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COVID-19 Associated Changes in Pediatric Preventive Care Utilization

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An abstract of
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Abstract

COVID-19 Associated Changes in Pediatric Preventive Care Utilization
By Min-Hsuan Chen

Prior studies examining how the COVID-19 pandemic affects children's health and well-being showed that pediatric preventive care use had dropped significantly since the onset of the pandemic. Research incorporating full year post-COVID data is needed to compare the health services utilization among children. Furthermore, little is known about how the pandemic affects healthcare disparities among children. To fill this knowledge gap, we used 2019 (pre-COVID) and 2021 (post-COVID) data from the National Survey of Children's Health to examine (1) whether there are differences in the children's receipt of any preventive care visits during the past 12 months pre vs. post the COVID-19 pandemic and (2) whether such differences vary by household income among children ages ≤17 years. Multiple logistic regressions were used to estimate any receipt of preventive visits in the past year, adjusting for demographics (sex, race, family structure, primary household language, and number of children at home), enabling characteristics (parental education, parental employment, and insurance type), and need characteristics (usual source of preventive care, parental perceived child's health, and child's health conditions). Post (vs. pre) COVID, we observed a reduction in the likelihood of having any preventive visits of 2.9 percentage points (ppt) (95% CI: 1.0-4.9, $p = .003$) among children aged 0-4, 6.3 ppt (95% CI: 4.0-8.5 $p < .001$) among those aged 5-10 years, and 9.7 ppt (95% CI: 7.5-11.9, $p < .001$) among adolescents aged 11-17 years. When stratified by age and household income, the COVID-associated reduction was significantly larger in adolescents with family income ≤138% Federal Poverty Level (p = .039, [FPL]) or 139-399% FPL (p = .007) as compared to adolescents with family income ≥ 400% FPL. This pattern was not seen among younger groups. Future studies using qualitative data are needed to fully understand the changes in pediatric preventive care utilization and how these changes affect child health outcomes during the COVID-19 pandemic. Our findings provide important implications to strategies that aim to improve pediatric preventive healthcare utilization and promote children's health and well-being.

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Chapter 1 Introduction

Well-child visits are annual comprehensive preventive health services that aim to maintain children's health and well-being, determine if they have any physical, cognitive, emotional, and social development concerns.[1-3] These visits also provide parents the opportunities to receive counseling about health and developmental concerns they have for their children.[3,4] The American Academy of Pediatrics (AAP) establishes an annual guideline that recommends the types and frequency of preventive health services for infants, children, and adolescents for each age.[3,5] These services include body measurements, sensory screenings, developmental and behavioral health screenings, physical examinations, infectious disease screenings, immunizations, oral health check-ups, and anticipatory guidance from health care providers.[3,4] Moreover, the aims of preventive care visits may vary depending on the children's age, health needs, and development status. The recommended frequency of these preventive health services can range from bi-monthly to annually as children age.[3,6] These pediatric preventive health services are associated with a number of important health benefits, including higher immunization rates,[7,8] lower rates of injury,[9] and early detection of risky behaviors and chronic diseases.[10-13] Children who received the recommended visits also have lower rates of hospitalization and emergency department visits.[14,15]

Research that used different years of Medical Expenditure Panel Survey (MEPS) data (1996-2008) reported that about half of all children aged 0 to 18 years in the United States did not receive the recommended well-child visits.[16,17] The federal and state agencies are committed to promote these routine healthcare services for children. For example, the Centers for Disease Control and Prevention (CDC) encourages parents to help their children receive routine childhood vaccinations.[18] Federal and state sponsored healthcare plans such as Medicaid and

Children's Health Insurance Programs (CHIPs) financially support and incentivize parents and held webinars to promote well-child visits.[19] With the involvement of public agencies and complementary policies, the overall pediatric preventive care utilization rates have improved to over 70% during the last two decades.[16,20] A recent study by Lebrun-Harris and colleagues (2022) used the 2016-2020 National Survey of Children's Health (NSCH) data and reported an optimistic improvement in preventive visits rate from 78.9% in 2016 to 81% in 2019 across the states.[20] It was anticipated that the preventive care utilization rates would continue to increase.

However, the WHO declares COVID-19 a pandemic on March 11, 2020, which is a disease caused by a corona virus discovered in December 2019 spread globally.[21,22] The Secretary of the Department of Health and Human Services (HHS) also declared the federal Public Health Emergency (PHE) for COVID-19 in late January 2020, determining that the significant outbreak of COVID-19 in the United States presented a public health emergency.[23] The COVID-19 PHE had allocated federal funds to all states and assisted families through the expanded access to social services. It also provided additional financial support to low-income families to help them seek care when needed during the public health emergency, such as continuous enrollment of Medicaid, which otherwise required annual renewal.[24,25]

Since the start of the pandemic, some early COVID studies have investigated its impact on children's health and well-being. The five-year trend study conducted by Lebrun-Harris and colleagues (2022) provides a less favorable outlook, indicating that there was a substantial drop of 6.9% in preventive medical care comparing 2020 to 2019 data among all children under 18 years.[20] The probability of children completing any pediatric preventive visits decreased from 81% to 74.1%. A number of early COVID studies reflect findings that the utilization of immunizations, developmental and disease screenings, and preventive dental care has dropped

significantly during the pandemic.[26-30] Research also found negative children's health outcomes due to the COVID-19 pandemic, including increased behavioral or conduct problems,[20] increased mental health disorders,[31,32] and reduced quality of life.[31] The function of the routine preventive visits to detect these health problems among children in early stages was impeded during the pandemic. One study that used two months of US Census Bureau's Household Pulse Survey data in April and May 2021 estimated that approximately one-fourth of households had missed, skipped, or delayed preventive visits due to the pandemic.[33] Another study using IBM Market Scan Commercial Database (IMC) from January 2018 to March 2021 found substantial disruptions in well-child visits and vaccination in 2020 and early 2021.[26] One recent article revealed that COVID-19 led to significant service disruptions in pediatric preventive care because these services usually take place in person.[6] Specific populations may be affected by COVID-19 more than others in receiving pediatric preventive care visits.[6,20]

There are many social and economic changes, including job loss, reduced income, and insurance loss that occurred during the pandemic that have affected children and their families. The U.S. Bureau of Labor Statistics reported 22 million job loss from February to April 2020.[34] Low-wage workers and people of color were affected the most by the employment and relative income lost.[35,36] The volatile workplace put employer sponsored insurance in disarray and many families lost their jobs, income, and insurance all at once.[37] The HHS reported that low-income families and people of color experienced higher risk of COVID exposure, reduced access to healthcare, and food insecurity during the pandemic.[35] Research also found that families with lower income experienced reduced access to healthcare services and increased hospitalization rate.[38,39] Because children depend on their parents to access healthcare, several studies found that the economic recession during the pandemic reduced children's health services utilization.[40-42]

As such, more evidence is needed to better understand changes in the receipt of pediatric preventive care during the pandemic and how this is affected by family income and other social determinants of health. This information will help inform strategies and policies that can be developed to ensure timely access to needed preventive healthcare for all children.

This study provided new information by examining whether there are differences in the receipt of preventive visits post (2021) versus (vs.) pre COVID-19 pandemic (2019). We also assessed whether the differences in preventive care receipt differ by household income (as measured by levels of federal poverty [FPL]), to reflect whether COVID-19 increases or exacerbates the healthcare disparities of children based on their family income. We hypothesized that (1) there was significant decrease in the probability of preventive visits from 2019 to 2021 across all children's age groups, and (2) such decrease was more prominent in low-income households than in high-income households. This study was guided by the Anderson Behavioral Model for Health Services Use[43] to inform the key covariates, including enabling characteristics, demographics, and need characteristics that influence whether the patients seek care.

Chapter 2 Literature Review

Children's utilization of recommended pediatric preventive care has historically been low in the United States. Over the last twenty-five years, the utilization rates have ranged between 40% to 81% depending on the study populations.[16,20] Substantial improvement in the utilization of preventive healthcare services for children has been made since the implementation of the Affordable Care Act (ACA).[44,45] However, the proportion of children who completed preventive care visits has dropped significantly from 81% in 2019 to 74% in 2020, the onset of the COVID pandemic. Previous studies have demonstrated that disparities in the utilization of these preventive healthcare services exist based on socioeconomic status and demographic characteristics.[46,47] The COVID-19 pandemic may further exacerbate such disparities by disproportionately affecting certain subpopulations. Thus, it is critical to understand the contemporaneous uptake of recommended preventive care visits among children, potential changes during and beyond the COVID-19 pandemic in this population, and the pediatric subgroups that are disproportionately affected by the pandemic.

2.1 Trends of Pediatric Preventive Care Visits

Prior to the ACA, research showed that about half of all children aged 0 to 18 years in the United States received the recommended pediatric preventive visits. This trend has been recognized and improved over time. For example, Selden (2006) found that during 2000-2002, over 56% of children did not complete the visits in the past 12 months, with almost 40% having no visits over two years.[16] In a similar study comparing Medical Expenditure Panel Survey (MEPS) data from 1996-1998 to 2007-2008, the researchers found that the proportion of children missing preventive care visits decreased from 54% to 41%.[17] Since the implementation of ACA in 2010, improvement in pediatric preventive care visits has been reported. Ortega and

colleagues (2017) found a significantly increased in the probability of children aged 0 to 17 years having a well-child visit during the past 12 months across all racial groups from 2011 to 2015, reaching over 75%.[48] Lebrun-Harris and colleagues (2022) examined five-year trends of children's health and reported that preceding the COVID pandemic (2016-2019), there was an increase in the probability of children receiving preventive medical care from 79% to 81%,[20] which dropped to 74% in 2020 (onset of the pandemic).

Early COVID studies focusing on specific subpopulations or geographic regions showed that the pandemic negatively impacted the probability of a child receiving preventive healthcare services. For example, Kujawski and colleagues (2022) found a 47% decrease in routine well-child visits comparing April 2020 to data from 2018-2019.[26] CDC in 2020 reported notable decreases in multiple vaccination orders such as non-influenza childhood vaccines and measles-containing vaccines,[28] and many studies found similar results across the United States.[28,29,49-53] Other pediatric healthcare services such as blood testing,[49] outpatient visits,[54] medical care were also affected by the COVID pandemic.[20,26] One theme that emerged from these early studies is that, in addition to the general decreases in children's healthcare service utilization, large gaps exist for different socioeconomic groups among children and families.

2.2 Factors Influencing Pediatric Preventive Care Visits

The disparities in access to pediatric preventive care is well known; however, research examining the key factors associated with preventive healthcare use among U.S. children generated mixed findings. Abdus and Selden (2013), for example, reported that adherence to children's preventive visits was influenced by age, race or ethnicity, insurance coverage, family income, parental education, parental insurance, family structure, urbanicity, and region.[17] Goedken and colleagues (2014) found that, among children with full years of insurance

coverage, parent education and parent healthcare use affected utilization of pediatric preventive visits, whereas family income, race or ethnicity, and the number of children in the household did not.[55] Wolf and colleagues (2020) investigated parents with children aged 1 to 3 years on their barriers to attend well-child visits and found publicly insured or uninsured children were 8 times less likely to complete these visits than privately insured ones.[56] Koschmann and colleagues (2021) identified financial barriers as one of the biggest challenges that affected well-child care for urban, low-income, African American families. These and many other studies identified family income as a variable that either directly affected pediatric preventive care use or affected other variables such as insurance coverage and employment status that can influence pediatric preventive care use. It is important to investigate whether the COVID pandemic affects pediatric preventive care visits differently by family income levels.

2.3 Family Income, Age, And Pediatric Preventive Care Visits

Research focusing on the relationship between family income and pediatric preventive care during the COVID-19 pandemic showed mixed results. Weston and colleagues (2021) examined the effects of sociodemographic and psychosocial factors on preventive pediatric care during the pandemic. They found that parents with income above 150% FPL (vs. those below 150% FPL) were more likely to complete the recommended visits during the pandemic (78% and 71%, respectively).[57] In contrast, Lebrun-Harris and colleagues (2022) estimated the prevalence of missed or delayed preventive visits during COVID-19 and reported no significantly different across household federal poverty levels (FPL) and health insurance coverage.[33] The former study utilized the Parid Assessment of Pandemic Impact on Development-Early Childhood in November 2020, sampled adults with children ages 5 and younger, and investigated whether the households missed a well-child check-up since the COVID pandemic began. The latter study

utilized U.S. Census Bureau's Household Pulse Survey from April to May 2021, sampled adults with children under 18 years old, and investigated whether the households reported missed or delayed a preventive visit because of COVID-19. The mixed findings may be due to different research periods, samples, and outcome measures. Other COVID-related studies found that COVID-19 has negatively affected families' capacity to receive preventive visits for children for financial reasons that include loss of jobs, loss of insurance, and reduced earnings.[58-63] Many of these factors are associated with a consequent decrease in family income. However, to date, limited studies have examined how the changes in pediatric preventive visits post (vs. pre) COVID differ by family income.

AAP recommended different types of preventive healthcare services and frequencies of preventive visits based on children's age groups.[3,20,57] These preventive healthcare services should occur from every 2 months in infancy to annual check-ups in adolescence. Newborn babies require often health check-up schedules that include preventive services such as developmental surveillance, body measures, and immunization.[3] On the other hand, adolescents are recommended to schedule annual visits with their primary healthcare providers and complete additional check-ups such as behavioral health screenings (e.g., tobacco, alcohol, or drug use assessment) and sexually transmitted infections detections (e.g., HIV).[3] It is very likely that the completion of pediatric preventive care visits differs by age, which is affected by the recommended frequencies of the preventive care visits. However, early COVID studies investigating the changes in children's health and healthcare services utilization have sampled either a specific age group (e.g., children under the age of 5) or all children without age classification.[20,57] Research on COVID-19 changes in pediatric preventive care visits by age groups is needed.

2.4 Gaps filled and Policy Implications

This study aims to provide evidence through the most recent data available and fill three research gaps in this area. First, limited research was able to fully distinguish pre vs. post COVID service utilization as their utilization measurement window span both pre and post COVID periods.[20] Our study addressed this gap and provided contemporaneous estimates on COVID-associated changes by comparing the 2019 data (pre-COVID) to 2021 data that were exclusively post-COVID. Second, prior research reported mixed findings on whether family income affects children's preventive services use during the COVID pandemic. Our study included family income as FPLs, which is an income measure commonly used in similar COVID-related research, and investigated the differential changes associated with COVID in pediatric preventive care use by family income. Third, the frequency of various pediatric preventive healthcare services recommended by the AAP guidelines for children can range from bi-monthly to annually, depending on children's age.[6] Children of different ages may have different needs for preventive services, and thus our study was stratified by children's age groups. A theoretical framework was used to direct the research design and the selection of other important covariates included in our study.

Children's access and utilization of preventive healthcare services rely on their caregiver's socioeconomic status. Although research findings vary in terms of which key factors are associated with preventive healthcare use among children in the United States, it was clear that income disparities exist in access to healthcare. There is a concern that low-income families were disproportionally affected by the COVID-19 pandemic socially and economically, and the gap between utilization of preventive care among children may be exacerbated and transferred into a long-term effect. Children are also recommended with different types of preventive

healthcare services and frequencies of preventive care visits by age. Limited research identified the variation and implemented age stratifications in research design. Research is needed to investigate the COVID-19 related changes among children of different ages and understand what socioeconomic characteristics of the caregivers contributed to the potential disparities.

2.5 Conceptual Model

Theoretical Framework

Our study used the Andersen Behavioral Model for Health Services Use[64] to examine the association between the COVID-19 pandemic and children's receipt of pediatric preventive care (Figure 1). We also examined whether family income moderates this association. Andersen's model defines the predisposing, enabling, and need characteristics at the contextual and individual levels that influence health services utilization.[64] Predisposing characteristics included demographics (detailed below) that influence whether children seek care. Individual-level enabling characteristics refer to the financing and organization of health services that directly affect a child's ability to seek care (detailed below). Need-related characteristics are defined as parental perceptions of their children's need for health services (i.e., perceived need) and professionals' diagnoses of health conditions (i.e., evaluated need). Contextual-level factors refer to the community-level characteristics that affect children's access to healthcare services. Demand for Health Services economic theory and existing literature in pediatric preventive care were also drawn to identify potential mechanisms and confounders and direct the relationships of these factors to the hypotheses.

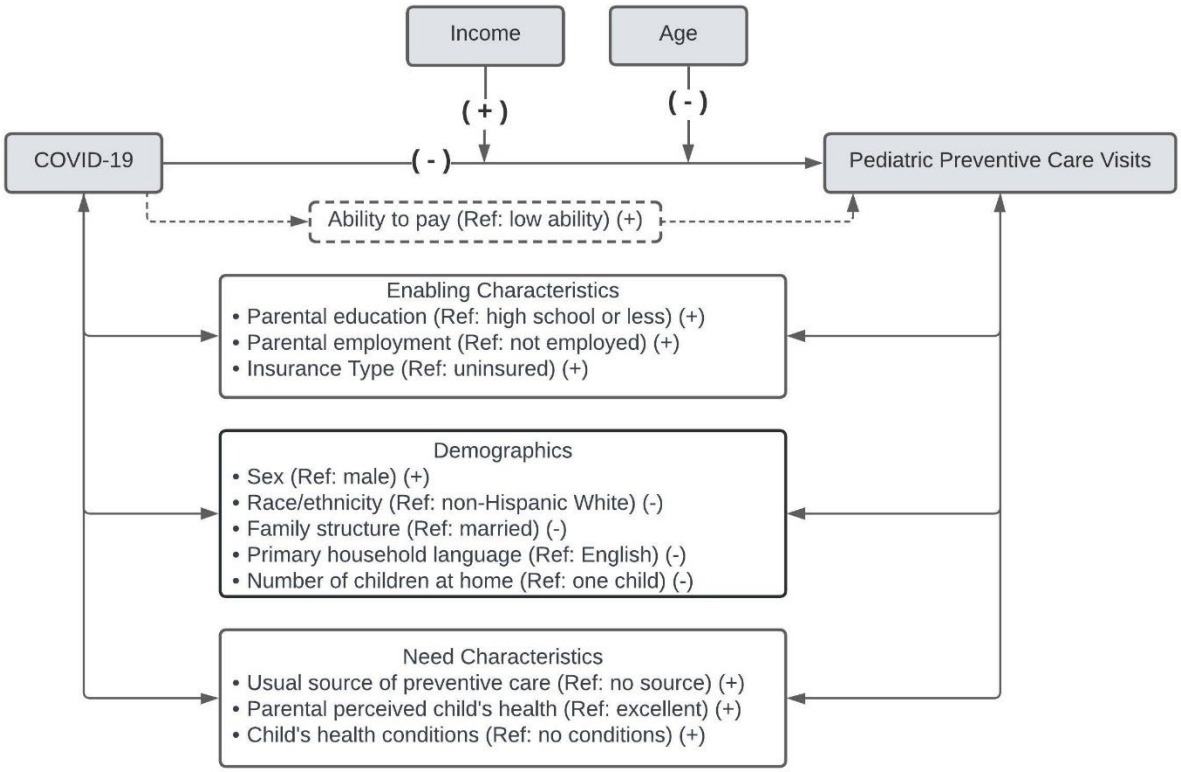

Figure 1. Conceptual model.

Focal Relationship

The focal relationship of this study is the association between the COVID-19 pandemic (our independent variable) and pediatric preventive care visits (dependent variable). To match the timeframe of the COVID-19 pandemic, this study defines 2019 as pre-COVID period and 2021 as post-COVID period. Pediatric preventive care visits are defined as well-child visits, which are a set of annual comprehensive preventive health services that aim to maintain children's overall health and well-being, determine if they have any physical, cognitive, emotional, and social development concerns,[1-3] and provide parents the opportunities to receive counseling.[3,4] The AAP establishes annual guidelines that recommend the types and frequency of preventive health services for infants, children, and adolescents for each age.[3,5] Several studies reported that the pandemic negatively impacts family income as well as the probability of a child

receiving well-child visits, [26,62,65,66] vaccination,[28,29] and other medical care as recommended since its onset.[20,26]

The ability to pay is the unmeasured mechanism drawn from the Demand for Health Services theory that may explain our focal relationship. The ability to pay is defined as whether the caregivers have enough monetary resources to afford the intended healthcare services for their children.[67] Previous literature suggests that ability to pay is positively associated with income and pediatric preventive visits,[67,68] but negatively associated with COVID-19 due to employment loss and the resulting loss in family income and insurance coverage during the beginning of the pandemic.[69] Thus, we hypothesize that the post-COVID (vs. pre-COVID) period is negatively associated with pediatric preventive care visits.

Income as a Moderator of the Focal Relationship

The U.S. Census Bureau defined family income as the total monetary resources received of all adults in the family based on the entire calendar year.[70] The HHS issues FPL from annual family income to determine eligibility for multiple government sponsored health benefit programs.[71] Several studies have reported that families with lower incomes and FPL face more barriers in helping their child receive care than those with higher incomes among children under five years old.[17,48,72-74] We theorized that, during the COVID pandemic, the FPL moderate the association between COVID-19 and pediatric preventive care visits, with the association stronger among those with lower family income.

Age as another Moderator of the Focal Relationship

Age is defined as a period of human life measured by years from birth.[75] Literature reported that age is negatively associated with preventive care visits.[55,76,77] This study categorized children by 0-4, 5-10, and 11-17 years. We hypothesized that adolescents had a

lower rate of pediatric preventive care visits than those younger and were disproportionately affected by the COVID pandemic.

Confounders of Interest

Enabling characteristics were the main confounders of interests in this study. Demographics (individual predisposing characteristics), need of services (individual need-related characteristics), and contextual factors are the other confounders associated with both COVID-19 and pediatric preventive care visits.[43]

Enabling Characteristics

Enabling characteristics included insurance type, parental employment status, and health belief. Insurance type is the healthcare benefit programs typically categorized by the payers that cover the children's medical and surgical expenses.[78] The common categories include private health insurance paid by the consumers themselves, public health insurance sponsored by states and federal government, and other insurance plans. Children not enrolled in any type of healthcare benefit programs are classified as uninsured. Several studies reported that being fully insured with private health insurance is positively associated with income and preventive visits.[55-57,79] While public health insurance is negatively associated with family income, continuity in either type of insurance is positively associated with preventive visits.[55]

Parental employment status is the state of the caregiver(s) in the labor force, which usually refers to the type of contract between the employer and employee.[80] The most common classifications that are used in this research are full-time employment (35-40 hours of work per week) and part-time employment (less than 35 hours per week). Full-time employed is positively associated with income,[57,79] however, negatively associated with health services use due to the challenges full-time employees parents to find time taking their children to the visits during work

days.[81] It is also negatively associated with COVID-19 due to company closures, job loss, and underemployment.[69]

Health belief is an unmeasured enabling characteristic defined as a person's attitude towards the benefits of and need for preventive care.[56] It is positively associated with income, and if the parents do not think preventive care visits are necessary, their children are more likely to miss a visit.[56] Parental education is the highest formal educational degree obtained by the primary caregiver(s).[78] Evidence suggests that as higher education level is positively associated with both income and visits.[17,55-57,79] Research has reported that parental education is highly correlated with health belief. [82] Therefore, this research uses parental education as the proxy for health belief.

Predisposing Characteristics

Predisposing characteristics (demographics) include sex, race and ethnicity, family structure, primary household language, and number of children at home. Sex refers to the biological status of males and females.[83] Literature suggests that women are more likely to utilize preventive care than men.[84] Among all COVID-19 patients in the U.S., more than half of the children (57%) and adults (53%) were males.[85] Race and ethnicity refers to the social categorization of people on the basis of physical characteristics and cultural identification.[86] Research reported that being other race and ethnicity groups as opposed to non-Hispanic White is negatively associated with income and visits.[17,56,87] Both sex and race/ethnicity are children's individual predisposing characteristics. The following predisposing characteristics are at the family level. Family structure is the number of caregiver(s) living in the household with the children and the relationship between these adults.[70] Families with married parents both present in the household is positively associated with income and visits.[56] Primary household language is

defined as the system of conventional spoken, manual, or written symbols that the family is using as the first priority.[88-90] Primary household language as English is positively associated with income and visits.[55,91] The number of children in the household is defined as whether the subject child is the only dependent in the household. Research reported that more children in the household is associated with a decreasing probability of preventive care visits because of caregivers' lack of time.[92]

Need Characteristics

Need for services include having a usual source of preventive care, parental perceived child's health, and child's health conditions. Usual source of care is the medical professional, doctor's office, clinic, health center, or other place where a person would usually go if sick or in need of advice about his or her health.[78] Usual source of care is often used in previous research as a proxy of need for healthcare services, and is positively associated with both income and preventive visits.[17] Because during the pandemic many healthcare providers limited their availability or closed the physical locations,[33] we anticipate COVID-19 is negatively associated with having usual source of preventive care. While the availability of healthcare providers reduced, parents' perceived healthcare needs is anticipated to increase. Parental perception of children's health status is defined as the caregiver(s)' view of their child's general health and functional state.[70,78] Parents perceiving their child as unhealthy is positively associated with perceived healthcare need, and increase the probability of receiving preventive visits.[64,93] Evaluated healthcare needs, or child's health conditions, is defined the professional judgment and objective measurement of the child's physical conditions and need for medical care.[70,78] We anticipate that children with at least one physical and mental health conditions are positively associated with COVID-19 and preventive visits.[64,93]

Contextual Factors

Contextual factors included urbanicity and geographic availability of the providers that may affect the environment and the outcome. Urbanicity is defined as the impact of living in an existing city or its surrounding area at a given time.[94] Households that live in urban areas are positively associated with income and visits.[17] Geographic availability of the providers is defined as the number of providers providing the intended services within a given radius circle from the household.[95] More providers available near the household is positively associated with income and visits.[17]

2.6 Research Objectives

Early research reported significant dropped from 2019 to 2020 in various pediatric health services utilization, including preventive dental care, preventive medical care, and vaccinations.[20,28,29] This study builds on current literature and contributed to the filed by clearly distinguishing the pre-COVID vs. post-COVID periods through utilizing the 2019 and 2021 data. Moreover, this study aims to provide new information by age group among children and investigate how COVID-19 related changes differ by family income level.

The research objectives of this study are:

1. To examine whether there are differences in children's receipt of preventive care post (2021) vs. pre (2019) COVID-19 pandemic.
2. To assess whether the COVID-associated changes in the receipt of preventive care differ by household income as measured by FPLs.

Chapter 3 Methodology

3.1 Study Design

This is a pooled cross-sectional study using the National Survey of Children's Health (NSCH) data. The NSCH is a nationally representative, annual, cross-sectional household survey directed by the Health Resources and Services Administration (HRSA) Maternal and Child Health Bureau (MCHB), and included a US nationally representative sample of non-institutionalized children ages 0-17 years. This study utilized two years of NSCH data (2019 and 2021) and identified households with at least one child whose caregiver responded to the relative health questions. This study was exempt from IRB approval because the institutional review board of Emory University determined this study did not require review as it was not research with human subjects nor clinical investigation.

3.2 Hypotheses

Two hypotheses were tested in this research study (Figure 2):

1. There were statistically significant decreases in the receipt of pediatric preventive care from pre-COVID (2019) to post-COVID (2021) across all age groups of children.
2. This COVID-associated decrease was more prominent in low-income households than in high-income households.

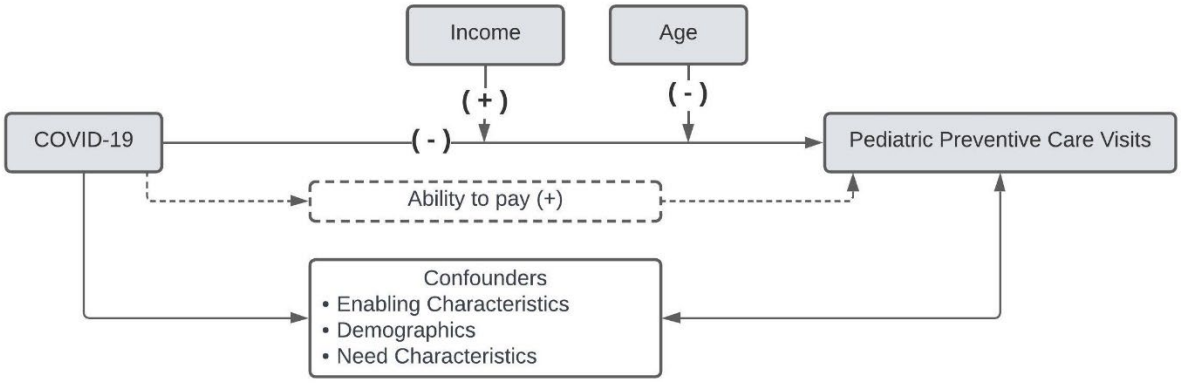

Figure 2. Simplified conceptual model.

3.3 Data Sources

The NSCH is an annual survey investigating children and youth ages 0-17 across the United States, sponsored and directed by the HRSA MCHB. It is a state-clustered random sample, oversampling 7 states (Colorado, Georgia, Louisiana, Nebraska, Ohio, Oregon, and Wisconsin), children from minority racial and ethnic groups, children with special health care needs, and children 0-5 years old.[96] Survey weights are provided by the NSCH and used to reflect the representability of the sample to the U.S. non-institutionalized children under the age of 18. The overall weighted response rate was 42.4% in 2019 and 40.3% in 2021. NSCH covers topics including demographics, physical and mental health, access to quality health care, and the child's family, neighborhood, school, and social context. Starting 2016, the HRSA started to collect the survey data via mail and web-based surveys every June through December, and the cross-sectional data are released in October the following year. In households with two or more children, the parents or caregivers were asked to answer the survey questions about one randomly selected child.

3.4 Analytic Sample Derivation

The analytic sample used for this study included 75,778 children from the NSCH. This sample was derived from a total of 98,206 households which were first identified from the 2019 and 2021 survey data, including 36,196 households in 2019 and 62,010 households in 2021. The data consisted of 186,866 children, including 67,625 in 2019 and 119,241 in 2020. Then, one child from each household was randomly selected by the NSCH, and the caregivers were asked questions regarding their child's health.[97] As a result, 98,206 households were randomly selected. A total of 80,325 caregiver respondents completed the survey, with 29,433 in 2019 and 50,892 in 2021. The response rates were 81% and 82% in 2019 and 2021, respectively. Of these caregivers, I excluded 326 (0.4%) caregivers with missing data in the outcome measure. I further excluded 4441 (5.5%) caregivers with missing values in any of my model covariates; these include insurance type, employment status, sex, family structure, primary household language, usual source of preventive care, parental perceived child's health, and health conditions. There were no missing data on income as FPL, parental education, race and ethnicity, number of children in the household, and state of residency. These exclusion criteria yielded a final analytic sample of 75,558 caregivers for statistical analyses (Figure 3). All statistical analyses were stratified by three age categories based on relevant literature and the AAP guideline:[3] 0-5 (early childhood, n = 21,988), 6-11 (middle childhood, n = 23,174), and 12-17 (adolescence, n = 30,396).

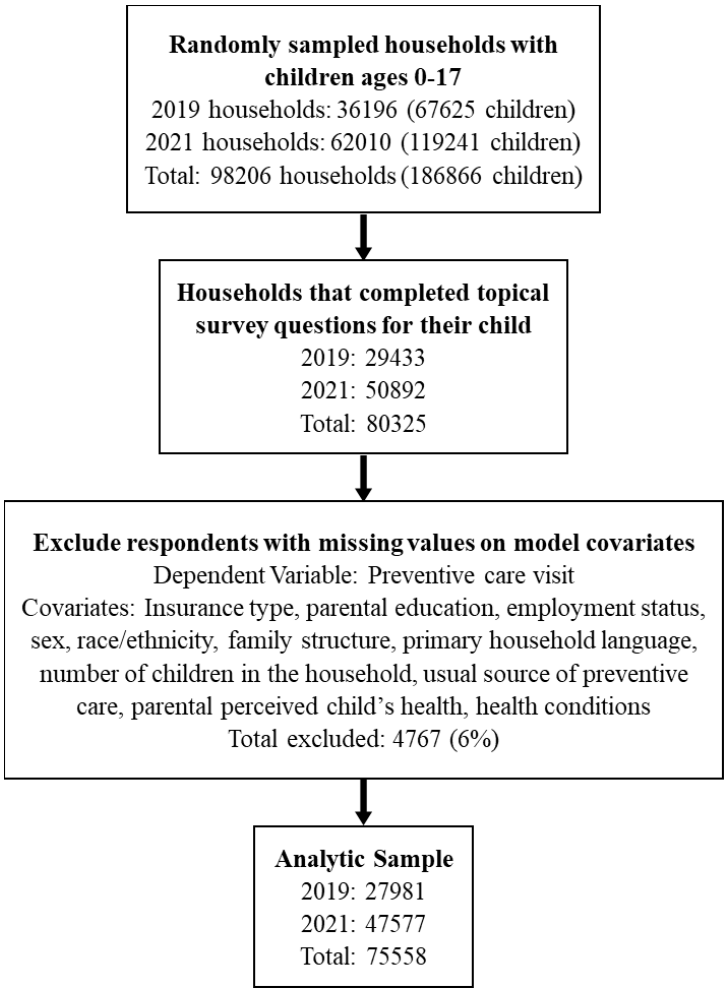

Figure 3. Analytic sample derivation, using 2019 and 2021 NSCH.

3.5 Measurement

Table 1 provides a summary of the constructs, the measurements created to operationalize each construct, and their anticipated correlations to the independent variable and dependent variable.

Table 1. Constructs and measurements.

Construct	Operationalization	Associations to independent and dependent variables
Pediatric Preventive Care Visits	Whether the child received any pediatric preventive care visits during the past 12 months. (Dichotomous)	Dependent Variable

	• No visits (reference), one or more visits	
COVID-19	Classification of years as related to the onset of the COVID-19 pandemic. (Dichotomous) • Pre-COVID (2019, reference), post-COVID (2021)	Independent Variable (–)
Family Income as Federal Poverty Level	Household poverty level derived from total family income. (Nominal) • 400% FPL or above (reference), 139-399% FPL, 138% FPL or below	Moderator (+)
Age	Age categories developed from the child's age. (Nominal) • 0-4, 5-10, 11-17 years old	Moderator (–)
Ability to Pay	Unmeasured	(–,+)
Parental Education	The highest education level reported from the child's primary caregiver(s). (Nominal) • High school or less (reference), some college/technical school, college degree or higher	(–,+)
Parental Employment Status	At least one caregiver worked part-time or full-time during the past 12 months. (Dichotomous) • No (reference), at least one caregiver employed full- or part-time	(–,+)
Insurance Type	The type(s) of healthcare benefit programs the child and the family were enrolled in during the past 12 months. (Nominal) • Uninsured (reference), privately and publicly insured, privately insured only, publicly insured only	(–,+)
Sex	Sex of the subject child. (Dichotomous) • Males (reference), females	(–,+)
Race/Ethnicity	The child identification of race and ethnicity group. (Nominal) • Non-Hispanic White (reference), Hispanic, Non-Hispanic Black, Non-Hispanic others	(+,–)
Family Structure	Number of caregivers in the household and the relationship between them. (Nominal) • Two married parents (reference), single parent, caregivers of other relations (e.g., grandparent)	(+,–)
Primary Household Language	The primary language spoken in the household. (Dichotomous) • English (reference), not English	(+,–)
Number of Children at Home	Number of children (including the subject child) living in the household. (Nominal) • 1 child (reference), 2 children, 3 or more children	(+,–)
Usual Source of Care	Whether the child has a usual place to go when sick. (Dichotomous) • No (reference), have a usual source of care	(–,+)
Parental Perceived Child's Health	Caregiver(s)' perceptions of whether their child is healthy. (Nominal) • Excellent or very good (reference), good, fair or poor	(+,+)
Child's health conditions	Number of physical and mental health conditions the child currently has from a list of 26 conditions. (Nominal) • None (reference), one condition, two or more conditions	(+,+)

Dependent Variable

The outcome of interest, pediatric preventive care visits, was derived from two questions. The first question asked whether the child ever saw a doctor, nurse, or other health care professional for sick-child care, well-child check-ups, physical exams, hospitalizations, or any other kind of medical care during the past 12 months. Those who responded to any medical care were asked a second question about the number of times the child visited a doctor, nurse, or other health care professional to receive a preventive check-up during the past 12 months. Using these two questions, children were dichotomized as having one or more, vs. zero, preventive care visits in the past 12 months.

Independent Variable

To construct the key independent variable, we defined 2019 as pre COVID and 2021 as post COVID, and we excluded 2020 data because this year included a mix of pre and post pandemic. Therefore, the independent variable is dichotomous (i.e., 2010 vs. 2019).

Family Income

The total amount of income as a percentage of federal poverty levels (FPLs), which are the government's annual updated monetary thresholds, was used to determine the household's financial capability. This variable includes three mutually exclusive categories: less than 138% FPL, 139-399% FPL, and 400% and above FPL.

Age

Age was assessed at the time of survey. We included three age categories: in the analyses, including 0-5 years, 6-11 years, and 12-17 years.

Parental Education

Parental education was defined as the highest education of the primary caregiver(s),

which was classified into three categories: high school graduate or less than high school, some college or technical schools, and college degree or higher.

Parental Employment Status

Parental employment status was defined as whether the primary caregiver(s) were full-time employed during the last 12 months. Notably, the survey question investigating the employment status of the caregiver(s) changed during our study period. In 2019, the caregivers were asked if they were employed 50 out of 52 weeks during the year. In 2020, the caregivers were asked if they were full-time employed, part-time employed, not employed but seeking a job, or not employed and not seeking a job. We compared the proportion of responses from both years and developed a dichotomous variable indicating whether at least one caregiver was employed full-time or part-time with pay in the past year.

Health Insurance Type

Insurance type was derived from two survey questions asking whether the child was covered with any health care plans when surveyed, and the specific type of insurance coverage. Responses indicating that the child was never covered at the time or survey or was covered by Indian Health Services or a religious health share are defined as uninsured, according to the definition drawn from the NSCH codebook. Responses indicating that the child was covered by Medicaid, Medical Assistance, or any kind of government assistance plan for those with low incomes or a disability (e.g., CHIP) were defined as publicly insured. Responses indicating that the child was covered by insurance through a current or former employer or union, insurance purchased directly from an insurance company, or TRICARE or other military health care, or coverage through the Affordable Care Act Marketplaces or other private insurance are defined as privately insured. Responses indicating that the child was covered by both private and public

health insurance plans were categorized as both privately and publicly insured. Together, we created a categorical variable with the following mutually exclusive categories: both privately and publicly insured, privately insured, publicly insured, and uninsured.

Sex

The sex of the child was reported by the caregiver who responded to the survey. The response was dichotomized into male vs. female.

Race/Ethnicity

The caregiver reported if the child was Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, American Indian and Alaska Native, Native Hawaiian and other Pacific Islander, or multiple races. This study recategorized the responses into a categorical variable with four mutually exclusive categories: non-Hispanic White, Hispanic, non-Hispanic Black, and non-Hispanic others. Non-Hispanic others included non-Hispanic Asian, American Indian and Alaska Native, Native Hawaiian and other Pacific Islander, and multiple races; these groups were combined together due to small sample sizes.

Family Structure

Family structure was derived from survey questions asking about the number of parents or parental figures present in the household and the relationship of parents or other adults in the household and their marital status. Using these questions, we created a mutually exclusive, categorical variable with the following categories: two married parents or unmarried couples, single parent (mother or father), and caregivers of other relations.

Primary Household Language

We used a survey question asking about what the primary language was in the child's household. Responses indicating that English was the primary language spoken are defined as

English, with others defined as non-English.

Number of Children at Home

The survey asked the caregiver the number of children living in the household with them. We categorized the responses into one child, two children, and three or more children in the household.

Usual Source of Care

The survey asked whether the child has a usual place to go when they are sick and what type of place they go for medical care when they are sick. Responses indicating that the child does not have a usual source of care or that the place of care is a hospital emergency room were defined as not having a usual source of care, and all other types of places (including physician clinics and nurse practitioners) were defined as having a usual source of care.

Parental Perceived Need

We used a survey item of a five-point scale asking the caregiver(s) to describe their child's health status. We categorized the responses into excellent or very good, good, and fair or poor.

Child's health conditions

This variable was derived from survey questions asking whether the child has current or lifelong health conditions from a list of 26 health conditions. The measures of health conditions include: allergies (food, drug, insect, or other), arthritis, asthma, blood disorders, brain injury/concussion/head injury, cerebral palsy, cystic fibrosis, diabetes, Down Syndrome, epilepsy or seizure disorder, genetic or inherited condition, heart condition, frequent or severe headaches including migraine, Tourette Syndrome, anxiety problems, depression, behavioral and conduct problem, substance use disorder, developmental delay, intellectual disability, speech or other

language disorder, learning disability, autism or autism spectrum disorder, Attention Deficit Disorder or Attention-Deficit/Hyperactivity Disorder, hearing problems, and vision problems.[97] Responses are categorized into three levels: no health conditions, one helath condition, and two or more conditions.

3.6 Data Analysis

Bivariate analyses using the Wald test were conducted to compare our outcome measure (preventive visits) and key covariates by age group. We then conducted regression analyses to examine the unadjusted and adjusted association between COVID-19 and pediatric preventive care visits. We first ran unadjusted logistic regression models to estimate the receipt of any pediatric preventive care visits, and then estimated multiple logistic regressions that controlled for all confounders described above. All analyses were stratified by age group (i.e., 0-5, 6-11, and 12-17 years old). We further stratified the analysis by family income. Finally, the regression model was interacted with family income to test whether the association between COVID-19 and pediatric preventive care visits differed by family income levels. For ease of interpretation, our results were presented in marginal effects and the associated 95% confidence interval. Data were analyzed using Stata, version 17 SE (StataCorp LLC). We applied the “svy” command to adjust for sampling weights and survey design.

Chapter 4 Results

4.1 Bivariate Analyses

Sample characteristics

In our analytic sample, the largest proportion was children aged 11-17 years (40.2%), followed by those aged 5-10 years (33.1%) and those aged 0-4 years (26.7%) (Table 2).

Children aged 0-4 years were more likely than those older to have one or more preventive visits (88.2% vs. 79.9% in those aged 5-10 and 74.8% in those aged 11-17, $p < .001$), live with parents who had college degree or higher (56.8% vs. 52.0% in those aged 5-10 and 49.0% in those aged 11-17, $p < .001$), live with two parents (77.4% vs. 73.9% in those aged 5-10 and 69.8% in those aged 11-17, $p < .001$), have a usual source of preventive care (92.6% vs. 91.6% in those aged 5-10 and 89.4% in those aged 11-17, $p < .001$), be perceived as lower needs in healthcare by their parents (93.9% vs. 91.6% in those aged 5-10 and 86.4% in those aged 11-17, $p < .001$), and have no chronic health conditions (91.7% vs. 73.1% in those aged 5-10 and 65.2% in those aged 11-17, $p <.001$).

Children aged 11-17 were more likely than those younger to be uninsured (7.6% vs. 6.3% in those aged 5-10 and 5.9% in those aged 0-4, $p = .005$) and less likely to be identified as non-Hispanic White (50.2% vs. 52.3% in those aged 5-10 and 51.4% in those aged 0-4, $p = .019$).

Children aged 5-10 were more likely than others to have siblings (81.8% vs. 69.8% in those aged 11-17 and 73.3% in those aged 0-4, $p < .001$).

Table 2. Overall sample characteristics by age group

	Ages 0-4 years Weighted %	**Ages 5-10 years Weighted %**	**Ages 11-17 years Weighted %**	**P values**
Unweighted sample size	21988	23174	30396	
Weighted sample size	18001223	22303801	27095152	
Proportion of sample	26.7	33.1	40.2	

Outcome				
Preventive visits				<.001
None	11.8	20.1	25.2	
One or more visits	88.2	79.9	74.8	
Key Independent Variable				
Year				.925
2019	50.7	50.9	50.5	
2021	49.3	49.1	49.5	
Covariates				
Enabling characteristics				
Income as FPL				.080
400% or above	32.8	32.2	31.6	
139-399%	40.0	41.3	42.9	
138% or below	27.2	26.5	25.5	
Insurance type				.005
Uninsured	5.9	6.3	7.6	
Public and private	4.2	4.7	4.3	
Private only	58.9	58.5	60.3	
Public only	31.0	30.5	27.8	
Employment status				.010
No	8.6	8.2	10.1	
At least one employed full or part time	91.4	91.8	89.9	
Parental Education				
High school or less	24.0	27.0	29.9	<.001
Some college or technical school	19.2	21.0	21.1	
College degree or higher	56.8	52.0	49.0	
Demographics				
Sex				.957
Male	50.9	51.2	51.0	
Female	49.1	48.8	49.0	
Race/ethnicity				.019
NH White	51.4	52.3	50.2	
Hispanic	25.1	24.0	25.9	
NH Black	11.8	12.8	13.6	
NH others	11.8	10.9	10.3	
Family structure				<.001
Two parents	77.4	73.9	69.8	
Single parent	18.1	21.2	24.7	
Other relations	4.5	4.8	5.5	
Primary household language				.520
English	86.2	86.4	85.4	
Non-English	13.8	13.6	14.6	
Number of children in the household				<.001
1 child	26.7	18.2	30.2	

2 children	39.5	40.9	38.5	
3 or more children	33.7	40.9	31.4	
Need characteristics				
Usual source of preventive care				<.001
No	7.4	8.4	10.6	
Have usual source of care	92.6	91.6	89.4	
Parent perceived child's health status				<.001
Excellent or very good	93.9	91.6	86.4	
Good	5.0	6.9	11.4	
Fair or poor	1.1	1.5	2.2	
Number of health condition				<.001
None	91.7	73.1	65.2	
One condition	5.1	13.5	16.7	
Two or more conditions	3.2	13.4	18.1	

Note: Total Sample size n = 75,558, reflecting a total weighted sample of N = 67,400,176. The table was created using the 2019 and 2021 NSCH data.

Outcome changes during 2019-2021

Table 3 characterizes our sample stratified by age group and year. From 2019 to 2021, the percent of children that did not have any preventive care visit increased across all age groups (from 10.2% to 13.6% among those aged 0-4, 16.7% to 23.6% among those aged 5-10 years, and 20.0% to 30.4% among those ages 11-17 years; Table 3).

Changes in Covariates during 2019-2021

From 2019 to 2021, the percentage of children having a usual source of preventive care dropped from 93.7% to 91.6% (p = .031) among those aged 0-4 years and from 90.5% to 88.3% (p = .033) among those aged 11-17 years, but stayed similar for those aged 5-10 years (Table 3).

Table 3. Sample characteristics by age group and year.

	Ages 0-4 years		**Ages 5-10 years**		**Ages 11-17 years**	
	2019 %	2021 %	2019 %	2021 %	2019 %	2021 %
Unweighted sample size	6301	15687	8457	14717	13223	17173
Weighted sample size	9125495	8875728	11342643	10961158	13674021	13421131
Proportion of sample	13.5	13.2	16.8	16.3	2.3	19.9

Outcome						
Preventive visits						
None	10.2	13.6	16.7	23.6	20.0	30.4
One or more visits	89.8	86.4	83.3	76.4	80.0	69.6
Covariates						
Enabling characteristics						
Income as FPL						
400% or above	31.8	33.8	31.0	33.5	32.0	31.2
139-399%	40.0	39.9	42.4	40.2	43.2	42.6
138% or below	28.2	26.3	26.7	26.3	24.8	26.2
Insurance type						
Uninsured	5.9	5.9	6.3	6.4	7.2	8.0
Public and private	4.7	3.7	5.3	4.1	4.3	4.3
Private only	58.4	59.3	58.1	58.9	61.7	59.0
Public only	31.0	31.1	30.3	30.7	26.9	28.8
Employment status						
No	9.2	8.1	8.6	7.9	1.3	9.9
At least one employed full or part time	90.8	91.9	91.4	92.1	89.7	9.1
Demographics						
Sex						
Male	50.8	51.0	51.1	51.4	50.9	51.1
Female	49.2	49.0	48.9	48.6	49.1	48.9
Race/ethnicity						
NH White	51.6	51.2	51.2	53.4	50.9	49.5
Hispanic	25.7	24.4	24.4	23.6	24.9	27.0
NH Black	11.5	12.1	13.0	12.6	13.9	13.2
NH others	11.3	12.3	11.4	10.4	10.3	10.3
Family structure						
Two parents	77.5	77.4	75.2	72.6	71.2	68.4
Single parent	17.3	18.9	19.6	22.9	23.1	26.3
Other relations	5.2	3.7	5.2	4.5	5.7	5.3
Primary household language						
English	86.8	85.6	86.6	86.2	86.8	84.0
Non-English	13.2	14.4	13.4	13.8	13.2	16.0
Number of children in the household						
1 child	26.4	27.1	19.6	16.7	30.9	29.5
2 children	39.1	40.0	39.0	42.8	38.6	38.3
3 or more children	34.5	32.9	41.4	40.5	30.5	32.2
Need characteristics						
Usual source of preventive care						
No	6.3	8.4	7.9	8.9	9.5	11.7
Have usual source of	93.7	91.6	92.1	91.1	90.5	88.3

care						
Parent perceived child's health status						
Excellent or very good	94.7	93.1	90.8	92.4	87.1	85.6
Good	4.7	5.4	7.6	6.2	10.8	12.0
Fair or poor	0.6	1.5	1.6	1.4	2.1	2.4
Number of health condition						
None	92.0	91.4	72.0	74.1	65.8	64.6
One condition	5.1	5.0	15.1	11.9	16.6	16.7
Two or more conditions	2.9	3.5	12.9	14.0	17.6	18.7

Note: Total sample size n = 75558, reflecting a total weighted sample of N = 67400176. All percents are weighted.

4.2 Regression Analyses

COVID-associated changes in preventive care visits

Unadjusted logistic model showed that the likelihood of any preventive visit was lower in 2021 (post-COVID) than in 2019 (pre-COVID) for children overall and across age groups (Table 4). The reductions of preventive visits across age groups persisted after controlling for all key covariates, including enabling characteristics, predisposing characteristics, and need characteristics. Overall, the post-COVID period (vs. pre-COVID) was associated with a reduction of 6.8 percentage points (ppt; 95% CI: 5.5-8.1) in the likelihood of a child having at least one preventive visit during the past 12 months (Table 5), which is equivalent to an 8.2% (6.8/83.4) relative reduction.

Table 4. Unadjusted logistic regressions by age group.

	Total		**Aged 0-4 Years**		**Aged 5-10 Years**		**Aged 11-17 Years**	
	Marginal Effect [95% CI]	***P* value**	**Marginal Effect [95% CI]**	***P* value**	**Marginal Effect [95% CI]**	***P* value**	**Marginal Effect [95% CI]**	***P* value**
Intercept	83.7 [82.7, 84.7]	<.001	89.8 [88.1, 91.5]	<.001	83.3 [81.5, 85.0]	<.001	80.0 [78.3, 81.7]	<.001
Year								
2019	Ref		Ref		Ref		Ref	

2021	-7.4 [-8.8, -6.0]	<.001	-3.4 [-5.6, -1.3]	.002	-6.8 [-9.3, -4.4]	<.001	-10.5 [-12.9, -8.0]	<.001

Note: Sample size n = 75,558 and the presented population size N = 67,400,176. Sample size for aged 0-4 years group n = 21988, for aged 5-10 years group n = 23174, for aged 11-17 years n = 30396. Due to data collection period, data from 2019 consist of time before COVID-19 and 2021 after COVID-19. Preventive visit was dichotomous, with one (1) being "at least one preventive visit during the past 12 months" and zero (0) being "no preventive visits during the past 12 months." The marginal effects indicate that compared to the Ref group (2019), the percentage points increase or decrease on the estimated proportion of participants completed at least one preventive visit during the past 12 months.

When stratified by age group, the model-adjusted reduction in the likelihood of having any preventive visits was 2.9 ppt (95% CI: 1.0-4.9, $p = .003$) among children aged 0-4, 6.3 ppt (95% CI: 4.0-8.5 $p < .001$) among those aged 5-10 years, and 9.7 ppt (95% CI: 7.5-11.9, $p < .001$) among adolescents aged 11-17 years (Table 5). These are equivalent to relative reductions of 3.2% (2.9/89.6), 7.6% (6.3/83.0), and 12.2% (9.7/79.7), respectively. The reductions were the largest in magnitude among adolescents.

Table 5. Adjusted logistic regressions by age group.

	Total (n = 75558)		**Aged 0-4 Years (n = 21988)**		**Aged 5-10 Years (n = 23174)**		**Aged 11-17 Years (n = 30396)**	
	Marginal Effect [95% CI]	**P**	**Marginal Effect [95% CI]**	**P**	**Marginal Effect [95% CI]**	**P**	**Marginal Effect [95% CI]**	**P**
Intercept	83.4 [82.5, 84.4]	<.001	89.6 [88.1, 91.1]	<.001	83.0 [81.4, 84.6]	<.001	79.7 [78.1, 81.2]	<.001
Independent Variable								
Year								
2019	Ref		Ref		Ref		Ref	
2021	-6.8 [-8.1, -5.5]	<.001	-2.9 [-4.9, -1.0]	.003	-6.3 [-8.5, -4.0]	<.001	-9.7 [-11.9, -7.5]	<.001
Covariates								
Enabling characteristics								
Income								
400% or above	Ref		Ref		Ref		Ref	
139-399%	-2.4 [-3.7, -1.1]	<.001	-2.2 [-4.2, -0.1]	.039	-2.3 [-4.6, -0.0]	.048	-2.9 [-5.0, -0.8]	.006
138% or below	-2.4 [-4.3, -0.4]	.017	-0.1 [-3.1, -2.8]	.920	-3.6 [-7.4, -0.2]	.061	-4.5 [-7.6,-1.4]	.004
Insurance type								
Uninsured	Ref		Ref		Ref		Ref	
Public and	17.0	<.001	13.1	<.001	22.5	<.001	14.8	<.001

Private	[12.9, 21.1]		[6.8, 19.5]		[14.2, 30.7]		[8.4, 21.2]	
Private only	14.1 [10.5, 17.6]	<.001	13.7 [8.3, 19.1]	<.001	18.6 [11.3, 25.9]	<.001	12.5 [7.3, 17.7]	<.001
Public only	16.0 [12.5, 19.5]	<.001	13.0 [7.6, 18.3]	<.001	20.3 [13.0, 27.6]	<.001	14.0 [8.9, 19.2]	<.001
Parental Education								
High school or less	Ref		Ref		Ref		Ref	
Some college	2.3 [0.4, 4.2]	.020	1.0 [-2.1, 4.1]	.510	1.9 [-1.5, 5.3]	.283	2.6 [-0.4, 5.7]	.087
College degree or higher	8.4 [6.5, 10.3]	<.001	4.8 [1.9, 7.6]	.001	7.5 [4.2, 10.9]	<.001	9.5 [6.4, 12.5]	<.001
Employment status								
No	Ref		Ref		Ref		Ref	
At least one parent employed full or part time	-0.3 [-2.5, 1.0]	.805	-1.9 [-4.6, 0.8]	.167	-2.8 [-6.5, 0.8]	.127	2.7 [-1.4, 6.9]	.191
Demographics								
Sex								
Male	Ref		Ref		Ref		Ref	
Female	0.4 [-0.8, 1.5]	.521	-0.9 [-2.6,0.9]	.316	0.1 [-1.9, 2.1]	.929	1.7 [-0.1, 3.6]	.071
Race/Ethnicity								
NH White	Ref		Ref		Ref		Ref	
Hispanic	-0.3 [-2.1, 1.4]	.690	-1.7 [-4.2, 0.8]	.173	0.9 [-2.0, 3.7]	.552	-0.6 [-3.8, 2.6]	.721
NH Black	0.5 [-1.3, 2.3]	.595	-1.1 [-3.9, 1.8]	.458	-0.3 [-3.6, 3.1]	.873	2.3 [-0.5, 5.2]	.107
NH others	-2.9 [-4.6, -1.2]	.001	-1.8 [-4.3, 0.6]	.148	-1.7 [-4.8, 1.4]	.283	-5.1 [-7.9, -2.3]	<.001
Family structure								
Two parents	Ref		Ref		Ref		Ref	
Single parent	-2.6 [-4.2, -1.0]	.002	0.4 [-1.9, 2.8]	.731	-4.0 [-7.1, -0.8]	.013	-1.9 [-4.1, -0.6]	.135
Other relations	-3.8 [-7.2, -0.4]	.031	-0.3 [-4.2, 3.7]	.899	-4.4 [-9.3, -0.5]	.081	-3.9 [-10.3, 2.5]	.229
Primary household language								
English	Ref		Ref		Ref		Ref	
Non-English	-2.1 [-4.4, -0.1]	.066	-4.3 [-7.6, -1.0]	.011	-2.4 [-6.5, 1.7]	.245	1.1 [-2.6, 4.8]	.559
Number of children in the household								
1	Ref		Ref		Ref		Ref	
2	1.1 [0.2, 2.4]	.094	-0.2 [-2.3, 1.8]	.835	0.4 [-2.3, 3.1]	.774	2.0 [-0.1, 4.0]	.066
3 or more	-0.6 [-2.1, 0.8]	.362	-0.7 [-3.0, 1.5]	.518	-1.5 [-4.4, 1.3]	.289	-0.7 [-3.1, 1.8]	.588
Need characteristics								
Usual source of preventive care								
No	Ref		Ref		Ref		Ref	
Have usual source of care	24.2 [20.6, 27.7]	<.001	19.3 [12.2, 26.3]	<.001	23.6 [17.7, 29.6]	<.001	28.6 [23.1, 34.0]	<.001
Parental perceived child's health								
Excellent or very good	Ref		Ref		Ref		Ref	

Good	1.1 [-1.2, 3.3]	.343	-1.2 [-5.6, 3.2]	.599	3.2 [-0.7, 7.2]	.106	1.9 [-1.5, 5.2]	.271
Fair or poor	2.5 [-3.5, 8.6]	.411	4.7 [-0.1, 9.3]	.045	-4.1 [-17.5, 9.3]	.547	4.5 [-4.3, 13.3]	.319
Health conditions								
None	Ref		Ref		Ref		Ref	
One condition	3.2 [1.4, 4.9]	<.001	3.3 [0.2, 6.4]	.038	6.1 [3.1, 9.0]	<.001	6.0 [3.5, 8.6]	<.001
Two or more conditions	4.2 [2.6, 5.7]	<.001	1.6 [-2.6, 5.8]	.454	6.7 [3.9, 9.5]	<.001	8.4 [6.1, 10.6]	<.001

Note: Sample size n = 115,178 and the presented population size N = 66,912,024. The marginal effects are the relative percentage point differences.

COVID-associated changes in preventive care visits by family income

When stratified by age group and family income, significant reductions in the likelihood of any preventive visit in the past year were observed across each subgroup. Among adolescents, the model-adjusted reduction in the likelihood of any preventive care visit was 4.4 ppt (95% CI: 1.8-7.1), 11.8 ppt (95% CI: 8.6-15.1), and 13.1 ppt (95% CI: 7.9-18.3) for family income ≥ 400% FPL, 139-399% FPL, and ≤138% FPL, respectively (Table 6). The COVID-associated reduction was significantly larger in adolescents with family income ≤138% FPL (p = .039) or 139-399% FPL (p = .007) as compared to adolescents with family income ≥ 400% FPL (Table 6 and Figure 4). Similar reductions were observed among those younger; yet, these reductions did not differ significantly across income groups.

Table 6. Adjusted COVID-associated reductions in preventive care visits from 2019 to 2021.

	Aged 0-4 Years		**Aged 5-10 Years**		**Aged 11-17 Years**	
	Marginal Effect [95% CI]	**Interaction (p value)**	**Marginal Effect [95% CI]**	**Interaction (p value)**	**Marginal Effect [95% CI]**	**Interaction (p value)**
≥ 400% FPL	-3.5*** [-5.5, -1.5]	Reference	-6.7*** [-9.7, -3.7]	Reference	-4.4*** [-7.1, -1.8]	Reference
139-399% FPL	-1.8 [-4.8, 1.3]	.240	-6.8*** [-10.2, -3.4]	.687	-11.8*** [-15.1, -8.6]	.007
≤ 138% FPL	-4.6* [-9.1, 0.0]	.561	-4.4 [-9.5, 0.7]	.243	-13.1*** [-18.3, -7.9]	.039

Note: * p<.05 ** p<.01 *** p<.001. Marginal effects were used to compare the predicted percentage of preventive care visits (2021 vs. 2019) within each age and income group. The p values indicate whether the differences in the predicted probability of preventive care visits differ by income, using 400% FPL as the reference group.

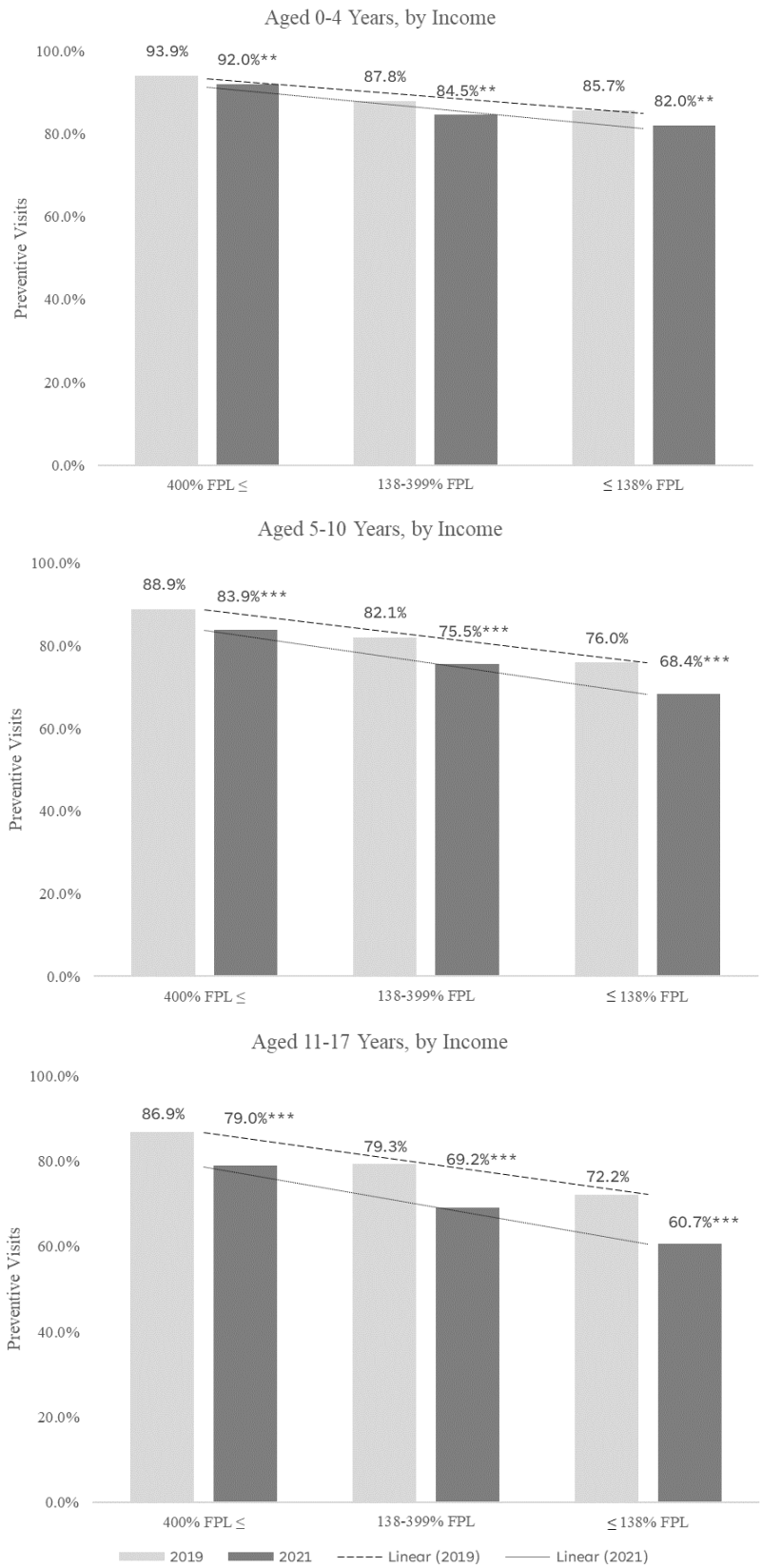

Figure 4. Model-adjusted likelihood of preventive care visits comparing 2021 to 2019, by age group and income.

Other predictors of preventive care visits

Compared to children who were uninsured, those publicly insured (marginal effect ME = 16.0 ppt; 95% CI: 12.5-19.5, $p < .001$), privately insured (ME = 14.1 ppt; 95% CI: 10.5-17.6, $p < .001$), and both (ME = 17.0 ppt; 95% CI: 12.9-21.1, $p < .001$) were more likely to have any preventive care visit (Table 5). Children with their parent/caregivers having a college degree or higher (ME = 8.4 ppt; 95% CI: 6.5-10.3, $p < .001$) (vs. high school or less) were more likely to have preventive visits. These findings persisted across all age groups. Children of all ages with a usual source of preventive care had a significantly higher probability of preventive care visits than those without a usual source of preventive care (ME=24.2 ppt among all children, $p < .001$; ME=19.3 ppt among those aged zero to four, $p < .001$; ME=23.6 ppt among those aged five to 10, $p < .001$; ME=28.6 ppt among those aged 11 to 17, $p < .001$). Furthermore, children ages 5-10 years and adolescents diagnosed with one health condition (ME=6.1 and 6.0 ppt, respectively), or two or more health conditions (ME=6.7 and 8.4 ppt, respectively) were more likely to complete the preventive visits than those who did not have any chronic conditions ($p <.001$).

Chapter 5 Discussion

5.1 Summary of Findings

This study found significant reductions in pediatric preventive care utilization across all age groups following the COVID-19 pandemic, using NSCH data in 2019 compared to 2021. Among children aged 0-4, 5-10, and 11-17, the relative reduction was 3.2%, 7.6%, and 12.2%, respectively. Our findings aligned with our first hypothesis and the literature to date: there were significant decreases in the probability of preventive care visits from 2019 to 2021 across all children's age groups.

To date, few studies have investigated the impact of COVID-19 on pediatric preventive care other than preventive vaccinations.[26,28,29] One five-year-trend study focusing on multiple health services utilization found reductions in pediatric medical preventive care, pediatric dental preventive care, and developmental screening from 2019 to 2020.[20] Another study estimated pediatric preventive visits using two months of data in 2021 and found similar reductions.[33] There is a lack of literature investigating the impact of COVID-19 on children's preventive healthcare services in the longer term. Our study adds to the current literature by comparing the period completely post-COVID (2021) with pre-COVID (2019) using a nationally representative sample. The affordability and accessibility of pediatric preventive services may have been changed during the year of 2020 due to the COVID-driven changes in health policy, AAP guidelines, and other environmental factors. Therefore, excluding data from 2020 provides a clear view of the changes in preventive care utilization influenced by COVID-19.

There are several possible explanations of the observed reductions in pediatric preventive visits during the COVID-19 pandemic. First, loss or change in health insurance status due to the caregivers' employment loss after the onset of the pandemic may reduce children's access to

preventive care. Second, patients without a usual source of preventive care and patients whose treating providers allowed limited appointment availability or was temporarily closed due to COVID were much less likely to access and complete preventive care.[33] Third, parents' concerns of their children being exposed to coronavirus at the healthcare provider's site may prevent preventive care visits. Fourth, some caregivers were carrying out double duties and had less time, given that their jobs shifted remotely while children were at home due to school being closed.[98] Moreover, as limited providers were available during the pandemic, some caregivers may face long distances to available providers, which is particularly challenging for parents with limited access to transportation.

Our age-stratification analysis also found that younger children were more likely to complete the pediatric preventive visits compared to older children. This trend persisted in the pre and post COVID-19 periods. Our interpretation was that children in younger age groups have more healthcare needs, such as developmental surveillance, hence required more frequent visits than the older group.[3] The intervals of the recommended preventive visits can range from once per two months in infancy to once per year in adolescence.[57] Therefore, it is not surprising that younger children were more likely to complete preventive care at least once during the past 12 months compared to older children. The variation in healthcare needs by age may also contribute to our research finding that the reduction in preventive care visits during the past 12 months was greater among adolescents than younger children during the pandemic.

We found that the COVID-associated reductions in pediatric preventive care were more prominent in low-income households than in high-income households among adolescents, which supports our second hypothesis. Although our income-stratified analyses reported statistically nonsignificant difference among the two younger groups, adolescents in lower-income

households (138% FPL and below, 139%-399% FPL) experienced a significantly larger drop in pediatric preventive care utilization than their richer counterparts (400% FPL and above). This may be partially explained by the differences in the frequency and types of pediatric preventive healthcare services that the AAP recommended for each age group.[3,6] Another potential explanation is that insurance coverage is affected by family income and parental employment status. Children who were uninsured were less likely to complete the preventive visits than those insured, and there was a significantly higher proportion of adolescents uninsured compared to other younger children. Although the PHE paused disenrollment of public health insurance such as Medicaid during 2020 and 2021 in response to the COVID-19 pandemic, research indicated that a proportion of families experiencing loss of insurance due to unemployment were not qualified for Medicaid and were unable to find new helath insurance. The additional uninsured adolescents may be the families that lost their employer sponsored insurance and were not able to find an alternative health care plan.[99,100] The interaction between family income and the post-COVID changes in pediatric preventive visits indicates the importance of future policies toward addressing the preventive healthcare needs of underserved adolescents.

Besides COVID, several other factors also significantly affect whether the children received pediatric preventive healthcare services. Children with their parents or caregivers being better educated were more likely to complete the preventive visits. This finding is consistent with the literature.[17,55,56] Having a usual source of preventive care had a significant impact on pediatric preventive care visits from pre to post COVID pandemic. During the COVID pandemic, caregivers may face challenges in care seeking, such as physician office closures and limited availability of healthcare providers;[33] yet, access to a usual source of care instead of relying on acute care is critical for children to ensure timely receipt of pediatric preventive care.

All children with more than two current and long-term health conditions were also found more likely to receive preventive care visits than those who did not have any chronic conditions, comparing 2021 to 2019. Our finding echoes the literature that children diagnosed with diseases or health conditions have higher needs for healthcare services than those without a health condition. Specifically, one study utilizing the Truven MarketScan Database from 2010 to 2014 found that most children covered by Medicaid and with medical complexity did not receive preventive healthcare, and those with fewer preventive visits had higher hospitalization rates.[101] Another population-based study in Hawaii with data between 1999 and 2006 found that time spent during preventive care visits among children with special needs was longer than those without special needs.[102] Additionally, children may also "grow out" of certain conditions, such as asthma and allergies, and their healthcare needs may decrease accordingly. Further research is needed to compare preventive care utilization between children with and without health conditions and investigate the variations among children with different conditions and the time since the first diagnosis.

5.2 Study Limitations

As with other survey-based research, this study is subject to nonresponse and recall bias. The NSCH collected data across states and employed oversampling strategies and survey weights to appropriately represent the entire population and utilized a computer-assisted survey approach to reduce non-response bias. Our results can still be generalizable to all children in the United States.

Because NSCH is an annually collected cross-sectional survey, our research design was pooled cross-sectional and should not be interpreted as causal. Yet, this research is intended to investigate the association between COVID-19 and visits, and how the association varies by age

group and family income.

Several unmeasured confounders may potentially lead to omitted variable bias, including urbanicity, geographic availability of providers, caregivers' ability to pay, and their health belief. Although urbanicity (being in the urban area) and providers' availability in the geographic area are leading away from the null, the state of residency can partially capture the variation, and there is less concern in them biasing the results. While parental education is used as the proxy for health belief, there is no proxy for the ability to pay.

Pediatric preventive care includes multiple domains of healthcare services, such as vaccination, physical body measures, behavioral screening, preventive medical care, preventive dental care, and counseling. This study did not assess the specific types of preventive care services due to a lack of data. Therefore, the results of this study can only represent a broader concept of receiving any preventive care. We suggest that future data collection include detailed items on the specific types of preventive care services.

5.3 Clinical and Policy Implications

Future health policy in the United States should help eliminate obstacles to pediatric preventive care visits and increase access to preventive healthcare for children during and beyond the COVID-19 pandemic. These may include increasing access to public healthcare resources, such as improving Medicaid coverage; promoting telemedicine for services that can be done virtually, such as primary care, behavioral screening, and mental healthcare;[103,104] and reducing structural barriers to increase family access to clinical services by increasing transportation, expanding clinic hours, and increasing internet access in rural areas. Furthermore, due to the end of PHE, all states are in progress of unwinding the continuous enrollment provision of Medicaid and CHIP programs.[105] Many families and children will face the potential

disenrollment of Medicaid and CHIP at the end of 2023,[106] which may have important consequences for children's access to preventive care. Timely updates in the utilization of pediatric preventive care visits beyond the COVID pandemic is critical during the rapid change.

5.4 Recommendations for Future Research

Future research assessing the impact of COVID-19 on pediatric preventive healthcare should consider several directions. First, we recommend the use of newer data to investigate the changes post and beyond the COVID-19 pandemic. Second, qualitative research is needed to evaluate perceptions of providers and caregivers on the barriers to accessing and delivering preventive services, and to make recommendations for strategies that can improve access to care. Third, we recommend that researchers explore the recovery period of preventive care visits, as the COVID-19 pandemic ends, such as the time that will take for preventive care visits to return to the pre-COVID level. Finally, future studies should address whether the COVID-associated reductions in pediatric preventive care and the recovery period differ by children's sociodemographic characteristics.

5.5 Conclusions

This study found that children of all ages had a decreased probability of pediatric preventive care visits post-COVID as compared to pre-COVID, and adolescents from low-income families experienced the most pronounced decline in preventive care receipt. More studies are needed to monitor the impact of the ongoing COVID-19 pandemic on care receipt, to investigate changes in pediatric preventive care utilization using qualitative approach, and to develop measurements of specific types of pediatric preventive healthcare services. This line of research helps enhance the literature by better understanding the barriers to pediatric preventive visits and healthcare disparities across sociodemographic subgroups. Future interventions and

policies supporting children's preventive healthcare utilization are critical to eliminate unmet needs and promote children's health and well-being.

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