

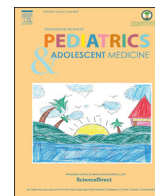
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Adolescents as partners in the fight against COVID-19

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ABSTRACT

We report our experience of COVID-19 disease burden among patients aged 0–21 years at two tertiary care institutions in the Northeast and Midwest from New Jersey and Iowa. Our results showed that during the initial surge (March to August 2020) at both geographic locations, majority of COVID-19 disease burden occurred in adolescents and that they were more likely to be hospitalized for COVID-related illnesses, as well as develop severe disease needing intensive care. The study results emphasize the need for providing more targeted interventions toward this group to help prevent disease acquisition and transmission.

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1. Introduction

More than one million children in the United States of America have been diagnosed with COVID-19, also known as SARS-CoV-2, representing 12.0% of the disease burden and 1,777 cases per 100,000 children [1]. Adolescents also play a significant role in household and community transmission due to risk-taking behaviors, including the less likelihood of adhering to mitigation measures. The period of adolescence therefore presents a good opportunity to maximize preventive and intervention efforts for positive health outcomes [2]. Pediatric providers are well positioned to empower adolescents by building on their intrinsic strengths and values in a way that promotes active participation in SARS-CoV-2 transmission prevention. Here, we describe SARS-CoV-2 disease epidemiology and severity in the pediatric age group,

particularly in the adolescent age group at 2 different geographic locations in the United States and discuss potential adolescent-driven strategies to reduce transmission.

2. Methods

Our study investigated the epidemiology of SARS-CoV-2 during the initial surge using percentage positivity of SARS-CoV-2 in the pediatric population (0–21 years) at two different geographic locations in Northeastern and Midwestern United States. We reviewed medical records of pediatric patients hospitalized with SARS-CoV-2 at our tertiary health care systems in Northeastern New Jersey (NJ) and Northwestern Iowa (IA) to describe trends and patterns for different age groups and to draw conclusions for preventive practices aimed at mitigating community SARS-CoV-2 infection.

Study period/time frame was chosen to reflect the positive testing percentage pattern during the first surge period, that ranged from a peak of 45.5% (March) to <5% in August 2020 (in NJ) and 31% (April) to 5% in August in IA. Testing for SARS-CoV-2 on nasopharyngeal swabs was done using real-time reverse transcription polymerase chain reaction (rt-PCR; BioGX SARS-CoV-2 BD MAX™ kit [Becton, Dickinson, MD, USA, and Xpert® Xpress SARS-

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CoV-2 kit [Cepheid, Sunnyvale, CA, USA] during initial clinical visit/hospital admission. Adolescence was defined as age group 12–21 years of age. This study was approved by our respective institutional review boards as exempt from consent. Comparisons between study groups for categorical variables were performed with chi-square or Fisher's exact test. GraphPad Prism version 8 (GraphPad Software, San Diego, CA) was used to analyze the data. A P value of < .05 was considered statistically significant.

3. Results

Overall, at both geographic locations, there were 23733 SARS-CoV-2 tests with a 14% overall positivity rate; in pediatrics, there were 2600 individual tests with a 9.1% overall positivity rate [In NJ, a total of 19233 tests with 15% (2913/19233) positivity rates with 175/1941 (9%) positives in pediatrics; in Iowa, a total of 4500 tests with 10.5% (474/4500) positivity rates with 62/659 (9.5%) positives in pediatric patients].

Pediatric testing as fraction of total tests ranged from a low of 3–7% (March and April respectively) to a stable rate of approximately 10% (May to August) in both the locations. Highest number of tests were performed in the Pediatric Emergency Department (PED) and Urgent Care setting (80%) at both the geographic locations, followed by outpatient/sub-specialty clinics (10%), Labor/Delivery (LDR) (7%), Pediatric Intensive Care Units (PICU) (2%), and General Pediatric Inpatient Units (GPIU) (1%). Highest positivity rates were seen in all inpatient settings [PICU (32%), LDR (16%), GPIU (11.3%), and PED (9%).

SARS-CoV-2 percentage positivity trends and data points for the study period are shown in Fig. 1. Overall percentage positivity in NJ ranged from a high of 45.5% in March to 4% in August 2020, while in IA, the highest positivity rates were seen from April–May (20%) with <10% from June–August.

Among 0–21-year-olds, adolescents accounted for the majority of tests performed (64% in NJ and 60% in IA, respectively) as well as the majority of positive tests (73% in NJ and 77% in IA, respectively).

The majority of patients (78%) in the 0- to 21-year age group needing hospitalization were adolescents (77.1% in NJ and 81% in IA, respectively). Compared to 0–12 year olds, significantly more adolescent patients required hospitalization (7% Vs. 27%, $P < .001$). Clinical characteristics of all hospitalized patients at both geographic locations are presented in Table 1.

Significantly more adolescents (26%) developed severe illness needing PICU admission than patients aged <12 years (10%) ($P = .013$). Adolescents accounted for 73% of all PICU SARS-CoV-2-related admissions (100% of PICU admissions in IA and 66% in NJ). ARDS and respiratory failure were the most common diagnoses in PICU patients (31%), and 20% of PICU patients needed mechanical ventilation. All patients needing mechanical ventilation were adolescents.

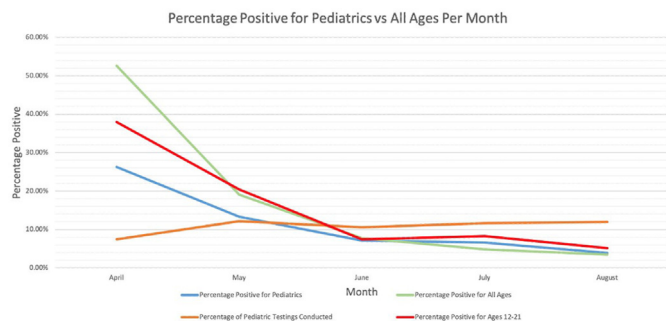


Fig. 1. Percentage of SARS-CoV-2 pediatric tests comparison across age groups (*April–August 2020).

4. Discussion

Our study from two geographically distinct tertiary carecenters shows that adolescents bear the major burden of SARS-COV-2 disease in 0- to 21-year age group, accounting for the majority of SARS-COV-2 infections and related hospitalizations as well as need for intensive care. Our results highlights opportunities for the adolescent-centered solutions in curbing COVID-19 disease trend [3–6].

Adolescence begins at approximately the age of 12 years with continuing neurologic developments to early adulthood. During this period, adolescents experience significant changes in cognitive abilities including problem solving, social capacities and creative thought [7–9]. On the other hand, it is also a period of increased risk-taking, which can contribute to increased household and community transmission of SARS-CoV-2. The adolescent's curiosity in understanding themselves and their environment can make them more receptive to health promotion using platforms to which they are more likely to engage, such as social media and other E-Health platforms, which provide youth appropriate online information. Therefore, targeted intervention directed at this group can significantly reduce the risk of household transmission.

Pediatric providers therefore play a critical role [10–12] in building partnership on a model that fosters various levels of autonomy and empowers the adolescent in their key role in prevention.

The role of the provider includes the following: adequate information using online resources [2,4] should be provided to the adolescent to promote participation and decision-making competence; providers should educate caregivers to include adolescent participation in home, community and other preventive actions to combat COVID-19. Adolescent visits should be performed using in office and Tele-Health platform with the goal of active engagement, communication and feedback. The provider should elicit information on resources and look into them with respect to the adolescent population and at same time direct the adolescents to scientific-based resources with an interactive discussion format.

Our definition of adolescents included ages 12-21 reflecting different developmental needs and various empowerment approaches. We suggest that providers empower adolescents based on the provider's familiarity with the adolescent's social and cognitive development and their ability to participate or lead home and community based interventions. A stepwise approach might entail presenting recommendations and discussing infection prevention measures like vaccination as effective means to prevent spread of COVID-19 as well as other infection control strategies like mask wearing and social distancing, addressing any questions and discussing any concerns that the adolescent might have, and offering practical solutions tailored to their local situation. The collaborative initiatives encourage a co-learning environment with caregivers and adults serving as collaborators through facilitation of critical dialogue [6,12] on creating solutions for home and community preventive models, social and emotional welling and other health promotion solutions tailored to their needs. The independent and autonomous approach focuses mostly on adolescent control and participation in information dissemination and its application to home and community.

"The process of participation itself changes participants" (Nagel 1987) [13] allowing them to own, create, and drive solutions for themselves and their community.

While pediatrics forms a small proportion of COVID disease burden, our study also shows high risks for pediatricians working in inpatient and outpatient settings. Providers should protect themselves by adhering to infection control procedures [11] while

Table 1
Demographics and clinical characteristics of the study patients.

Characteristics	All ages (%)	No./Total no. (%) ICU admission
Age group (N = 82)		
< 1 Y	5/82 (6.1)	–
1 Y - 5 Y	5/82 (6)	–
6 Y - 11 Y	8/82 (10)	–
12 Y - 17 Y	23/82 (28)	–
18 Y - 21 Y	41/82 (50)	–
Sex (N = 82)		
Male	27/82 (33)	–
Female	55/82 (67)	–
Race/Ethnicity (N = 82)		
NH White	19/82 (23)	–
NH Black	17/82 (21)	–
Hispanic and Latino	46/82 (56)	–
NH American Indian/Alaska Native	0 (0)	–
NH Asian or Pacific Islander	0 (0)	–
Multiple races	0 (0)	–
Unknown	3/82 (3.6)	–
Location (N = 82)		
ICU	29/82 (36)	–
LOS, d, (Median)	1–59 d (4)	–
NON ICU Floors	53/82 (64)	–
LOS, d, (Median)	1–50 d (3)	–
Any underlying condition (N = 29)		
Obesity ^a	–	5/29 (17)
Chronic lung disease	–	2/29 (7)
Asthma	–	3/29 (10)
Prematurity (gestational age <37 weeks)	–	1/29 (3)
Neurologic disorder	–	6/29 (21)
Chronic metabolic disease	–	1/29 (3)
Diabetes mellitus	–	2/29 (7)
Prader Willi Syndrome	–	1/29 (3)
Blood disorders	–	1/29 (3)
New clinical discharge diagnoses (N = 29)		
Pneumonia	–	7/29 (24)
Multisystem inflammatory syndrome in children (MIS-C)/Shock	–	7/29 (24)
ARDS/respiratory failure	–	9/29 (31)
Acute kidney injury	–	2/29 (7)
Altered mental status	–	1/29 (3)
Existing diagnosis (N = 82)		
Metabolic disorders ^b	3/82 (4)	2/29 (7)
Intentional injury	3/82 (4)	2/29 (7)
Other infections ^c	2/82(2.4)	1/29 (3)
Neurological disorders ^c	2/82(2.4)	2/29 (7)
Unintentional injury	6/82(7.3)	2/29 (7)
Blood disorders ^d	2/82(2.4)	1/29 (3)
Active labor	27/82(33)	–
Psychiatric illness	2/82(2.4)	–
Interventions (N = 29)		
Invasive mechanical ventilation ^d	–	6/29 (20)
BIPAP/CPAP	–	4/29 (14)
High flow nasal cannula	–	2/29 (7)
Systemic steroids	–	6/29 (21)
IVIG	–	1/29 (3)
Vasopressor	–	2/29 (7)
Died during hospitalization (N = 82)	0/82	0/29

^a Obesity was defined as body mass index (kg/m²) ≥ 95th percentile for age and sex based on CDC growth charts among children aged ≥2 y.

^b Among Metabolic Disorders 2 patients had Diabetes Mellitus leading to Diabetic Ketoacidosis and 1 patient had Central adiposia leading to Hypernatremia.

^c Among Neurological Disorders 2 patients had Epilepsy and 1 patient had AVM leading to a Subarachnoid Hemorrhage.

^d Among 6 patients requiring mechanical ventilation 1 patient had Prader Willi Syndrome and CLD; 2 patients had CLD as underlying conditions.

^e Other infections included 1 patient each for Pyelonephritis and Cellulitis.

^f Among the patients who had Blood disorders, 2 had Sick Cell Anemia and 1 had Anemia secondary to menorrhagia.

providing patient care as well as stress mitigation strategies to enhance their own mental and physical welling [14].

5. Summary/conclusions

Our study from two geographically distinct tertiary carecenters shows that adolescents share the majority of disease burden of

COVID-19 in terms of numbers and severity of disease in the 0- to 21-year age group. Not only is the majority of pediatric testing performed in adolescents but adolescents also have the highest positivity rates in the 0-21-year age group. Adolescents are also more likely to have adult-like hospitalization and related complications. As COVID-19 pandemic rages on, we are constantly seeking community participatory solutions to combat the trend and

adolescents have the capacity to participate in creating effective solutions for home and community. The pediatric provider should effectively partner and engage adolescents through participation in combating COVID-19.

Statement of authorship

The submitting author affirms that all individuals listed as authors have met the criteria of authorship.

Kest, H contributed to conception and design contributed to acquisition, analysis, or interpretation drafted the manuscript critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Kaushik, A Contributed to design Contributed to acquisition and analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Jagunla, A Contributed to analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Shaheen, S Contributed to analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Zaveri, S Contributed to analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Fernandez, N Contributed to analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Gupta, S Contributed to analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy Goldberg, D Contributed to analysis critically revised the manuscript gave final approval Agrees to be accountable for all aspects of work ensuring integrity and accuracy.

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The authors have no conflicts of interest relevant to this article to disclose.

Visual abstract

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