Vaccine: X 15 (2023) 100406

Contents lists available at ScienceDirect

Vaccine: X

journal homepage: www.elsevier.com/locate/jvacx

COVID-19 vaccination in urban American Indian and Alaska Native children: Parental characteristics, beliefs and attitudes associated with vaccine acceptance

Ann Futterman Collier [a,*], Krista R. Schaefer [a], Azhar Uddin [b], Carolyn Noonan [b], Denise A. Dillard [a], Linda Son-Stone [c], Spero M. Manson [d], Dedra Buchwald [b], Richard MacLehose [e], CONCERTS Collaborative [1]

[a] Southcentral Foundation, Anchorage, AK, United States
[b] Institute for Research and Education to Advance Community Health, Elson S Floyd College of Medicine, Washington State University, United States
[c] First Nations Community Healthsource, Albuquerque, NM, United States
[d] Centers for American Indian and Alaska Native Health, University of Colorado Anschutz Medical Campus, United States
[e] Department of Epidemiology and Community Health, University of Minnesota, School of Public Health, United States

ARTICLE INFO

Keywords:
Alaska Native and American Indian people
COVID-19 vaccination
Children
Parents
Vaccine acceptance
Reasons for vaccine hesitancy

ABSTRACT

Background: Little is known about vaccination rates for American Indian and Alaska Native (AI/AN) parents and their children, or parental decisions in this regard. Improving vaccination rates is a serious concern due to the disproportionate incidence and morbidity of COVID-19 in AI/AN people.
Purpose: Our goal was to describe urban AI/AN parental attributes associated with COVID-19 vaccination of their children.
Methods: Survey participants (n = 572) were ≥18 years of age, had children ≥5 years of age, AI/AN, and seen at one of six urban health organizations serving primarily AI/AN people within the prior year. They were asked about gender, age, education, marital status, perceived stress, trauma history, whether they had received the COVID-19 vaccine, tested positive for COVID-19 in the past, and if their child was vaccinated. They were also asked about 16 vaccine hesitancy reasons.
Results: Parental vaccination rate was 82%, with 59% of their children vaccinated. Parents who vaccinated their children were older, had higher education, lower stress and trauma, and were more likely to be vaccinated compared to parents who did not vaccinate their children. Forty-two percent of parents indicated they would likely vaccinate their unvaccinated child in the future. Sixteen vaccine hesitancy reasons revealed four factors: distrust, inconvenience, lack of concern about the pandemic, and AI/AN concerns. Parents who had no plans to vaccinate their children had the highest vaccine distrust and lack of concern about the pandemic. Parents with greater vaccine distrust and AI/AN specific concern reported significantly greater trauma history and higher levels of education.
Conclusion: Even though vaccination rates for AI/AN parents and children are high, the consequences of COVID-19 for AI/AN people are more severe than for other US populations. Providers should use trauma-informed, trust-building and culturally competent communication when discussing choices about vaccination with AI/AN parents.

* Corresponding author at: Colorado School of Public Health, University of Colorado Anschutz, 13055 E. 17th Avenue, Aurora, CO 80045, United States.
E-mail address: Ann.D.Collier@cuanschutz.edu (A.F. Collier).

[1] CONCERTS Collaborative: Dedra Buchwald, Richard MacLehose, Spero M. Manson, Odile Madesclaire, Katie Nelson, Austin Henderson, Talia Quandelacey, Carolyn Noonan, Southcentral Foundation, Denver Indian Health and Family Services, Indian Health Board of Minneapolis, First Nations Community Healthsource, Hunter Health Clinic, and the Urban Indian Center of Salt Lake City.

https://doi.org/10.1016/j.jvacx.2023.100406
Received 6 May 2023; Received in revised form 7 November 2023; Accepted 12 November 2023
Available online 14 November 2023

Introduction

In the United States (US), 1–5 % of all diagnosed COVID-19 cases occurred among youth 19 years of age or younger. [1] Systematic reviews found that children generally experience less severe symptoms of disease or are asymptomatically infected; susceptibility to infection and virus transmissibility remains unclear. [2] However, as many as 7 % of infected children experience multisystem inflammatory syndrome, a post-acute sequelae of SARS-CoV-2 infection. [3] Widespread vaccination is the best strategy to control COVID-19 morbidity and mortality in all age groups. The US initially had the lowest vaccine acceptance rates of high income countries in the world [4] in the completion of COVID-19 primary series and updated booster doses, albeit with wide regional variability. [5–7]

COVID-19-associated morbidity and mortality are urgent concerns for American Indian and Alaska Native (AI/AN) communities across the US. Compared to non-Hispanic Whites (NHW), AI/AN people have higher incidence of COVID-19 cases (5,445 vs. 9,256 per 100,000, respectively) and greater COVID-19-associated mortality (137 vs. 220 per 100,000, respectively). [8–10] Although AI/AN people initially led the United States in rates of first-dose and full vaccination, over time COVID-19 vaccination and booster rates have been reported as lower, when compared to other racial and ethnic minority groups. [11–12] While these figures may be inaccurate due to poor reporting of COVID-19 data for AI/AN people, there is still cause for concern and the need to better understand attitudes and beliefs associated with vaccine acceptance in adults and children. [13] In one study, AI/AN parents expressed more willingness to have their children vaccinated then Non-Hispanic White or Black parents. [14]

Little is known about the factors contributing to COVID-19 vaccine hesitancy among AI/AN parents. [14] Vaccine hesitancy has been defined by the World Health Organization (WHO) Strategic Advisory Group of Experts (SAGE) as "delay in acceptance or refusal of vaccines despite availability of vaccine services." [15] People can delay, be reluctant but still accept, or refuse vaccines. [15] Many factors contribute to vaccine hesitancy, including practical, psychological, sociocultural, political, and economic factors. Parents have expressed concern about childhood vaccinations because of misinformation about the safety and utility of them including overtaxing a child's immune system, vaccines causing autism or other neurodevelopmental outcomes, and ideas that vaccines contain other contaminates. [16–17]

Parents play a critical role in the vaccination of their children against COVID-19. Studies indicate that 49 %-60 % of US parents have vaccinated or intended to vaccinate their children against COVID-19; the rest were either unsure or indicated they would decline vaccination. [18–23] Reasons for parental willingness to vaccinate their children include protecting them, their families, and others. [23] Parents who are more likely to have their children vaccinated are themselves more willing to be vaccinated, [20–22,24–26] are older, [20–21] work in healthcare, [25] are fathers, [20,27] have more education, [20,23,28–29] believe in social distancing, [20] and have positive views of the COVID-19 vaccine. [30] Parents who do not vaccinate their children with a COVID-19 vaccination typically think it is unnecessary to protect the child from infection or that s/he is at lower risk of severe disease. [26] Other parents voice concerns about vaccine side-effects, safety, efficacy, and question the benefits for their children. [18,23–24,26,31–33] Parental history of trauma [34] and distress [35] may also serve as additional barriers to COVID-19 vaccination.

The US lacks systematic national data about AI/AN people. [13,36–37] This is particularly true for urban AI/AN people, 70 % of whom live outside of tribal statistical areas. [38] Seeking to fill this gap in our knowledge, we first surveyed and described urban AI/AN parental attributes (demographic, psychosocial, and health factors) associated with COVID-19 vaccination of their children. We then examined key reasons urban AI/AN parents were hesitant to vaccinate their children.

Methods

Community Organizations for Natives: COVID-19 Epidemiology, Research, Testing, and Services (CONCERTS) was designed to identify and reduce barriers to COVID-19 testing and vaccination among urban AI/AN people and to address health disparities related to COVID-19. Toward this end, we created and implemented a cross-sectional survey in partnership with six health organizations serving primarily AI/AN people in urban settings to identify barriers, facilitators, attitudes, and factors related to COVID-19 testing and vaccination. The urban areas served by the tribal healthcare organizations participating in CONCERTS are Albuquerque, NM; Pheonix, AZ; Anchorage, AK; Denver, CO; Minneapolis-St. Paul, MN; Wichita, KS. The active patient populations of these programs ranged from 1,269 to 25,043 unique patients seen in 2019. While not fully representative of the diversity of AI/AN peoples and experiences, the CONCERTS participants constitute the most comprehensive and geographically inclusive sample of urban AI/AN populations to be studied in regard to their COVID-19 experience.

Study population

Data were collected and managed using REDCap electronic data capture tools hosted at Washington State University. REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data acquisition and reporting. [39] Patients eligible for inclusion in the study were seen at any of the six primary care clinics operated by these organizations during the year prior to the survey, were 18 years or older, self-identified as AI/AN, and were not diagnosed with dementia or other serious cognitive issues (ICD-10 codes F01-04, G30, or G31). To ensure we enrolled enough older adults at highest risk of COVID-19, we stratified sampling by age (18–54 vs. 55 and over).

Each clinic generated a list of eligible patients from its electronic health records (EHRs) and randomly sampled patients from both age groups. These patients were invited to participate by their respective clinics using a multi-pronged recruitment strategy. Clinic patients with an email address in their respective organization's EHRs were sent an invitation to participate in CONCERTS together with a link to an online REDCap survey. Patients without an email address were mailed invitations to participate. Patients received up to 4 emails or phone call reminders over a 14-day period. Our goal was to enroll up to 150 patient-participants per urban area. If this sample size was not achieved through the first round of emails, letters, and phone calls, we selected a new random sample of eligible patients from the EHR of the clinic in question.

Participants were enrolled from January to May 2022 and were compensated $100 for their time and effort. The survey timeframe aligned with the Federal Drug Association's Emergency Use Authorization for COVID-19 vaccinations from children $\geq$ 5 years of age for Pfizer, which was approved in October 2021. The Moderna vaccine was not approved for children $\geq$ 5 years of age until June 2022, after the survey collection was completed.

This study was approved by the Washington State University IRB (#18590), the Alaska Area Institutional Review Board (#2020–11-044), and Tribal research review committees at Southcentral Foundation (SCF) and the Alaska Native Tribal Health Consortium. Tribal approval was also obtained for dissemination.

Measures

The CONCERTS patient survey collected comprehensive information from each person. Survey questions were developed guided by the NIH RADX-UP Common Data Elements and PhenX Toolkit. [40] For the current study, we included the following questions: identification as a parent of a child $\geq$ 5 years of age; gender, age, education, and marital status; perceived stress and history of trauma; whether they or their

child had received the COVID-19 vaccine; whether they had tested positive for COVID in the past; and parental reasons for reluctance to have their children vaccinated.

The stress variable included four items from the Perceived Stress Scale [41](PSS), rated from "0″ (none) to "4" (very often), and was treated as a summative variable ranging from 0 to 16. The trauma history variable was a summary of four items from a PTSD questionnaire [42] wherein positive (for trauma) was identified as PTSD score ≥ 3. [42]

Child vaccination status was captured as "yes" or "no." If a child was vaccinated, parents were asked if they were hesitant before getting their child vaccinated. No definition for vaccine hesitancy was provided to parents. If a child was not vaccinated, parents were asked how likely they were to subsequently get their child(ren) vaccinated for COVID-19. We created an outcome variable for child vaccination status and parental intent to vaccinate with four levels: child vaccinated with no parental hesitancy; child vaccinated with parental hesitancy; child not vaccinated but parent likely to vaccinate their child; child not vaccinated and parent unlikely to vaccinate their child.

Parents were asked about reasons they were hesitant to vaccinate their child for COVID-19 if they did not vaccinate their child, or, if they had vaccinated their child but were initially hesitant. They were provided with a total of 16 different statements to rate and asked to indicate if the reason was a major, minor, or not a reason that they were hesitant. Eleven of the reasons were based on the WHO SAGE working group reasons [43] and included the following: safety risk, lack of trust of public health officials, don't trust pharmaceutical or drug companies, vaccine will not prevent infection with new strains, too expensive to get the vaccine, too difficult to find a place to get vaccine, believes not at risk for serious COVID-19, do not think pandemic is as serious as public officials think, too late in pandemic to make it worthwhile, can get medication if gets COVID-19, and already had COVID-19. Based on the investigators' clinical and research experiences, i.e., with both pilot-testing and clinical observations with AI/AN people, five additional items were added. These included: worry about revealing personal information to the government, worry that AI/AN people will be used as guinea pigs for COVID-19 vaccine, belief that the COVID-19 vaccine was not made for AI/AN people, belief that they (respondents) were allergic to vaccines, and dislike of needles. For each of the 16 reasons, participants indicated if it was a major reason, minor reason, or not a reason. These responses were then assigned values of 3 (major), 2 (minor), and 1 (not a reason).

Statistical analysis

We calculated descriptive statistics (e.g., percentage, mean, standard deviation) for the AI/AN parents who answered the survey and had children ages 5 and older with regard to parental demographic characteristics, parental psychosocial characteristics, and parental COVID-19 experiences. Descriptive statistics were stratified by child vaccination status and parental intent to vaccinate: namely, 1) child vaccinated with no parental hesitancy; 2) child vaccinated with parental hesitancy; 3) child not vaccinated but parents likely to vaccinate their child, and 4) child not vaccinated and parents unlikely to vaccinate their child. We examined differences in parental demographic characteristics, parental psychosocial characteristics and parental COVID-19 experiences across the four child vaccination status and parental intent to vaccinate. All analyses used inverse probability weights to account for nonresponse according to age and sex as well as to account for our sampling design. Weights were scaled so that each of the six participating healthcare organizations contributed equally to the final analyses.

Principal component analysis (PCA) was applied to the 16 vaccine hesitancy reasons for parents who either did not vaccinate their child or for parents who had vaccinated their child but were initially hesitant. PCA was done to ensure the items created for each of the four hesitancy factors (distrust, inconvenience, lack of concern, AI/AN concerns) were statistically consistent and distinct. The resulting factors were checked for internal reliability with Cronbach's alpha. We next computed mean scores for each person by each factor, and employed ANOVA tests to examine group-wise differences across these factors for each child vaccination status groups, adopting a p-value of < 0.05 to signify a meaningful difference between groups.

Finally, we used ordinary least square (OLS) regression to examine the associations among each of the four hesitancy factors (the dependent variables in four separate models), the demographic characteristics, psychosocial variables, and COVID-19 experiences, among parents who were hesitant to vaccinate their children. For the independent variables in each of the models, we created dummy variables to assign a value of 1 if: the respondent was female, college educated, married, positive history of trauma, had COVID-19 illness, and was vaccinated against COVID-19. Otherwise, the respondent was assigned a value of 0. Age and stress levels were modeled as continuous variables. In all models, we accounted for differences across the six healthcare organizations by creating dummy variables. Results are presented as the mean difference in hesitancy factors between levels of the independent variables listed above. All analyses were conducted using Stata 17.

Results

Of 7,832 eligible patients contacted for this study, 1,450 (19 %) participants were enrolled and completed the survey. Of those, five hundred and seventy-two urban AI/AN parents completed the cross-sectional survey between January to May 2022 and had children ≥ 5 years of age. Eighty-two percent of parents who answered the questions were vaccinated against COVID-19. Fifty-nine percent of parents had vaccinated their child. Of those who had a child who was unvaccinated, almost half (42 %) indicated they would be likely to vaccinate their child in the future.

Demographics

Table 1 presents parental demographic characteristics, parental psychosocial characteristics, and parental COVID-19 experiences for all parents, stratified by child vaccination status and parental intent to vaccinate. We compared the mean for continuous variables (age, perceived stress scale) and percentages for categorical variables (gender respondent, married, college educated, history of trauma, perceived COVID test, and received COVID vaccine) across four groups using Analysis of Variance (ANOVA) and Pearson Chi-squared test respectively. Across the four groups, there were significant differences in parental age, percentages of parents with a college education, perceived stress levels, and trauma history. In particular, parents of vaccinated children were older and, more likely to be college educated than the other groups. Parents of vaccinated children with no parental hesitancy had the lowest perceived stress while parents of unvaccinated children were unlikely to vaccinate in the future and were more likely to have a history of trauma than the other groups. In addition, there were significant differences across the four groups for parental receipt of COVID-19 vaccination. In particular, parents of vaccinated children were most likely to be vaccinated.

Principal component analysis

Initially, the factorability of the 16 vaccination hesitancy items was examined with the Kaiser-Meyer-Olkin measure of sampling adequacy; this was 0.88, higher than the commonly recommended value of 0.8 that indicates sampling adequacy. Initial eigen values indicated that the first four components explained 18 %, 17 %, 16 % and 12 % of the variance, respectively. The additional 12 components had eigen values below 0.98. The four-factor solution, which explained 62.8 % of the variance, was preferred because it had previous theoretical support, [43] a 'leveling off' of eigen values on the scree plot after four factors, an

Table 1
Distribution of demographic, psychosocial and COVID-19 experiences in AI/AN parents of children ages ≥ 5 years of age, stratified by child vaccination status and parental intent to vaccinate.

		Child Vaccinated		Child not Vaccinated		
		Child vaccinated, no parental hesitancy (n = 248)	Child vaccinated, parent hesitant (n = 91)	Child not vaccinated, parent likely to (n = 97)	Child not vaccinated, parent unlikely to (n = 136)	
Variables	Total					p-value[1]
Parent Demographics						
Age in years (mean, CI[2])	43.7 [42.8, 44.6]	48.3 [46.9, 49.7]	43.0 [41.2, 44.8]	39.3 [37.3, 41.3]	39.2 [37.7, 40.7]	≤0.01
Gender Respondent	430 (66.5 %)	175 (63.3 %)	73 (73.8 %)	78 (75.8 %)	99 (61.5 %)	≤0.1
Married	199 (34.4 %)	95 (37.8 %) (N	32 (34.7 %)	27 (31.2 %)	42 (30.3 %)	0.55
College educated	149 (25.1 %)	83 (32.3 %)	28 (28.5 %)	16 (15.5 %)	22 (16.9 %)	≤0.01
Parent Psychosocial Characteristics						
Perceived Stress Scale (mean, CI[2])	6.4 [6.1, 6.7]	5.89 [5.5, 6.3]	7.12 [6.5, 7.8]	6.4 (3.57) [5.7, 7.1]	6.9 (3.54) [6.3, 7.5]	0.02
History of Trauma	302 (51.1 %)	118 (45.0 %)	44 (44.7 %)	52 (48.2 %)	87 (67.6 %)	≤0.01
Parent COVID experiences						
Positive COVID test	222 (37.9 %)	91 (36.2 %)	36 (37.2 %)	37 (28.2 %)	57 (41.1 %)	0.86
Received COVID vaccine	468 (81.9 %)	243 (99.1 %)	83 (93.0 %)	81 (82.9 %)	56 (44.3 %)	≤0.01

[1] P-values were derived using ANOVA for continuous variables (age, perceived stress scale) and Pearson Chi-squared test for categorical variables (gender respondent, married, college educated, history of trauma, positive COVID test, received COVID vaccine).
[2] 95% confidence interval.

insufficient number of primary loadings, and difficulty of interpreting the fifth and subsequent factors. There were no differences between the four factor varimax and oblique solution data outpouts. We decided to present the oblique rotation for the final solution because of correlations between the factors.

Of the 16 items, six items were eliminated because they did not contribute to the four-component structure and failed to meet the minimum criterion of a primary factor loading of 0.4 or above and no cross-loadings of 0.3 or above. These items are listed in the footnote of Table 2. Themes proposed by the SAGE working group [43] suited the extracted factors but naming was modified to best describe our sub-groups: distrust, lack of concern, inconvenience. One new factor was identified from additional items added to represent possible concerns for AI/AN people; this was called AI/AN specific concerns and included the following items: "I am worried that AI/AN people will be used as guinea pigs for the COVID-19 vaccine"; "the COVID-19 vaccine is not specifically made for AI/AN people"; "I don't like needles". The principal component loading matrix for this final solution is presented in Table 2.

Internal consistency of each of the items on the four scales was then examined using Cronbach's alpha. The alphas were acceptable: 0.84 for distrust (3 items), 0.69 for lack of concern (2 items), 0.79 for inconvenience (2 items), and 0.65 for AI/AN specific issue (3 items). Composite scores were then created for each of the four factors, based on the mean of the individual hesitancy items that loaded in the hesitancy component. Higher scores indicated greater endorsement of this vaccination hesitancy reason. Skewness and kurtosis of each scale were well within a tolerable range for assuming a normal distribution and examination of the histograms suggested the distributions looked approximately normal. Although an oblique rotation was used, only small correlations between each of the composite scores existed.

Associations with vaccine hesitancy reasons

As displayed in Table 3, we examined the vaccination hesitancy factors in parents who did not vaccinate their child and in parents who

Table 2
Principle component analysis for reasons parents were hesitant to vaccinate their child.[1]

	Rotated Component
Distrust	
I was concerned about safety risks from the COVID-19 vaccine.	0.462
I didn't trust public health officials to provide reliable information about the safety of the COVID-19 vaccine for children.	0.549
I didn't trust pharmaceutical or drug companies that make the COVID-19 vaccine to provide reliable information about its safety.	0.560
Lack of concern	
My child is not at risk of getting a serious case of COVID-19.	0.458
I did not think the pandemic was as serious as public officials thought it was.	0.517
Inconvenience	
It would be too expensive for me to get the COVID-19 vaccine for my child.	0.560
It was too difficult to get to a place where I could get my child vaccinated for COVID-19.	0.560
American Indian/Alaska Native Specific Concerns	
I was worried that American Indian and Alaska Native people will be used as guinea pigs for the COVID-19 vaccine.	0.521
The COVID-19 vaccine was not specifically made for American Indian and Alaska Native people	0.469
My child doesn't like needles.	0.590

Note: Only items that loaded (0.4 or higher) on a component are displayed in Table 2. The additional 6 items that did not load were: "I did not think the vaccine will prevent infection by COVID-19; I was worried to reveal personal information to the government in order to get them vaccinated for COVID-19; it will be too late in the pandemic to make getting vaccinated for COVID-19 worthwhile; if my child gets COVID-19, they could get medication to treat it; they already had COVID-19; my child is allergic to vaccines."
[1] Includes parents who vaccinated their child(ren) and were initially hesitant *plus* parents who did not vaccinate their child(ren).

Table 3
Vaccine hesitancy reasons in all parents who were hesitant to vaccinate their child.

	Total (All parents who were hesitant) n = 324 Mean (*sd*)	Child vaccinated, parent was hesitant n = 91 Mean (*sd*)	Child not vaccinated, parent likely to n = 97 Mean (*sd*)	Child not vaccinated, parent unlikely to n = 136 Mean (*sd*)	p-value[1]
Distrust	2.09 (0.75)	2.20 (0.66)	1.66 (0.71)	2.29 (0.72)	≤ 0.01
Lack of concern	1.44 (0.61)	1.34 (0.59)	1.20 (0.38)	1.64 (0.68)	≤ 0.01
Inconvenience	1.17 (0.41)	1.18 (0.42)	1.22 (0.43)	1.13 (0.39)	0.29
AI/AN specific	1.51 (0.59)	1.43 (0.50)	1.43 (0.58)	1.62 (0.64)	0.09

Note: [1]P-values were derived using ANOVA for continuous variables. Mean values for each type of hesitancy, ranging from 1 to 3, where higher scores indicate greater use of the vaccination hesitancy reason.

had vaccinated their child but were initially hesitant. Distrust of the vaccine was the strongest hesitancy factor (mean = 2.09), followed by AI/AN specific hesitancies (1.51), then lack of concern about the pandemic and inconvenience (mean = 1.44 and 1.17, respectively). There were differences across these groups for two hesitancy reasons: distrust in the safety of the vaccine and lack of concern about the seriousness of the pandemic. Parents who vaccinated their child but were hesitant reported high distrust of the vaccine's safety (mean = 2.20). Parents who reported they would never vaccinate their child also reported high distrust (mean = 2.29), lack of concern about the seriousness of the pandemic (mean = 1.64), and reported more AI/AN specific issues (mean = 1.62) associated with why they would not vaccinate their child.

We next considered how parental demographic characteristics, parental psychosocial characteristics and parental COVID-19 experiences may be associated with each of the four vaccine hesitancy factors among parents that expressed hesitancy (Table 4). Again, this included parents who did not vaccinate their child and also parents who did, but were initially hesitant. From the regression results, we found that higher parental education (beta = 0.25), greater perceived stress (beta = 0.03), and higher history of trauma (beta = 0.26) were each associated with increased distrust in the COVID-19 vaccination for their child. In other words, parents with these characteristics reported greater distrust in the safety of the vaccine and therefore were hesitant to vaccinate their children. This did not necessarily impact their child's vaccination status. The coefficient for parental vaccination (beta = -0.27) was negative and significant, suggesting that vaccinated parents were less likely to report distrust as a hesitancy factor compared to unvaccinated parents. No important associations were observed between lack of concern and inconvenience and parental characteristics. An increase in parental experience of trauma was also associated with an increase in AI/AN specific concerns (beta = 0.28).

Table 4
Coefficient for the regression of the hesitancy factor by parent demographic, psychosocial and COVID-19 experiences in parents who were hesitant to vaccinate their child.

Variables	Distrust	Lack of Concern	Inconvenience	AI/AN Specific Concerns
Parent Demographics				
Age in years	0.03 (−0.07, 0.12)	−0.03 (−0.12, 0.06)	−0.02 (−0.07, 0.03)	−0.00 (−0.08, 0.07)
Female	0.12 (−0.10, 0.34)	−0.05 (−0.23, 0.13)	−0.03 (−0.14, 0.08)	0.07 (−0.11, 0.25)
Married	−0.15 (−0.35, 0.05)	0.02 (−0.15, 0.19)	−0.02 (−0.11, 0.07)	−0.09 (−0.26, 0.09)
College educated	0.25** (0.06, 0.44)	−0.01 (−0.21, 0.19)	−0.08 (−0.17, 0.02)	0.04 (−0.14, 0.21)
Parent Psychosocial Characteristics				
Perceived Stress Scale	0.03* (0.00, 0.06)	0.00 (−0.02, 0.03)	0.01 (−0.01, 0.03)	0.01 (−0.01, 0.03)
Trauma history	0.26** (0.06, 0.45)	0.08 (−0.07, 0.23)	0.03 (−0.06, 0.13)	0.28** (0.10, 0.46)
Parent COVID-19 Experiences				
Positive COVID test	−0.02 (−0.22, 0.18)	−0.00 (−0.17, 0.17)	−0.08 (−0.18, 0.03)	−0.13 (−0.29, 0.03)
Received COVID vaccine	−0.27** (−0.46, −0.07)	−0.09 (−0.27, 0.08)	0.00 (−0.10, 0.11)	−0.07 (−0.24, 0.10)

Note: * = $p < 0.05$.
** = $p < 0.01$.

Discussion

Overall, AI/AN parents were vaccinated and had their children vaccinated at rates consistent with the general rates of COVID-19 vaccination reported in the US population. [19,44–45] It is important to recognize that even though AI/AN vaccination rates are similar to the general US population, the incidence and morbidity of COVID-19 among AI/AN people are higher. Also consistent with the general literature, AI/AN parents who vaccinated their children were older, [20–21] experienced less stress, [35,46] reported less trauma, [34,46] had higher education, [20,23,28–29] and were more likely to be vaccinated themselves. [20–22,24–26] No differences were observed for COVID-19 childhood vaccination rates by gender or parental history of previous exposure to the virus.

Among parents who had not yet vaccinated their children, 42 % said they may be willing to do so in the future; 58 % were not willing to vaccinate their children. At the time of this study, childhood COVID-19 vaccines (Pfizer only) had been available for children 5–11 years old for three to seven months; it is possible parents of children in this age range intended to vaccinate their children but had not yet had the chance to do so. For those who reported hesitancy or had not vaccinated their children, the primary reasons were summarized as: a distrust in the COVID-19 vaccine, lack of concern about the pandemic, inconvenience in obtaining the vaccine, and AI/AN-specific concerns about the vaccine for their community. Across these four reasons for parental vaccination hesitancy, meaningful differences emerged with respect to distrust and lack of concern: parents who had no plans to vaccinate their children had the highest scores for both distrust in the vaccine and lack of concern about the seriousness of the pandemic. AI/AN people may

mistrust vaccines, researchers, and medical providers more than other populations that experience health disparities. [47–48] Many AI/AN people have experienced historical trauma, adverse childhood and adult experiences, institutional and interpersonal racism, and oppression, all associated with the long-term effects of colonialization. [48] It is critical for investigators, providers and health educators to be sensitive to these issues and prioritize establishing meaningful relationships and trust with their patients when discussing vaccinations and potential infection with COVID-19.

AI/AN parents who expressed distrust in the COVID-19 vaccine for their children were more likely to be unvaccinated, have a history of trauma, and, unexpededly, had higher educational attainment. It is unclear why higher education was associated with distrust in the COVID-19 vaccination when our general findings showed that parents who vaccinated their children had higher education levels. We postulated that the association with higher education and distrust in the hesitant subsample (both parents who did and did not vaccinate their child) was driven by parents whose child was vaccinated but they were initially hesitant. They made up almost 50 % of those who were hesitant and had a college education. Though counterintuitive, higher education is associated with what we surmiss as a healthy distrust in the COVID-19 vaccination and the evolving media communication about it, not with unvaccinated children. Some studies in the US have identified higher education as a deterrent to immunization. [49–50] AI/AN parents with higher education may be more likely to know about the history of what has happened to AI/AN people, e.g., sterilization without consent, and be less likely to trust providers, drug companies, and healthcare systems. The source of educational disparities in AI/AN people are multifold and include higher teacher turnover in tribal schools and fewer opportunities that prepare students for college and advanced placement classes. [51–53] Historically, boarding school educational practices and policies in the US were used to colonize AI/AN peoples through suppression of languages and cultural practices, and sometimes through emotional, verbal, physical and sexual abuse. Thus, even though higher education is lower in AI/AN people in general, it is simultaneously associated with higher vaccination rates unless distrust in the vaccine is strong, whereby higher education is then associated with lower child vaccination rates.

We found that AI/AN parents who have experienced greater stress and trauma report greater hesitancy to vaccinate their children. Based on the surveys used in the current study, the nuances of stress, e.g., acute, chronic, situational, and a more comprehensive understanding of generational trauma, abuse and neglect, were not evaluated. However, significant stress and trauma have been found to be associated with adult vaccine hesitancy in AI/AN adults. [46] To be responsive to trauma, providers and healthcare professionals should rely on a trauma-informed approach during their communication. [54–55] This involves grounding interventions in local AI/AN knowledge, activities, and communities, ensuring a culturally competent workforce that builds trust, reduces re-traumatization, and respects confidentiality and choice, supporting healthcare workers in using trauma-informed approaches, and responding to people in contexts that center on families, engaged elders, and community ownership. [54] Providers need to be aware about the risk of re-traumatization during discussions and offer respect for confidentiality and choice. [54]

For a subgroup of the participants, AI/AN concerns about the vaccine were notable. People were concerned that they would be used as “guinea pigs” for the COVID-19 vaccine; that the COVID-19 vaccine was not specifically made for AI/AN people; and expressed a dislike for needles. It is unclear why dislike of needles grouped with the other two AI/AN specific concerns. Children who fear needles tend to remain unvaccinated, placing them at a greater risk of disease. [56] Fear of needles is prevalent in children (e.g., 30 to 50 % [57]) but decreases as they age into adulthood (e.g., 3.5 % to 26 %[58,59]). Needle phobias have deterred COVID-19 vaccination in as many as 10 % of adults who express vaccine hesitancy. [59] A dislike or fear of medical procedures could contribute to reluctance in AI/AN parents and their children to accept vaccination, possibly reflecting fears associated with prior immunizations and blood/biological specimen use concerns. [58]

Strengths and limitations

There are several strengths associated with our study. First, the strong academic and program partnerships with tribal health organizations, informed the survey construction and sampling. Second, these partnerships substantially enhanced the interpretation, dissemination, and translation of findings into practice.

Regarding limitations, we could not determine whether parental decisions to vaccinate their children against COVID-19 depended on the child’s age. The survey did not ask about children’s ages, nor about vaccine hesitancy by age. For example, based on vaccination trends in the US, parents may express different degrees of confidence in the vaccine for younger children, compared to older children. [60] We did not provide definitions for “hesitancy” when asking parents about their decisions to vaccinate their children. Our survey items relied on the parent’s subjective definition of the term. As a result, we cannot evaluate the complexity associated with parental decision making around vaccines. We also did not ask parents to explain reasons for changing their minds about vaccination. Only three AI/AN specific concerns were statistically cohesive based on our principal component analysis. It is possible there were additional AI/AN concerns that we did not include in this study. A multi-methods approach that draws upon qualitative investigative procedures to discover locally meaningful experiences or concerns promises to enrich measures of this nature. Lastly, the study’s cross-sectional design constrained our ability to capture the influence of illness severity and vaccine concerns that may have changed over the period in question.

Conclusion

Children with COVID-19 are susceptible to multisystem inflammatory syndrome, post-acute sequelae of SARS-CoV-2 infection [3], and exhibit mortality rates that are higher than other infections like influenza. [61] Therefore, it is critically important to understand the factors that underlie parental intent to vaccinate their children. Children living in urban AI/AN communities were vaccinated at the high end of COVID-19 vaccination rates in the general population. The reasons associated with attitudes and beliefs about vaccines are meaningful and require further exploration. A better understanding of the reasons for COVID-19 vaccine acceptance promises to inform direct care as well as the design of interventions to increase child vaccination rates, including among AI/AN people.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Research reported in this publication was supported by the National Institute Of Minority Health And Health Disparities of the National Institutes of Health under Award Number U54MD011240 and the National Institute Of Allergy And Infectious Disease of the National Institutes of Health under Award Number R01AI170946. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Data availability

The authors do not have permission to share data.

References

[1] Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. Acta Paediatr 2020;109(6):1088–95. https://doi.org/10.1111/apa.15270. In eng.

[2] Gaythorpe KAM, Bhatia S, Mangal T, et al. Children's role in the COVID-19 pandemic: a systematic review of early surveillance data on susceptibility, severity, and transmissibility. Sci Rep 2021;11(1):13903. https://doi.org/10.1038/s41598-021-92500-9.

[3] Rhedin S, Lundholm C, Horne A, et al. Risk factors for multisystem inflammatory syndrome in children–A population-based cohort study of over 2 million children. The Lancet Regional Health-Europe 2022::100443.

[4] Sallam M. COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates. Vaccines 2021;9(2):160. https://doi.org/10.3390/vaccines9020160.

[5] Lin C, Tu P, Beitsch LM. Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review. Vaccines 2020;9(1):16. https://doi.org/10.3390/vaccines9010016.

[6] Shah A, Seervai S, Schneider E. How can the US catch up with other countries on COVID-19 vaccination? The Commonwealth Fund 2021.

[7] Mathieu E, Ritchie H, Rodés-Guirao L, et al. Coronavirus pandemic (COVID-19). Our world in data 2020.

[8] UIHI. COVID-19 Data Dashboard. Urban Indian Health Institute. (https://www.uihi.org/covid-19-data-dashboard).

[9] Bassett MT, Chen JT, Krieger N. Variation in racial/ethnic disparities in COVID-19 mortality by age in the United States: A cross-sectional study. PLoS Med 2020;17(10):e1003402.

[10] Ward LA, Black KP, Britton CL, Tompkins ML, Provost EM. COVID-19 Cases, Hospitalizations, and Deaths Among American Indian or Alaska Native Persons—Alaska, 2020–2021. Morb Mortal Wkly Rep 2022;71(22):730.

[11] Prevention CfDCa. COVID Data Tracker. (https://covid.cdc.gov/covid-data-tracker).

[12] Kriss JL, Hung M-C, Srivastav A, et al. COVID-19 vaccination coverage, by race and ethnicity—national immunization survey adult COVID module, United States, December 2020–November 2021. Morb Mortal Wkly Rep 2022;71(23):757.

[13] Skinner A, Raifman J, Ferrara E, Raderman W, Quandelacy TM. Disparities made invisible: gaps in COVID-19 data for American Indian and Alaska native populations. Health Equity 2022;6(1):226–9.

[14] de St Maurice A, Block Jr R, Sanchez G, Szilagyi PG, Collaborative AAR, Group C. Parental COVID-19 Vaccine Hesitancy in Diverse Communities: A National Survey. Acad Pediatr 2022.

[15] MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. Vaccine 2015;33(34):4161–4.

[16] Gidengil C, Chen C, Parker AM, Nowak S, Matthews L. Beliefs around childhood vaccines in the United States: A systematic review. Vaccine 2019;37(45):6793–802.

[17] Wheeler M, Buttenheim AM. Parental vaccine concerns, information source, and choice of alternative immunization schedules. Hum Vaccin Immunother 2013;9(8):1782–9.

[18] Evans S, Klas A, Mikocka-Walus A, et al. "Poison" or "protection"? A mixed methods exploration of Australian parents' COVID-19 vaccination intentions. J Psychosom Res 2021;150:110626. (In eng). DOI: 10.1016/j.jpsychores.2021.110626.

[19] Nguyen KH, Nguyen K, Geddes M, Allen JD, Corlin L. Trends in adolescent COVID-19 vaccination receipt and parental intent to vaccinate their adolescent children, United States, July to October, 2021. Ann Med 2022;54(1):733–42.

[20] Goldman RD, Ceballo R. Parental gender differences in attitudes and willingness to vaccinate against COVID -19. J Paediatr Child Health 2022. https://doi.org/10.1111/jpc.15892.

[21] Chen F, He Y, Shi Y. Parents' and Guardians' Willingness to Vaccinate Their Children against COVID-19: A Systematic Review and Meta-Analysis. Vaccines 2022;10(2):179.

[22] Goldman RD, McGregor S, Marneni SR, et al. Willingness to vaccinate children against influenza after the Coronavirus disease 2019 pandemic. J Pediatr 2021;228(87–93):e2.

[23] Pan F, Zhao H, Nicholas S, Maitland E, Liu R, Hou Q. Parents' Decisions to Vaccinate Children against COVID-19: A Scoping Review. Vaccines 2021;9(12):1476.

[24] Yoda T, Katsuyama H. Parents' hesitation about getting their children vaccinated against COVID-19 in Japan. Hum Vaccin Immunother 2021:1–6.

[25] Yılmaz M, Sahin MK. Parents' willingness and attitudes concerning the COVID-19 vaccine: A cross-sectional study. Int J Clin Pract 2021;75(9). https://doi.org/10.1111/ijcp.14364.

[26] Teasdale CA, Borrell LN, Shen Y, et al. Parental plans to vaccinate children for COVID-19 in New York city. Vaccine 2021;39(36):5082–6. https://doi.org/10.1016/j.vaccine.2021.07.058. In eng.

[27] Kest H, Kaushik A, DeBruin W, Colletti M, Goldberg D. Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with 2019 Novel Coronavirus (SARS-CoV-2) Infection. Case Reports in Pediatrics 2020;2020:8875987. https://doi.org/10.1155/2020/8875987.

[28] Chu H, Ko LK, Ibrahim A, et al. The impact of an educational forum intervention on East African mothers' HPV vaccine-related knowledge, attitudes, and intentions to vaccinate their adolescent children. Vaccine 2021;39(28):3767–76.

[29] Rhodes ME, Sundstrom B, Ritter E, McKeever BW, McKeever R. Preparing for a COVID-19 vaccine: a mixed methods study of vaccine hesitant parents. J Health Commun 2020;25(10):831–7.

[30] Gendler Y, Ofri L. Investigating the Influence of Vaccine Literacy, Vaccine Perception and Vaccine Hesitancy on Israeli Parents' Acceptance of the COVID-19 Vaccine for Their Children: A Cross-Sectional Study. Vaccines (Basel) 2021;9(12) (In eng). DOI: 10.3390/vaccines9121391.

[31] Ruggiero KM, Wong J, Sweeney CF, et al. Parents' intentions to vaccinate their children against COVID-19. J Pediatr Health Care 2021;35(5):509–17.

[32] Karlsson LC, Soveri A, Lewandowsky S, et al. Fearing the disease or the vaccine: The case of COVID-19. Pers Individ Differ 2021;172:110590.

[33] Walker KK, Head KJ, Owens H, Zimet GD. A qualitative study exploring the relationship between mothers' vaccine hesitancy and health beliefs with COVID-19 vaccination intention and prevention during the early pandemic months. Hum Vaccin Immunother 2021;17(10):3355–64.

[34] Milan S, Dáu ALB. The Role of Trauma in Mothers' COVID-19 Vaccine Beliefs and Intentions. J Pediatr Psychol 2021;46(5):526–35.

[35] Xu Y, Zhang R, Zhou Z, et al. Parental psychological distress and attitudes towards COVID-19 vaccination: a cross-sectional survey in Shenzhen. China Journal of Affective Disorders 2021;292:552–8.

[36] Huyser KR, Horse AJY, Kuhlemeier AA, Huyser MR. COVID-19 Pandemic and indigenous representation in public health data. American journal of public health 2021;111(S3):S208-S214.

[37] Patel AG, Hsiao CJ, Fasanya HO, Stoffel M, Lyon ME. Accuracy in measuring racial disparities during the COVID-19 pandemic needs improvement. The journal of applied laboratory medicine 2021;6(1):310–3.

[38] Home O. Profile: American Indian/Alaska Native People. HHS.gov. (https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=3&lvlid=62#:~:text=As%20of%202022%2C%20there%20are,reservations%20or%20other%20trust%20lands).

[39] Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: Building an international community of software platform partners. J Biomed Inform 2019;95:103208.

[40] RADXUP. RADXUP Data ToolKit. (https://myhome.radx-up.org/cdcc-resources/data-toolkit/).

[41] Lee E-H. Review of the psychometric evidence of the perceived stress scale. Asian Nurs Res 2012;6(4):121–7.

[42] Cameron RP, Gusman D. The primary care PTSD screen (PC-PTSD): development and operating characteristics. Prim Care Psychiatry 2003;9(1):9–14.

[43] (SAGE) TSAGoE. Report of the SAGE working group on vaccine hesitancy. 2014. (https://www.asset-scienceinsociety.eu/sites/default/files/sage_working_group_revised_report_vaccine_hesitancy.pdf).

[44] Nguyen KH, Nguyen K, Mansfield K, Allen JD, Corlin L. Child and adolescent COVID-19 vaccination status and reasons for non-vaccination by parental vaccination status. Public Health 2022;209:82-89. (In eng). DOI: 10.1016/j.puhe.2022.06.002.

[45] Pediatrics AAo. Children and COVID-19 Vaccination Trends. November 16, 2022 (https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-vaccination-trends/).

[46] Haskins C, Noonan, C., MacLeHouse, R., Buchwald, D., Manson, S.M. Mental health symptom associations with COVID-19 testing and vaccination among urban American 1 Indian and Alaska Natives. Submitted.

[47] Buchwald D, Mendoza-Jenkins V, Croy C, McGough H, Bezdek M, Spicer P. Attitudes of urban American Indians and Alaska Natives regarding participation in research. J Gen Intern Med 2006;21(6):648–51.

[48] Warne D, Lajimodiere D. American Indian health disparities: Psychosocial influences. Soc Pers Psychol Compass 2015;9(10):567–79.

[49] Wei F, Mullooly JP, Goodman M, et al. Identification and characteristics of vaccine refusers. BMC Pediatr 2009;9:1–9.

[50] Hudson A, Montelpare WJ. Predictors of vaccine hesitancy: implications for COVID-19 public health messaging. Int J Environ Res Public Health 2021;18(15):8054.

[51] Chatterji R, Campbell, N., Quirk, A. Closing Advanced Coursework Equity Gaps for All Students. GAP. 2021. (March 21) (https://www.americanprogress.org/article/closing-advanced-coursework-equity-gaps-students/).

[52] Hill MM. Schools in rural Alaska with higher rates of student achievement: A search for positive deviance in education. University of Alaska Fairbanks; 2017.

[53] President EOot. 2014 Native Youth Report. ED565658. 2014-Dec 2014. (https://files.eric.ed.gov/fulltext/ED565658.pdf).

[54] Cullen P, Mackean T, Walker N, et al. Integrating trauma and violence informed care in primary health care settings for First Nations women experiencing violence: a systematic review. Trauma Violence Abuse 2022;23(4):1204–19.

[55] Levine S, Varcoe C, Browne AJ. "We went as a team closer to the truth": impacts of interprofessional education on trauma-and violence-informed care for staff in primary care settings. J Interprof Care 2021;35(1):46–54.

[56] Doyle R, Donaldson A, Philips L, Nelson L, Clark JE, Wen SCH. The impact of a multidisciplinary care package for vaccination in needle phobic children: An observational study. J Paediatr Child Health 2022.

[57] McLenon J, Rogers MAM. The fear of needles: A systematic review and meta-analysis. J Adv Nurs 2019;75(1):30-42. (In eng). DOI: 10.1111/jan.13818.

[58] Love AS, Love RJ. Considering needle phobia among adult patients during mass COVID-19 vaccinations. Journal of Primary Care & Community Health 2021;12:21501327211007393.

[59] Freeman D, Lambe S, Yu L-M, et al. Injection fears and COVID-19 vaccine hesitancy. Psychol Med 2021:1–11. https://doi.org/10.1017/s0033291721002609.

[60] Archive: covid-19 Vaccination and Case Trends by Age Group, United States. CDC. (https://data.cdc.gov/Vaccinations/Archive-COVID-19-Vaccination-and-Case-Trends-by-Ag/gxj9-t96f).

[61] Pierce CA, Herold KC, Herold BC, et al. COVID-19 and children. Science 2022;377 (6611):1144-1149. doi: 10.1126/science.ade1675.