



Mental health symptom associations with COVID-19 testing and vaccination among urban American Indian and Alaska Native people

Cole Haskins^{a,*}, Carolyn Noonan^b, Richard MacLehose^c, Dedra Buchwald^d, Spero M. Manson^e

^a University of Colorado, Department of Psychiatry, Aurora, CO, USA

^b Washington State University, Institute for Research and Education to Advance Community Health (IREACH), Spokane and Seattle, WA, USA

^c University of Minnesota, School of Public Health, Minneapolis, MN, USA

^d University of Washington, School of Medicine, Neuroscience Institute, Seattle, WA, USA

^e University of Colorado, Colorado School of Public Health, Centers for American Indian and Alaska Native Health, Aurora, CO, USA

ARTICLE INFO

Keywords:

American Indian and Alaska Native People
 COVID-19
 Vaccination
 Testing
 Mental health
 Health disparities
 Epidemiology

ABSTRACT

Background: The COVID-19 pandemic has substantially impacted American Indian and Alaska Native (AI/AN) communities. Rates of infection, hospitalization, and mortality have been severe relative to non-Hispanic whites. While AI/AN communities have had some of the highest levels of COVID-19 vaccination, utilization rates remain suboptimal and there is a need to identify facilitators and barriers to testing and vaccination.

Methods: We examined cross-sectional survey data from January to May 2021, among 619 AI/AN patients from five tribal health organizations (AK, CO, KS, NM, WA). Exposures include perceived stress, Kessler distress, PTSD screening, and AUDIT-C alcohol misuse screen. Poisson regression was used to estimate associations with prevalence of COVID-19 testing and vaccination.

Results: Over three-quarters of participants were tested for COVID-19 and nearly half were vaccinated. Perceived stress and positive PTSD screening were associated with reduced vaccination prevalence, Prevalence Ratio (PR) 0.83 (0.73, 0.93) and PR 0.80 (0.66, 0.98), respectively. There was reduced prevalence of COVID-19 testing in subgroups with lower reported psychological resilience and PTSD, PR 0.78 (0.64, 0.95).

Conclusions: Past-month perceived stress and positive PTSD screening are associated with reduced prevalence of COVID-19 vaccination in urban AI/AN people. Subgroups reporting limited resilience and PTSD symptoms had lower prevalence of COVID-19 testing. The complex relationship between mental health and COVID-19 testing and vaccination warrants further exploration to identify interventions to improve health among urban AI/AN people, a population with known disparities in both mental health and COVID-19 outcomes.

Introduction

COVID-19 has substantially impacted the health of many, with Centers for Disease Control data estimating the pandemic has resulted in over one million deaths and five million hospitalizations in the United States [1]. Despite American Indian and Alaska Native (AI/AN) communities' successes with vaccination, significant COVID-19 disparities remain [2]. AI/AN community rates of infection, hospitalization, and mortality were elevated in the early pandemic; COVID-19-related mortality nearly double that of non-Hispanic white people [34]. Increased utilization of COVID-19 testing and vaccination is key to reducing related morbidity and mortality. Implementation of testing has major public health implications, specifically of surveillance and isolation

measures to stop the spread of illness [5]. Preventive measures including vaccination can also reduce the risk of infection and poor outcomes; vaccinated individuals have at least a 10-fold lower risk of mortality and hospitalization than unvaccinated people [6]. By December 2021, over 2.5 million vaccine doses were distributed to Indian Health Service (IHS) facilities, contributing to the highest levels of vaccination of any group in the US [7]. Seventy-eight percent of doses were administered to AI/AN people [7] and 72.6 % of this population has received at least one dose as of May 2022 [2,8].

While AI/AN community vaccination efforts have been remarkably successful, identifying facilitators and barriers to timely receipt remains critical. In the general population, mental disorders are associated with COVID-19 infection and vice versa [9]. However, studies on the

* Corresponding author.

E-mail address: Cole.Haskins@cuanschutz.edu (C. Haskins).

<https://doi.org/10.1016/j.jvaxc.2024.100520>

Received 8 January 2024; Received in revised form 29 June 2024; Accepted 3 July 2024

Available online 4 July 2024

2590-1362/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

relationship between mental health with COVID-19 testing and vaccination report mixed results. Severe mental disorders reduce the likelihood of influenza vaccination [10]. Conversely, individuals with diagnosed anxiety or depressive disorders may receive more healthcare than people without these diagnoses, presenting increased opportunity for testing and vaccination against COVID-19 [10]. However, in the Household Pulse Survey, individuals with anxiety and depressive symptoms were less likely to receive COVID-19 vaccination, despite potential opportunities and reported intent to receive it [11]. The association between mental health and vaccination status among AI/AN people needs further clarification.

Resilience in AI/AN communities and self-determination have contributed to improved vaccination rates, and should be examined in relation to pandemic mental health [12]. AI/AN collective resilience has been beneficial to overcoming adversity [13], and in the general population evidence suggests resilience has been protective for pandemic mental health [14]. Resilience warrants further exploration as AI/AN people may have elevated prevalence of mental disorders. National Survey on Drug Use and Health (NSDUH) data preceding the pandemic indicated about one-quarter of AI/AN adults evidenced mental disorders in the past year [15]; since the early 2000s AI/AN peoples' estimated lifetime prevalence of any mental disorder was 60–70 % [16]. Substance misuse is associated with mental disorders [17], with the NSDUH reporting 13 % of respondents met criteria for a past-year substance use disorder [15]. Given the possible association of mental health symptoms with reduced prevalence of COVID-19 testing and vaccination, and complex dynamic between resilience and mental disorders in AI/AN communities [13,15–17], the relationship between resilience, mental health, COVID-19 testing and vaccination warrants clarification.

We examined mental health symptoms of distress/depression, anxiety, post-traumatic stress, alcohol misuse, and the probability of COVID-19 testing and vaccination among 619 AI/AN patients from five tribal health organizations. We hypothesized the presence of mental health symptoms would be associated with decreased probability of testing and vaccination. Finally, we examined whether the association of mental health symptoms on testing and vaccination were modified by psychological resilience.

Methods

Study Population: Community Organizations for Natives: COVID-19 Epidemiology, Research, Testing, and Services (CONCERTS) was designed to identify and remove barriers to COVID-19 testing and to address health disparities related to COVID-19 among urban AI/AN people [18]. CONCERTS study details and methods have been previously described [18], with relevant summaries as follow. The Census Bureau estimates 3.7 million AI/AN people living in the United States [19], over 2 million receive care coordinated by Indian Health Service, across 574 tribes, in both urban and rural areas [20]. Over 60 % of IHS is administered by tribes and IHS provides funding to 41 urban-serving health care organizations [20]. CONCERTS partners with five tribal health organizations serving AI/AN people primarily in urban settings, and developed a cross-sectional patient survey to identify barriers, facilitators, attitudes, and factors related to COVID-19 testing and vaccination. Included tribal health organizations provide services including and not limited to primary and mental/behavioral health care. The tribal organizations are located in Albuquerque, NM; Anchorage, AK; Denver, CO; Minneapolis-St. Paul, MN; and Wichita, KS, with active patient populations ranging from 1,269 to 25,043 in 2019.

CONCERTS survey eligibility included AI/AN patients seen at one of the tribal primary care clinics within a year prior to survey distribution, aged 18 or older, not diagnosed with dementia or serious cognitive impairments (ICD-10 codes F01-04, G30-31). Sampling was stratified by age 18–54 vs. 55+ to adequately represent older participants who may experience severe COVID-19. Each tribal organization generated a list of eligible participants from their clinic electronic health records, 200 per

age group. Patients with an email address on file were sent an invitation to participate in CONCERTS with a link to an online REDCap survey, and the remainder were physically mailed an invitation and survey. Patients received reminders by email or phone call up to four times over 14 days. If 150 participants per clinic were not enrolled through the first round, a new random sample of eligible participants were selected. Enrollment occurred between January to May 2021 and participants received \$100 compensation. This study and data dissemination were 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, local review boards, and the Indian Health Service national IRB.

Measures: The patient survey collected comprehensive sociodemographic characteristics, co-morbid health conditions, social determinants of health, access to care, pandemic impact on physical and mental health, quality of life status, COVID-19 experiences, barriers and receipt of COVID-19 testing and vaccination [18]. The NIH RADX-UP Common Data Elements and PhenX Toolkit were used to develop the 164-question, 40-minute survey. Staff at each health organization provided feedback on the survey questions, with question modifications for study aims and cultural appropriateness as needed.

Study primary outcomes were self-reported receipt of COVID-19 testing and vaccination, both dichotomous variables. We examined four domains of mental health, representing different symptoms and disorders: the Kessler-6 psychological distress scale (depressive/distress symptoms in the past month) [21], perceived stress scale (stress and anxiety in the past month) [22], primary care posttraumatic stress disorder (PTSD) screen (lifetime PTSD symptoms) [23], and AUDIT-C screen (alcohol misuse in the past year) [24,25]. The perceived stress scale is continuous, 0 to 16, and results are reported per four-unit difference. Kessler distress scale ranges from 0 to 24, with ≥ 13 defined as positive. A PTSD positive screen included 3 or more positive responses; a score of four or more for men and three or more for women was deemed positive for AUDIT-C screen [24,25]. We examined psychological resilience as an effect modifier, constructed from the five-point Brief Resilience Scale [26]. Based on the sample distribution with most participant scores ranging 3–4, <3 was used to indicate lower resilience.

Statistical Analysis: Descriptive data were reported using means, standard deviations, and frequencies; data including sociodemographic characteristics, mental health exposures, and COVID-19 testing and vaccination. Poisson regression was used to estimate the association between mental health symptoms and the dependent variables, COVID-19 testing and vaccination. For each outcome comparison, we fit a set of two models for each of the exposure-outcome associations. The first model (1) estimated the crude association of each independent variable with the specific outcome. The second model (2) estimated the association adjusted for sociodemographic variables (including age, patient-reported sex, marital status, educational attainment, global self-rated assessment of health, and limited access to healthcare defined as not having a primary care provider that you see regularly or not getting needed medical care in the past 12 months due to cost). A sensitivity analysis simultaneously included all exposures and sociodemographic variables in a single model. Effect modification was assessed by fitting regression models that included model (2) with a main effect for resilience and the product term for the mental health symptom and resilience (low vs. high). Inferential results are presented as prevalence ratio (PR) with 95 % confidence interval (CI); PR was selected because the study outcomes are common [27]. All analyses used inverse probability weights to account for age-based sample selection and nonresponse according to age and sex, scaled so that each participating organization contributed equally to the analyses. Analyses were conducted using Stata 17.0 [28].

Results

Of 4,603 eligible participants contacted for this study, 788 (17.1 %) enrolled and completed the survey; 619 had complete data pertaining to the primary effects and outcomes and were included in these analyses. After inverse probability weighting was applied to the sample, the mean age was 43.1 years, 59 % were female, 24 % had a college degree or higher, 44 % were married or partnered, 79 % reported their global health as good or better, and 41 % reported limited access to healthcare (Table 1). Most participants, 80 %, had been tested for COVID-19 at least once. COVID-19 vaccination was common (49 %). The perceived stress scale had a mean score of 6.4 (out of 16). For the Kessler-6 psychological distress scale, 23 % of participants had a score ≥ 13 of 24 total. The PTSD screen had 48 % of participants screen positive. The AUDIT-C screen had 32 % meeting criteria for alcohol misuse. The brief resiliency scale had 20 % with scores less than 3 of 5 total, below the threshold for high resiliency.

Receipt of COVID-19 vaccination: In final adjusted models, the magnitude of association between perceived stress and vaccination was comparable to unadjusted models, PR 0.83 (0.73, 0.93); a four-unit increase in perceived stress corresponding with a 17 % relative reduction in the vaccination prevalence (Table 2). Screening positive for PTSD was associated with a 20 % relative reduction in vaccination prevalence, PR 0.80 (0.66, 0.98). Increased Kessler psychological distress was associated with a decrease in vaccination, though the data were compatible with a wider range of possible effects. Limited access to healthcare was associated with lower prevalence of vaccination, adjusted PR 0.82 (0.67, 1.00), in univariate models it was PR 0.77 (0.62, 0.96).

Receipt of COVID-19 testing: Covariates and mental health symptoms showed limited evidence of univariate effects associated with the prevalence of COVID-19 testing (Table 3). Of all four primary exposures,

Table 1
Participant characteristics among urban American Indians and Alaska Native (AI/AN) people Jan-May 2021 (N = 619).

	N = 619 ¹
<i>Sociodemographic and health</i>	
Age in years, mean (SD)	43.1 (14.0)
Female	59 %
<i>Education</i>	
Less than high school	8 %
High school graduate or GED	23 %
Some college	28 %
Associate, occupational, technical, or vocational degree	17 %
College degree or higher	24 %
<i>Marital status</i>	
Married or member of an unmarried couple	44 %
Divorced, separated, widowed	19 %
Never married	37 %
<i>Global self-rated health</i>	
Excellent	7 %
Very good	27 %
Good	45 %
Fair/Poor	21 %
Limited access to healthcare ²	41 %
<i>Outcomes</i>	
Tested for COVID-19 ≥ 1 time	80 %
Vaccinated for COVID-19	49 %
<i>Mental health</i>	
Perceived stress scale ³ , mean score (SD)	6.4 (3.4)
Kessler psychological distress scale ⁴ score ≥ 13	23 %
Primary care posttraumatic stress disorder screener ≥ 3 items endorsed	48 %
AUDIT-C indicator of alcohol use disorder	32 %
Brief resiliency scale ⁵ score < 3	20 %

¹The sample size is unweighted; all other results are weighted for sampling and non-response; ² Defined as not having a primary care provider that you see regularly or not getting needed medical care in the past 12 months due to cost; ³ Possible scores range from 0 to 16; ⁴ Possible scores range from 0 to 24; ⁵ Possible scores range from 0 to 5; SD = standard deviation; AUDIT-C = alcohol use disorders identification test.

Table 2

Association of mental health measures with COVID-19 vaccination, assessed among urban American Indians and Alaska Native people Jan-May 2021 (N = 619¹).

	<i>Model 1²</i>	<i>Model 2²</i>
	PR (95 % CI)	PR (95 % CI)
<i>Mental health</i>		
Perceived stress scale ⁴	0.78 (0.68, 0.89)	0.83 (0.73, 0.93)
Kessler psychological distress scale ≥ 13	0.71 (0.53, 0.96)	0.84 (0.63, 1.10)
PTSD screener ≥ 3 items endorsed	0.74 (0.60, 0.91)	0.80 (0.66, 0.98)
AUDIT-C indicator of problematic drinking	0.86 (0.68, 1.07)	0.92 (0.75, 1.14)
<i>Sociodemographic and health</i>		
Age in years ³	1.20 (1.13, 1.28)	1.25 (1.18, 1.33)
<i>Sex</i>		
Male	Reference	Reference
Female	1.02 (0.83, 1.26)	1.01 (0.84, 1.23)
<i>Education</i>		
Less than high school	0.96 (0.60, 1.53)	0.89 (0.60, 1.32)
High school graduate or GED	Reference	Reference
Some college	1.29 (0.95, 1.76)	1.33 (1.01, 1.76)
Associate, occupational, technical, or vocational degree	1.02 (0.70, 1.49)	1.01 (0.72, 1.43)
College degree or higher	1.67 (1.25, 2.22)	1.75 (1.34, 2.30)
<i>Marital status</i>		
Married or member of an unmarried couple	Reference	Reference
Divorced, separated, widowed	0.87 (0.68, 1.13)	0.78 (0.62, 1.00)
Never married	0.90 (0.71, 1.13)	1.10 (0.89, 1.36)
<i>Global self-rated health</i>		
Excellent	1.31 (0.96, 1.78)	1.12 (0.80, 1.58)
Very good	0.89 (0.67, 1.19)	0.77 (0.58, 1.01)
Good	0.93 (0.71, 1.21)	0.87 (0.68, 1.11)
Fair/Poor	Reference	Reference
<i>Limited access to healthcare</i>		
No	Reference	Reference
Yes	0.77 (0.62, 0.96)	0.82 (0.67, 1.00)

¹Unweighted sample size, results weighted for sampling and non-response; ² Model 1 includes the indicated variable as the only independent variable; Model 2 includes indicated variable and all sociodemographic and health variables; ³ Comparison for 10-year difference in age; ⁴ Comparison for 4-unit difference in perceived stress; PR = prevalence ratio; CI = confidence interval; PTSD = post-traumatic stress disorder; AUDIT-C = alcohol use disorders identification test. Boldface indicates statistical significance (p < 0.05).

Kessler distress, perceived stress, AUDIT-C, and PTSD screens, none were significantly associated with testing, in both univariate and final adjusted models.

Psychological resilience effect modification: Higher resilience was commonly reported in the cohort, with only 20 % beneath the threshold score of 3, which we define as low resilience. In subgroups with lower resilience, screening positive for PTSD was associated with lower prevalence of COVID-19 testing, PR 0.81 (0.67, 0.99) (Table 4). In the high resiliency subgroup there was less evidence of an association, PR 1.00 (0.89, 1.13), effect modification by resilience p = 0.07. In both subgroups with lower and higher resilience, perceived stress was associated with lower prevalence of COVID-19 vaccination, again without evidence of effect modification, PR 0.71 (0.53, 0.97) and PR 0.85 (0.73, 0.97), respectively, p = 0.30. In the high resiliency subgroup, a positive PTSD screen was associated with lower vaccination prevalence, PR 0.76 (0.60, 0.95), with wide confidence intervals in the low resilience group, PR 1.18 (0.72, 1.94), difference p = 0.11. The association of Kessler distress and AUDIT-C alcohol misuse with COVID-19 testing and vaccination were comparable between subgroups.

Table 3
Association of mental health measures with COVID-19 testing, assessed among urban American Indians and Alaska Native people Jan-May 2021 (N=619¹).

	Model 1² PR (95% CI)	Model 2² PR (95% CI)
<i>Mental health</i>		
Perceived stress scale ⁴	1.02 (0.96, 1.08)	1.01 (0.95, 1.07)
Kessler psychological distress scale ≥ 13	0.97 (0.85, 1.11)	0.95 (0.83, 1.08)
PTSD screener ≥ 3 items endorsed	1.00 (0.90, 1.10)	0.96 (0.87, 1.06)
AUDIT-C indicator of problematic drinking	1.08 (0.97, 1.19)	1.07 (0.97, 1.19)
<i>Sociodemographic and health</i>		
Age in years ³	0.97 (0.93, 1.00)	0.98 (0.94, 1.02)
<i>Sex</i>		
Male	Reference	Reference
Female	1.01 (0.91, 1.13)	1.02 (0.92, 1.13)
<i>Education</i>		
Less than high school	0.97 (0.75, 1.25)	0.97 (0.75, 1.26)
High school graduate or GED	Reference	Reference
Some college	1.11 (0.95, 1.30)	1.10 (0.94, 1.29)
Associate, occupational, technical, or vocational degree	1.10 (0.92, 1.30)	1.09 (0.91, 1.30)
College degree or higher	1.09 (0.94, 1.28)	1.09 (0.93, 1.28)
<i>Marital status</i>		
Married or member of an unmarried couple	Reference	Reference
Divorced, separated, widowed	0.96 (0.83, 1.11)	0.98 (0.84, 1.14)
Never married	1.08 (0.96, 1.21)	1.06 (0.95, 1.19)
<i>Global self-rated health</i>		
Excellent	1.10 (0.88, 1.37)	1.03 (0.82, 1.30)
Very good	1.03 (0.87, 1.21)	1.01 (0.85, 1.20)
Good	1.10 (0.95, 1.27)	1.08 (0.93, 1.26)
Fair/Poor	Reference	Reference
<i>Limited access to healthcare</i>		
No	Reference	Reference
Yes	1.06 (0.95, 1.17)	1.06 (0.95, 1.17)

¹ Unweighted sample size, results weighted for sampling and non-response; ² Model 1 includes the indicated variable as the only independent variable; Model 2 includes indicated variable and all sociodemographic and health variables; ³ Comparison for 10-year difference in age; ⁴ Comparison for 4-unit difference in perceived stress; PR = prevalence ratio; CI = confidence interval; PTSD = post-traumatic stress disorder; AUDIT-C = alcohol use disorders identification test.

Table 4
Association of mental health measures with COVID-19 vaccination and testing stratified by resilience, assessed among urban American Indians and Alaska Native people Jan-May 2021 (N = 619¹).

	COVID-19 vaccination Resilience²		p-value	COVID-19 testing Resilience²		p-value
	Low	High		Low	High	
Perceived stress scale	0.71 (0.53, 0.97)	0.85 (0.73, 0.97)	0.30	0.98 (0.84, 1.14)	1.02 (0.96, 1.09)	0.60
Kessler psychological distress scale ≥ 13	0.86 (0.53, 1.40)	0.84 (0.59, 1.20)	0.94	0.89 (0.70, 1.13)	0.97 (0.83, 1.14)	0.53
PTSD screener ≥ 3 items endorsed	1.18 (0.72, 1.94)	0.76 (0.60, 0.95)	0.11	0.81 (0.67, 0.99)	1.00 (0.89, 1.13)	0.07
AUDIT-C indicator of problematic drinking	1.11 (0.65, 1.87)	0.89 (0.71, 1.12)	0.47	1.19 (0.96, 1.49)	1.05 (0.93, 1.18)	0.30

Unweighted sample size, results weighted for sampling and non-response; ² Resilience defined by Brief Resilience Scale: Low = scores < 3, High = scores ≥ 3; Models adjusted for age, sex, education, marital status, self-rated health, healthcare access; PR = prevalence ratio; CI = confidence interval; PTSD = post-traumatic stress disorder; AUDIT-C = alcohol use disorders identification test. Boldface indicates statistical significance (p < 0.05), overall effect modification statistical significance listed in corresponding column.

Discussion

In this cross-sectional survey of urban AI/AN people seen at five tribal health organizations, we describe self-reported mental health symptoms during the COVID-19 pandemic and associations with COVID-19 testing and vaccination. Over three-quarters of participants were tested for COVID-19 at least once and nearly half were vaccinated. The rate of vaccination in 2021 is consistent with the literature for AI/AN people, suggesting excellent distribution and utilization of vaccines in AI/AN communities [7,2,8]. While other studies have described detrimental effects of mental health on COVID-19 vaccination rates [11], to our knowledge this report is the first to describe this phenomenon among urban AI/AN people, a population with known elevated prevalence of mental health concerns and poor COVID-19 outcomes [3,4,15]. Worse scores on the perceived stress scale and PTSD screen were associated with lower prevalence of vaccination; these relationships remained significant in adjusted models. We previously identified pandemic related stressors and fear of cultural harms were associated with poor pandemic emotional health in urban AI/AN people, suggesting complex health disparities and a critical need for improved mental health services [18].

Perceived stress was associated with reduced vaccination prevalence. Supporting the results, a sensitivity analysis model adjusting for all exposures simultaneously had similar results (Appendix 1 and 2). The perceived stress scale examines factors such as ability to control important things, confidence in handling problems, and difficulties not being overcome. The Kessler-6 scale evaluates symptoms often present in depression such as hopelessness, restlessness, low mood, worthlessness, and feeling everything is an effort [21]. However, this screening tool may only adequately capture frequency but not severity of symptoms. The perceived stress scale may better approximate limited functioning and thus barriers to care. The importance of last-month stress suggests managing mental health symptoms holds promise to improve likelihood of vaccine receipt.

The AUDIT-C alcohol misuse screen was not significantly associated with COVID-19 testing or vaccination. Other publications report co-occurring substance misuse and mental disorders cumulatively contributing to worse symptoms and general functional outcomes [29]. Individuals experiencing both depression and substance use disorders are more likely than those with depression alone to report more impairment; earlier depression onset, more episodes, inpatient care, and reported “self-medication” with substances [30]. Despite the potential for alcohol misuse to worsen mental health, such behaviors may not be directly associated with vaccine hesitancy [31]. Several reasons may explain the lack of findings. The AUDIT-C is a year-long snapshot of reported alcohol misuse that may not translate to clinically significant impairment; false positive screens for misuse can occur despite alcohol use within US recommended limits [32]. Alcohol misuse and related impacts change over time [33], difficult to capture in cross-sectional data. Finally, this screening tool does not assess other substances.

The underlying relationship between mental health and COVID-19 testing and vaccination is a complex dynamic between symptoms, access to care, and actual use of testing and vaccination. Univariate models suggested access to care improved rates of vaccination, but this was no longer significant in adjusted models. This is consistent with previous reports that people with anxiety and depressive symptoms may be less likely to receive COVID-19 vaccination, despite access and intent [11]. Reported access to care may approximate actual use, but we did not assess real-world use of mental health services that may modify the impact of mental health barriers to care. Additionally, there may be discrepancies between formally diagnosed mental disorders and survey-reported screening for mental health symptoms.

There was no consistent association of any mental health measure with COVID-19 testing. Exploratory analyses of resilience effect modification lend further insight into these relationships. In the adjusted model, screening positive for PTSD was not associated with COVID-19 testing, and resilience effect modification analyses provided limited evidence of differential effects between subgroups. These results are surprising as individuals with symptoms screening positive for PTSD and limited psychological resilience may experience challenges navigating testing resources during the pandemic. Also unexpected was the lack of significant difference between resilience subgroups as it relates to perceived stress and vaccination. We attribute these findings to the high levels of reported psychological resilience in the sample, which may limit the ability to detect differences between subgroups. Groups with lower reported resilience may differ in unmeasured characteristics such as psychiatric treatment history, other substance use disorders, social support, or specific coping behaviors. In general, psychological resilience is likely to benefit mental health and may be modified by interventions such as therapy, medication, social support, healthy lifestyle to enhance functioning and reduce the severity of PTSD symptoms [34]. Despite the complexity of these relationships, the data signal concern that individuals with symptoms screening positive for PTSD and higher perceived stress may experience suboptimal COVID-19 health behaviors and warrant additional study.

This study has several limitations. The cross-sectional design constrained detailed examination of causality between exposures and outcomes. Vaccine availability for participants in January 2021 may have differed from those completing in May. The testing rate for COVID-19 was high but we lacked longitudinal data to elucidate timeliness of testing. Mental disorders such as depression are episodic and symptoms are likely to change over time [35]. Future studies should collect longitudinal data along with information from electronic medical records to verify clinical information. Second, the mental health measures are primarily screening tools that do not substitute for a full clinical examination; we may have lacked detail regarding severity of mental health impairment. Ability to assess mental health history, diagnoses, and treatment could lend insight into possible confounders. Third, although we generally interpret lack of vaccination as a poor outcome, a similarly definitive statement regarding testing is premature. We lack the data to determine if the 20 % of patients who were not tested warranted it, did not seek testing, or had insufficient access. Fourth, we examined alcohol misuse and did not assess other substances that may contribute to adverse mental health and receipt of COVID-19 testing and vaccination. Fifth, results should be generalized cautiously as AI/AN people are heterogeneous; in addition, patient populations at the CONCERTS sites likely differed from those at IHS and other facilities serving AI/AN people. Finally, the response rate to the survey was low raising the possibility of selection bias, especially among individuals with severe mental health concerns who may be underrepresented in a cohort reporting relatively high rates of good global health.

In conclusion, this study revealed an association between mental health symptoms of past-month perceived stress, positive PTSD screening, and reduced prevalence of COVID-19 vaccination in urban AI/AN people. Subgroups with limited resilience and screening positive for PTSD also had lower prevalence of COVID-19 testing. Mental health

is associated with COVID-19 testing and vaccination, warranting further exploration of these complex relationships to identify strengths-based interventions to improve these specific behaviors among urban AI/AN people, a population with known disparities in both mental health and COVID-19 outcomes.

CRediT authorship contribution statement

Cole Haskins: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Carolyn Noonan:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Richard MacLehose:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Dedra Buchwald:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Spero M. Manson:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

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.

Data availability

The data that has been used is confidential.

Acknowledgements

- Research reported in this Rapid Acceleration of Diagnostics – Underserved Populations (RADx-UP) publication was supported by the National Institutes of Health under Award Number 3U54MD011240-06S1.

- Dr. Haskins is a member of the Pathways Resident Research Track, Department of Psychiatry, University of Colorado School of Medicine, which is supported by R25MH125758.

CONCERTS Community acknowledgement:

- Community Organizations for Natives: COVID-19 Epidemiology, Research, Testing, and Services (CONCERTS) would not have been possible without the extraordinary efforts of the clinic staff, administrators, providers, and patients from each of the partnering tribal health organizations. We are extremely grateful for their hard work and commitment to CONCERTS.

Banner authorship:

- CONCERTS Collaborative: Dedra Buchwald, Richard MacLehose, Spero Manson, Odile Madesclaire, Katie Nelson, Austin Henderson, Carolyn Noonan, Talia Quandelacey, 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.

Authorship contributions

- Authors Haskins, Noonan, MacLehose, Buchwald, and Manson all made a substantial contribution to conception and design of the study, data analysis and interpretation, writing/revision/approval of the manuscript. All authors attest they meet the ICMJE criteria for authorship.

Disclosures.

- Authors Haskins, Noonan, MacLehose, Buchwald, and Manson

have no competing interests to report. No financial disclosures were reported by the authors of this paper.

Appendix A

Table 1. Association of mental health measures with COVID-19 vaccination, assessed among urban American Indians and Alaska Native people Jan-May 2021 (N = 619¹).

	Model 3²
	PR (95 % CI)
<i>Mental health</i>	
Perceived stress scale ⁴	0.84 (0.73, 0.96)
Kessler psychological distress scale ≥ 13	1.01 (0.75, 1.38)
PTSD screener ≥ 3 items endorsed	0.89 (0.72, 1.09)
AUDIT-C indicator of problematic drinking	0.88 (0.72, 1.09)
<i>Sociodemographic and health</i>	
Age in years ³	1.20 (1.12, 1.28)
Sex	
Male	Reference
Female	1.06 (0.87, 1.28)
Education	
Less than high school	0.92 (0.62, 1.36)
High school graduate or GED	Reference
Some college	1.37 (1.04, 1.80)
Associate, occupational, technical, or vocational degree	1.04 (0.74, 1.47)
College degree or higher	1.81 (1.39, 2.35)
Marital status	
Married or member of an unmarried couple	Reference
Divorced, separated, widowed	0.79 (0.62, 1.01)
Never married	1.09 (0.89, 1.35)
Global self-rated health	
Excellent	0.93 (0.65, 1.33)
Very good	0.67 (0.51, 0.88)
Good	0.81 (0.63, 1.03)
Fair/Poor	Reference
Limited access to healthcare	
No	Reference
Yes	0.85 (0.70, 1.04)

Unweighted sample size, results weighted for sampling and non-response; ² Model 3 includes all sociodemographic and health variables and all mental health measures; ³ Comparison for 10-year difference in age; ⁴ Comparison for 4-unit difference in perceived stress; PR = prevalence ratio; CI = confidence interval; PTSD = post-traumatic stress disorder; AUDIT-C = alcohol use disorders identification test. Boldface indicates statistical significance (p < 0.05).

Appendix B

Table 2. Association of mental health measures with COVID-19 testing, assessed among urban American Indians and Alaska Native people Jan-May 2021 (N = 619¹).

	Model 3²
	PR (95 % CI)
<i>Mental health</i>	
Perceived stress scale ⁴	1.04 (0.97, 1.12)
Kessler psychological distress scale ≥ 13	0.93 (0.80, 1.08)
PTSD screener ≥ 3 items endorsed	0.96 (0.86, 1.06)
AUDIT-C indicator of problematic drinking	1.07 (0.97, 1.20)
<i>Sociodemographic and health</i>	
Age in years ³	0.98 (0.94, 1.02)
Sex	
Male	Reference
Female	1.03 (0.93, 1.15)
Education	
Less than high school	0.97 (0.75, 1.25)
High school graduate or GED	Reference
Some college	1.10 (0.95, 1.28)
Associate, occupational, technical, or vocational degree	1.09 (0.92, 1.30)
College degree or higher	1.08 (0.93, 1.25)
Marital status	
Married or member of an unmarried couple	Reference

(continued on next page)

(continued)

	Model 3 ²
Divorced, separated, widowed	0.97 (0.84, 1.13)
Never married	1.07 (0.95, 1.20)
Global self-rated health	
Excellent	1.07 (0.85, 1.35)
Very good	1.02 (0.86, 1.20)
Good	1.09 (0.94, 1.26)
Fair/Poor	Reference
Limited access to healthcare	
No	Reference
Yes	1.06 (0.95, 1.19)

¹Unweighted sample size, results weighted for sampling and non-response; ² Model 3 includes all sociodemographic and health variables and all mental health measures; ³ Comparison for 10-year difference in age; ⁴ Comparison for 4-unit difference in perceived stress; PR = prevalence ratio; CI = confidence interval; PTSD = post-traumatic stress disorder; AUDIT-C = alcohol use disorders identification test.

References

- Centers for Disease Control and Prevention. COVID-19 data tracker. Accessed June 21, 2024, <https://covid.cdc.gov/covid-data-tracker/>.
- Silberner J. Covid-19: How Native Americans led the way in the US vaccination effort. *BMJ* 2021;374.
- Centers for Disease Control. Disparities in COVID-19-Associated Hospitalizations: Racial and Ethnic Health Disparities; 2022. <https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/racial-ethnic-disparities/disparities-hospitalization.html>.
- Arrazola J, Masiello MM, Joshi S, et al. COVID-19 mortality among American Indian and Alaska native persons—14 states, January–June 2020. *Morbidity and Mortality Weekly Report* 2020;69(49):1853.
- Vandenberg O, Martiny D, Rochas O, van Belkum A, Kozlakidis Z. Considerations for diagnostic COVID-19 tests. *Nat Rev Microbiol* 2021;19(3):171–83.
- Scobie HM, Johnson AG, Suthar AB, et al. Monitoring incidence of COVID-19 cases, hospitalizations, and deaths, by vaccination status—13 US jurisdictions, April 4–July 17, 2021. *Morbidity and Mortality Weekly Report* 2021;70(37):1284.
- Indian Health Services. Coronavirus (COVID-19). 2022. <https://www.ihs.gov/coronavirus/>.
- Centers for Disease Control. Trends in Demographic Characteristics of People Receiving COVID-19 Vaccinations in the United States. Accessed 5/24/2022, <https://covid.cdc.gov/covid-data-tracker/#vaccination-demographics-trends>.
- Taquet M, Luciano S, Geddes JR, Harrison PJ. Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62 354 COVID-19 cases in the USA. *Lancet Psychiatry* 2021;8(2):130–40.
- Mazereel V, Van Assche K, Detraux J, De Hert M. COVID-19 vaccination for people with severe mental illness: why, what, and how? *Lancet Psychiatry* 2021;8(5):444–50.
- Nguyen KH, Chen S, Morris K, Chui K, Allen JD. Mental health symptoms and association with COVID-19 vaccination receipt and intention to vaccinate among adults, United States. *Preventive Medicine* 2022;154:106905.
- Foxworth R, Redvers N, Moreno MA, Lopez-Carmen VA, Sanchez GR, Shultz JM. Covid-19 Vaccination in American Indians and Alaska Natives—Lessons from effective community responses. *N Engl J Med* 2021;385(26):2403–6.
- Teufel-Shone NI, Tippens JA, McCrary HC, Ehiri JE, Sanderson PR. Resilience in American Indian and Alaska Native public health: An underexplored framework. *Am J Health Promot* 2018;32(2):274–81.
- Cusack SE, Bountress KE, Denckla CA, et al. A longitudinal investigation of resilience as a protective factor during the COVID-19 pandemic. *Traumatology* 2022;28(3):403.
- Park-Lee E, Lipari R, Bose J, et al. Substance use and mental health issues among US-born American Indians or Alaska Natives residing on and off tribal lands. 2018. CBHSQ Data Review: Substance Abuse Mental Health Services Administration.
- Brave Heart MYH, Lewis-Fernández R, Beals J, et al. Psychiatric disorders and mental health treatment in American Indians and Alaska Natives: results of the National Epidemiologic Survey on Alcohol and Related Conditions. *Soc Psychiatry Psychiatr Epidemiol* 2016;51(7):1033–46. <https://doi.org/10.1007/s00127-016-1225-4>.
- National Institute on Drug Abuse. *Common comorbidities with substance use disorders*; 2020. <https://www.drugabuse.gov/download/1155/common-comorbidities-substance-use-disorders-research-report.pdf?v=5>.
- Haskins C, Noonan C, MacLehose R, Buchwald D, Manson SM. COVID-19 pandemic effects on emotional health and substance use among urban American Indian and Alaska Native people. *J Psychosomatic Research*. Epub June 2023, 2023;172 (111424)doi:10.1016/j.jpsychores.2023.111424.
- United States Census Bureau. Decennial Census Data 2020. Accessed June 21, 2024, [https://data.census.gov/table?g=010XX00US&d=DEC%20Redistricting%20Data%20\(PL%2094-171\)](https://data.census.gov/table?g=010XX00US&d=DEC%20Redistricting%20Data%20(PL%2094-171)).
- Indian Health Service. Indian Health Service Health Equity Report. Accessed June 21, 2024, https://www.ihs.gov/sites/newsroom/themes/responsive2017/display_objects/documents/factsheets/IHS_Health_Equity_Report_FactSheet_2024.pdf.
- Kessler RC, Green JG, Gruber MJ, et al. Screening for serious mental illness in the general population with the K6 screening scale: results from the WHO World Mental Health (WMH) survey initiative. *Int J Methods Psychiatr Res* 2010;19(S1):4–22.
- Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *Journal of health social behavior* 1983;385–96.
- Cameron RP, Gusman D. The primary care PTSD screen (PC-PTSD): development and operating characteristics. *Prim Care Psychiatry* 2003;9(1):9–14. <https://doi.org/10.1185/135525703125002360>.
- Bush K, Kivlahan DR, McDonnell MB, Fihn SD, Bradley KA, Project ACQI. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. *Arch Intern Med* 1998;158(16):1789–1795.
- Bradley KA, Bush KR, Epler AJ, et al. Two brief alcohol-screening tests From the Alcohol Use Disorders Identification Test (AUDIT): validation in a female Veterans Affairs patient population. *Arch Intern Med* 2003;163(7):821–9.
- Smith BW, Dalen J, Wiggins K, Tooley E, Christopher P, Bernard J. The brief resilience scale: assessing the ability to bounce back. *Int J Behav Med* 2008;15(3):194–200.
- Cummings P. The relative merits of risk ratios and odds ratios. *J Pediatrics Adolescent Med* 2009;163(5):438–45.
- Stata Statistical Software: Release 17. StataCorp LLC; 2021.
- Najt P, Fusar-Poli P, Brambilla P. Co-occurring mental and substance abuse disorders: a review on the potential predictors and clinical outcomes. *Psychiatry Res* 2011;186(2–3):159–64.
- Blanco C, Alegria AA, Liu S-M, et al. Differences among major depressive disorder with and without co-occurring substance use disorders and substance-induced depressive disorder: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *J Clin Psychiatry* 2012;73(6):4463.
- Yang Y, Dobalian A, Ward KD. COVID-19 vaccine hesitancy and its determinants among adults with a history of tobacco or marijuana use. *J Community Health* 2021;46(6):1090–8.
- Delaney KE, Lee AK, Lapham GT, Rubinsky AD, Chavez LJ, Bradley KA. Inconsistencies between alcohol screening results based on AUDIT-C scores and reported drinking on the AUDIT-C questions: prevalence in two US national samples. *Addict Sci Clin Pract* 2014;9(1):1–9.
- White HR, Jackson K. Social and psychological influences on emerging adult drinking behavior. *Alcohol Res Health* 2004;28(4):182.
- Horn SR, Charney DS, Feder A. Understanding resilience: New approaches for preventing and treating PTSD. *Exp Neurol* 2016;284:119–32.
- American Psychiatric Association. *Diagnostic and statistical manual of mental disorders, fifth edition text revision*. American Psychiatric Association Publishing; 2022.