ABSTRACT

BACKGROUND: The COVID-19 pandemic presents unique opportunities for preexisting school telemedicine programs to reach pediatric populations that might otherwise experience a lapse in health care services.

METHODS: A retrospective analysis of one of the largest school-based telemedicine programs in the country, based in the Dallas-Fort Worth (DFW), Texas was conducted that included 7021 pediatric patients who engaged in telehealth visits from 2014 to 2019.

RESULTS: Asthma or other respiratory disease was the primary diagnosis (28.4%), followed by injury or trauma (18.4%), digestive disorders (6.9%), and ear/eye/skin disease (6.9%). More participants were from the North (34.4%) and West (33.2%) ISD compared to the South (20.6%) and East (11.7%) schools. Likewise, the majority of COVID-19 cases were in the North (61.8%) and West (31.6%) DFW regions, leading to 989 (59.9%) and 551 (33.4%) deaths, respectively.

CONCLUSIONS: School-based telehealth programs have the potential to reach large pediatric populations most in need of health care due to COVID-19-related lapses in services, and to address COVID-19-related health issues as schools reopen. In the future, utilization could be expanded to contact tracing, testing, and screening for COVID-19.

Keywords: COVID-19; coronavirus; school-based telehealth; pandemic; respiratory disease.

The COVID-19 pandemic has complicated and often severely limited healthcare access for children across the United States. The significant reduction in volume of in-person pediatric primary care visits since COVID-19 was declared a pandemic is well-documented. Schools have delayed opening in various parts of the country—either for some weeks, until 2021, or indefinitely. As of August 24, 2020,
4 states, the District of Columbia, and Puerto Rico had statewide school closures in place, with other states engaging in varied levels of in-person, distance, and hybrid models. With in-person contact more limited, preexisting telehealth programs have the potential to fill new gaps in health care for school-aged children.

Implementation of school-based telehealth programs has been widespread in recent years, with models varying widely between and within states in the United States. As of 2019, over a million students in more than 1800 public schools had access to some sort of school-based telemedicine program, representing 2% of students and almost 2% of public schools in the United States. Several states have tested use of telemedicine particularly targeted at rural areas, including Arkansas, California, Kansas, Kentucky, New Mexico, New York, North Carolina, Ohio, Tennessee, and Virginia. Children’s Health System of Texas has the largest initiative, with established programs with approximately 150 schools in the DFW area.

Consistent program evaluation for school-based telehealth programs is a challenge, which has led in the past to calls for consistent models of intervention design and measures by which to gauge effectiveness. Despite these limitations, the American Academy of Pediatrics has endorsed the use of school-based telemedicine for chronic childhood disease due to promising indications from pre-COVID-19 studies of potential benefits of school-based telemedicine to children with chronic diseases and those who live in rural and underserved areas. With the advent of COVID-19, resources that already exist as supplementary or auxiliary measures to more traditional models of pediatric care could prove vital to school-aged children cut off from in-person medical visits.

In June and July of 2020, the DFW metroplex area became a national COVID-19 hotspot. For the 2020 to 2021 school year, Texas school districts have been permitted to temporarily limit on-campus instruction for the first 4 weeks of school, and beyond that with a waiver. School-aged children across the state are currently engaged in distance learning for periods that could stretch from weeks to months. We examined the reach of a telehealth program operated in the DFW, Texas geographic area by Children’s Health System of Texas providers—the number and diversity of students, and prominent health issues—and to compare how COVID-19 cases/deaths were distributed in the same geographic regions.

METHODS

Participants
Students who have received care through the telemedicine program were identified through data extraction of Children’s Health electronic health record (EHR). Data regarding the medical conditions of these students, including clinical encounters which may have occurred in other regional hospital systems, was provided by the DFW Hospital Council Education and Research Foundation (DFWHC ERF). After excluding students with missing values for the independent school district (ISD) (N = 2), this retrospective cohort study included 7021 students enrolled in 150 elementary, middle, and high schools between 2014 and 2019 in the DFW metroplex and surrounding area. All school-based telemedicine programs are staffed by Children’s Health System of Texas providers.

Children’s Health School-Based Telehealth Program

Description and procedures. The school telemedicine program at Children’s Health was begun in 2013 as a means of reaching children where they spend most of their day—in school. With an increase in emergency department visits for nonemergent issues and low acuity complaints, the program was developed in hopes of reaching these families before they present to the emergency room. The overarching goal of the program is to benefit all stakeholders involved in the children’s education and well-being. The children benefit by receiving timely medical care when and where they need it most. Parents benefit by reducing time off from work and the costs associated with travel to and from doctor’s visits. Schools benefit by ultimately reducing absenteeism in their classrooms.

Partnering school nurses are equipped with secure, encrypted telemedicine technology, including high-definition, real-time videoconferencing equipment, and state-of-the-art digital diagnostic scopes—connecting their students directly to Children’s Health medical professionals for acute care issues. Strep and flu rapid tests are also available to assist with diagnostics alongside the virtual visit. At the end of each visit, a summary including diagnoses and plan of care is sent to the patient’s parent and primary care provider, thus, encouraging the medical home connection. From its start in 2 preschools in 2013, the program has grown to now include close to 200 schools and has served over 15,000 patients to date.

Measures

Demographics. Demographic information including age, sex, and race/ethnicity, as well as socioeconomic factors, such as insurance information was extracted from the EHR for school-based telehealth participants.

Medical conditions. Medical conditions were obtained through the data provided by DFWHC ERF. To compare publicly available COVID-19 infection
rates across different geographic locations, participants’ regions were categorized into North, South, East, and West based upon the physical location of ISD).

COVID-19. COVID-19-related measures were directly downloaded from the Texas Department of State Health Services (DSHS) and county health departments, where provided dynamic and accurate numbers of COVID-19 cases and deaths. In addition, we also reported the average of COVID-19 Pandemic Vulnerability Index (PVI) score of counties within 4 regions (North/South/East/West). PVI score is an indicator that combined community vulnerabilities baseline data with local infection rates and interventions, which can be used to compare the COVID-19 disease burden at a local, state, and national level. It can inform the researchers, governors, and publics about the vulnerability of each region. As such, it is updated on a daily basis on the National Institute of Health (NIH) website, https://covid19pvi.niehs.nih.gov/.

Data Analysis
Descriptive statistics were compared by ISD regions (North/South/East/West) via Pearson’s chi-square or Fisher’s exact test analyses. Continuous variables, such as age and COVID-19 PVI were compared by one-way analysis of variance. A 2-sided p-value < .05 was considered as statistically significant, and all analyses were performed in SAS v9.4 (SAS Institute Inc.).

RESULTS
A total of 7021 participants (mean [SD] age 8.8 [0.05] years, 52.9% girls) completed a school-based telemedicine visit. Of the participants, 39.8% were NHW, one-third (33.3%) were NHB, 8.8% were Hispanic, and 18.0% identified as “other” (multiracial, Asian, etc.). Medicaid covered 57.2% of visits with 28.9% private insurance and 13.9% self-pay. Asthma or other respiratory disease was the primary diagnosis among 28.4% of patients. Other prominent primary diagnoses included injury or trauma (18.4%), digestive disorders (6.9%), and ear, eye, or skin disease (6.9%). In addition, the demographic characteristics of participants differ by regions. More participants were from the North (34.4%) and West (33.2%) ISD compared to the South (20.6%) and East (11.7%) ISD (Table 1).

As of August 13, 2020, a total of 119,102 COVID-19 cases and 1652 deaths have been reported in the DFW area. Similar to the telehealth participants’ ISD regions, the COVID-19 cases and deaths were predominantly from the North and West region as well. Specifically, more than 90% (61.8% in the North and 31.6% in the West) cases were detected in the North and West region, leading to 989 (59.9%) and 551 (33.4%) deaths, respectively. The mean (SD) PVI score was 0.561 (0.01) for the DFW area, with 0.547 (0.04) from the North, 0.561 (0) from the South, 0.598 (0.01) from the East, and 0.552 (0.02) from the West.

DISCUSSION
The results of this analysis underscore the potential of school-based telemedicine to reach pediatric populations with diverse chronic and acute medical issues. The prominence of asthma and respiratory disease among this population pre-COVID, and the relatively high PVI, highlight the vulnerability of school-aged children in this region to respiratory illness in the COVID era. Although further research is needed into the prevalence of comorbid asthma in COVID-19 patients, per the latest guidance from the US Centers for Disease Control and Prevention (CDC), moderate-to-severe asthma (and other lung diseases), especially if not well-controlled, could put individuals at higher risk of contracting COVID-19. For the high percentage of pediatric patients with asthma and/or other respiratory illness in our dataset, telemedicine programs have the potential to provide more frequent access to needed prescriptions and general health guidance. They also allow the provision of real-time updates to the protective guidance from medical providers that may change as more information on the relationship between asthma and COVID-19 becomes available.

School-based telemedicine presents many advantages in the current environment, including offering a cost-effective way to expand health care capacity in rural or underserved areas, where low population density, high poverty, or underinsurance may leave children at risk. A remote telehealth design builds a system of care to link patients with available medical services, regardless of location or access to regional facilities. Schools serve as a natural hub of communications for children and their families. School-based telehealth models can take advantage of existing infrastructure and relationships to provide preventive, primary, and urgent care as needed, without the direct and opportunity costs of transportation of the child to a clinic or other physical location.

With the new school year underway, more generally, telehealth visits have the potential to serve as a touchpoint with primary care pediatricians and nursing staff. Prior studies have shown the reliance of student populations on school nurses, creating a possible gap for schools utilizing distance learning who may not have access to other primary care. Potential telehealth benefits include reminding parents/families to maintain vaccination schedules and well-child visits;
Table 1. Patient Characteristics and COVID-19 Data of DFW School-based Telehealth Program Participants by Independent School District (ISD) Regions, 2014 to 2019

| Variables                              | Total            | North           | South           | East            | West            | p-value*        |
|----------------------------------------|------------------|-----------------|-----------------|-----------------|-----------------|----------------|
| Total patients, N (%)                  | 7021 (100)       | 2415 (34.4)     | 1449 (20.6)     | 823 (11.7)      | 2334 (33.2)     | <.001          |
| Age, mean (SD), years                  | 8.8 (0.05)       | 7.7 (0.07)      | 9.5 (0.14)      | 11.7 (0.19)     | 8.5 (0.08)      | <.001          |
| Sex, N (%)                             |                  |                 |                 |                 |                 | .006           |
| Boy                                    | 3308 (47.1)      | 1206 (49.9)     | 669 (46.2)      | 365 (44.3)      | 1068 (45.8)     |                |
| Girl                                   | 3713 (52.9)      | 1209 (50.1)     | 780 (53.8)      | 458 (55.7)      | 1266 (54.2)     |                |
| Race/ethnicity, N (%)                  |                  |                 |                 |                 |                 | <.001          |
| NHW, non-Hispanic white                | 2796 (39.8)      | 1266 (52.4)     | 132 (9.1)       | 406 (49.3)      | 992 (42.5)      |                |
| NHB, non-Hispanic black                | 2340 (33.3)      | 554 (23.0)      | 1137 (78.5)     | 208 (25.3)      | 441 (18.9)      |                |
| Hispanic                               | 619 (8.8)        | 165 (6.8)       | 35 (2.4)        | 74 (9.0)        | 345 (14.8)      |                |
| Multi-race/Other                       | 1265 (18.0)      | 429 (17.8)      | 145 (10.0)      | 135 (16.4)      | 556 (23.8)      |                |
| Insurance type, N (%)                  |                  |                 |                 |                 |                 | <.001          |
| Medicaid                               | 4015 (57.2)      | 1214 (50.3)     | 906 (62.5)      | 460 (55.9)      | 1435 (61.5)     |                |
| Medicare                               | 1 (0.01)         | 1 (0.01)        | 0 (0)           | 0 (0)           | 0 (0)           | <.001          |
| Private insurance                      | 2032 (28.9)      | 909 (37.6)      | 355 (24.5)      | 191 (23.2)      | 577 (24.7)      |                |
| Self-pay                                | 973 (13.9)       | 291 (12.0)      | 188 (13.0)      | 172 (20.9)      | 322 (13.8)      |                |
| Primary reason for admission, N (%)    |                  |                 |                 |                 |                 | <.001          |
| Asthma or other respiratory disorder   | 1994 (28.4)      | 723 (29.9)      | 438 (30.2)      | 179 (21.7)      | 654 (28.0)      |                |
| Injury or trauma                       | 1292 (18.4)      | 454 (18.8)      | 242 (16.7)      | 162 (19.7)      | 434 (18.6)      | <.001          |
| Digestive disorder                    | 486 (6.9)        | 165 (6.8)       | 65 (4.5)        | 55 (6.7)        | 201 (8.6)       | <.001          |
| Ear, eye or skin disease              | 485 (6.9)        | 182 (7.5)       | 96 (6.6)        | 54 (6.6)        | 153 (6.6)       | <.001          |
| Infection                              | 453 (6.4)        | 157 (6.5)       | 100 (6.9)       | 45 (6.5)        | 151 (6.5)       | <.001          |
| Mental and behavior disorder          | 210 (3.0)        | 62 (2.6)        | 47 (3.2)        | 41 (5.0)        | 60 (2.6)        | .018           |
| Genitourinary disorders               | 207 (2.9)        | 51 (2.1)        | 47 (3.2)        | 35 (4.2)        | 74 (3.2)        | .105           |
| Endocrine and metabolic disease       | 108 (1.5)        | 36 (1.5)        | 27 (1.9)        | 19 (2.3)        | 26 (1.1)        | .126           |
| Pregnancy                              | 59 (3.0)         | 3 (0.1)         | 15 (1.0)        | 32 (3.9)        | 9 (0.4)         | .001           |
| Other                                  | 1727 (24.6)      | 582 (24.1)      | 372 (25.7)      | 201 (24.4)      | 572 (24.5)      | <.001          |
| COVID-19 deaths,† N (%)                | 119,102 (100)    | 73,568 (61.8)   | 3244 (2.7)      | 4662 (3.9)      | 37,628 (31.6)   | <.001          |
| COVID-19 cases,† N (%)                 | 1652 (100)       | 989 (59.9)      | 48 (2.9)        | 64 (3.9)        | 551 (33.4)      | <.001          |
| PVI,‡ mean                             | 0.561 (0.01)     | 0.547 (0.04)    | 0.561 (0)       | 0.598 (0.01)    | 0.552 (0.02)    | .174           |

NHW, non-Hispanic white; NHB, non-Hispanic black.

* Pearson’s chi-square analysis or Fisher’s exact analysis when n < 5 for categorical data; one-way ANOVA test for continuous data.
† Source: Texas DHSH and county health departments, as of 13 August 2020.
‡ Average of PVI score of counties within the region. Source: COVID-19 Pandemic Vulnerability Index (PVI), as of 13-Aug-2020, https://covid19pvi.niehs.nih.gov/.

connecting students with preventive and acute care amid school closures/online school; and prevention of acute care ER visits. In the future, this may also include COVID-19 (rapid) testing, antibody testing, and vaccination reminders.

Both the CDC and the European Centre for Disease Control and Prevention (ECDC) have released preliminary guidance related to COVID-19 testing and screening in schools. The main goals of this guidance are to identify potential cases among students and staff early to prevent further transmission, as well as to identify those individuals who may be at high risk of infection or severe symptoms due to preexisting conditions. In future scenarios where screening, testing, and contact tracing may be a fact of life for public settings, particularly schools, school-based telehealth programs are uniquely positioned to provide the first line of symptom screening and identification of preexisting chronic conditions, such as asthma and other respiratory disease—all while students are still relatively isolated at home. This model would allow health professionals to provide local governments, school boards, and other decision-makers guidance and recommendations tailored to their particular school or district population’s health and safety. Improved planning for reopening, including the tailoring of specific safety measures to implement ahead of and during the transition to in-person learning, as well as long-term strategies for mitigation of disease spread, are all possible benefits of a robustly supported telehealth program both during and after the period(s) of required distance learning that schools across the country are currently undergoing.

Limitations

A limitation of the present study is that reported findings are from one school-based telemedicine program implemented by one large pediatric healthcare system and thus may not be generalizable to all programs. Second, the regions for school-based telehealth program were classified by ISD, while COVID-19 data were categorized by counties; there may be overlap between ISD and counties.
Conclusion
School-based telehealth programs have the potential to reach pediatric populations most in need of health care due to COVID-19-related lapses in services, and to address COVID-19-related health issues as schools reopen. Unprecedented levels of adaptability, resources, time, and effort have already been required of both the educational and the health care sectors, and another new initiative may seem only to add to the already heavy burden; however, from a public health perspective, the 2020 to 2021 school year is an ideal time for currently existing telehealth programs to ramp up to serve both existing and new patients. Analysis of data on usage, reach, and effectiveness during this period may yield invaluable insights into the viability of school-based telehealth and similar programs as the world continues to battle the COVID-19 pandemic.

IMPLICATIONS FOR SCHOOL HEALTH AND EQUITY
As COVID-19 cases continue to persist in this region and throughout the United States, school-based telehealth programs are uniquely positioned to serve as touchpoints for pediatric patients and families as schools delay in-person openings and in-person primary care access has become more limited. School-based telehealth programs have the potential to reach large and pediatric populations most in need of health care due to COVID-19-related lapses in services, and to address COVID-19-related health issues as schools reopen. In the future, utilization could be expanded to contact tracing, testing, and screening for COVID-19.

Human Subjects Approval Statement
This study was approved by the University of Texas Institutional Review Board and followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines. Participants’ consent was waived because this study is a retrospective chart review using a deidentified data set; no patient contact was necessary.

Conflict of Interest
The authors declare no conflicts of interest.

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