages in local languages), and developing empathy to effectively combat vaccine hesitancy and ultimately increase children's immunization and COVID-19 vaccination coverage rates.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First case of 2019 novel coronavirus in the United States. N Engl J Med 2020;382(10):929–36. https://doi.org/10.1056/NEJMoa2001191.
[2] Johns Hopkins University & Medicine. Covid-19 Map - Johns Hopkins Coronavirus Resource Center, https://coronavirus.jhu.edu/map.html; 2020 [Accessed 8 April 2021].
[3] Centers for Disease Control and Prevention. Coronavirus disease 2019 (COVID-19), https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html; 2020 [Accessed 22 November 2020].
[4] Mervosh, Sarah; Lu, Denise; Swales V. See Which states and cities have told residents to stay at home, https://www.nytimes.com/interactive/2020/us/coronavirus-stay-at-home-order.html; 2020 [Accessed 1 October 2020].
[5] Svitek P. Coronavirus in Texas, https://www.texastribune.org/2020/03/31/greg-abbott-texas-executive-order-closures/; 2020 [Accessed 20 November 2020].
[6] Santoli JM, Lindley MC, DeSilva MB, Kharbanda EO, Daley MF, Galloway L, et al. Effects of the COVID-19 pandemic on routine pediatric vaccine ordering and administration — United States, 2020. MMWR Morb Mortal Wkly Rep 2020;69(19):591–3.
[7] Texas Department of State Health Services. Impacts of Covid-19 On TVFC Vaccine Administration. Texas DSHS; Austin, TX: 2020. https://www.dshs.texas.gov/immunize/docs/COVID19impactTVFC.pdf.
[8] Hoffman H. Vaccine rates drop dangerously as parents avoid doctor's visits, https://www.nytimes.com/2020/04/23/health/coronavirus-measles-vaccines.html; 2020 [Accessed 20 November 2020].
[9] Bramer CA, Kimmins LM, Swanson R, Kuo J, Vranesich P, Jacques-Carroll LA, et al. Decline in child vaccination coverage during the COVID-19 pandemic — Michigan Care Improvement Registry, May 2016-May 2020. Am J Transplant 2020;20(7):1930–1. https://doi.org/10.1111/ajt.v20.710.1111/ajt.16112.
[10] Shapiro E. Child vaccinations plummet 63 percent, a vew hurdle for N.Y.C. Schools, https://www.nytimes.com/2020/05/20/nyregion/coronavirus-schools-vaccinations.html; 2020 [Accessed 27 November 2020].
[11] Suk JE, Jimenez AP, Kourouma M, Derrough T, Baldé M, Honomou P, et al. Post-ebola measles outbreak in lola, Guinea, January-June 2015. Emerg Infect Dis 2016;22:1106–8. https://doi.org/10.3201/eid2206.151652.
[12] Hill HA, Yankey D, Elam-Evans LD, Singleton JA, Pingali SC, Santibanez TA. Vaccination coverage by age 24 months among children born in 2016 and 2017 — National Immunization Survey-Child, United States, 2017–2019. MMWR Morb Mortal Wkly Rep 2020;69:1505–11. 10.15585/mmwr.mm6942a1.
[13] National Foundation for Infectious Diseases. #COVID-19 & routine vaccinations: what parents need to know, https://www.nfid.org/2020/04/28/covid-19-and-routine-vaccinations-what-parents-need-to-know/; 2020 [Accessed 20 November 2020].
[14] Centers for Disease Control and Prevention. Interim guidance for routine and influenza immunization services during the COVID-19 pandemic, https://www.cdc.gov/vaccines/pandemic-guidance/index.html; 2020 [Accessed 19 November 2020].
[15] Jaklevic MC. Researchers strive to recruit hard-hit minorities into COVID-19 vaccine trials. JAMA 2020;324:826–8. https://doi.org/10.1001/jama.2020.11244.
[16] Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. Lancet 2011;378(9790):526–35. https://doi.org/10.1016/S0140-6736(11)60678-8.