



Trends and factors associated with change in COVID-19 vaccination intent among residents and staff in six Seattle homeless shelters, March 2020 to August 2021



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ABSTRACT

Introduction: Achieving high COVID-19 vaccination coverage in homeless shelters is critical in preventing morbidity, mortality, and outbreaks, however, vaccination coverage remains lower among people experiencing homelessness (PEH) than the general population.

Methods: We conducted a cross-sectional study to retrospectively describe attitudes and identify factors associated with change in COVID-19 vaccination intent among shelter residents and staff during March 2020 - August 2021. To identify factors associated with change in COVID-19 vaccine intent becoming more positive overall compared to other attitudes, we utilized a Poisson model to calculate Risk Ratios with robust standard errors, adjusting for confounding by shelter site and demographic variables determined *a priori*.

Results: From July 12 - August 2, 2021, 97 residents and 20 staff participated in surveys across six shelters in Seattle King County, Washington. Intent to be vaccinated against COVID-19 increased from 45.3 % (n = 53) when recalling attitudes in March 2020 to 74.4 % (n = 87) as of August 2021, and was similar among residents and staff. Many participants (43.6 %, n = 51) indicated feeling increasingly accepting about receiving a COVID-19 vaccine since March 2020, while 13.7 % (n = 16) changed back and forth, 10.3 % (n = 12) became more hesitant, and 32.5 % (n = 38) had no change in intent. In the model examining the relationship between becoming more positive about receiving a COVID-19 vaccine compared to all other attitudes (n = 116), we found a 57.2 % increase in vaccine acceptability (RR 1.57; 95 % CI: 1.01, 2.45) among those who reported worsening mental health since the start of the pandemic.

Conclusions: Findings highlight opportunities to improve communication with residents and staff about COVID-19 vaccination and support a need for continued dialogue and a person-centered approach to understanding the sociocultural complexities and dynamism of vaccine attitudes at shelters.

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Introduction

People experiencing homelessness (PEH) who utilize shelter services, as well as shelter staff, are at increased risk for coronavirus disease 2019 (COVID-19) [1–3]. Achieving high COVID-19

vaccination coverage in shelters is critical to prevent morbidity, mortality, and outbreaks, but vaccination coverage remains lower among PEH than the general population [1,4]. Early studies have shown disparities in COVID-19 vaccination intent and uptake among PEH in the United States (U.S.) [1,5,6]. Understanding reasons behind COVID-19 vaccine attitudes and factors associated with change in vaccination intent among PEH is essential to inform strategy to increase vaccine uptake now that vaccines are widely available.

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A previous study conducted in King County, Washington found no trends towards increased vaccine acceptance among shelter residents or staff before the broadening of COVID-19 vaccine eligibility [1], highlighting potential for challenges in initial COVID-19 vaccine implementation. In February 2021, approximately 45 % of Seattle shelter residents and staff were undecided or not planning to receive a COVID-19 vaccine, of whom one-third did not provide a primary reason for their deliberation or reluctance. Strong disparities in COVID-19 vaccination intent associated with education and race were also observed, illustrating a need to better understand reasons for low COVID-19 vaccine acceptance and factors that associated with change in vaccination intent over time.

Various factors may influence change in vaccine attitudes and behavior over time, including risk perceptions, ideologic and demographic characteristics. Higher socioeconomic status, education, and age have been associated with higher vaccine uptake [7–9]. Political ideology has also been shown to be a determinant of vaccine-related attitudes and behaviors [10,11]. While research suggests that increased salience of a disease threat may improve attitudes toward vaccines [12–14], preliminary data on the association between COVID-19 risk perceptions and vaccine attitudes prior to vaccine rollout show mixed findings about the direction of association [11,15].

Here, we aimed to understand how many adult shelter residents and staff had a change in their vaccine perception, the reasons for a change in vaccine perception, and factors associated with change in intent to receive COVID-19 vaccination over time during March 2020 - August 2021 in Seattle King County. This study aims to fill critical gaps in understanding of COVID-19 vaccine attitudes among PEH to optimize vaccine implementation and coverage.

Methods

Study design and population

Our study used a single cross-sectional design to retrospectively identify factors associated with change in COVID-19 vaccination intent among shelter residents and staff during March 2020 - August 2021, after vaccines were widely available. All shelter residents and staff aged ≥ 18 years whose primary residence or place of employment was at one of six homeless shelters in the Seattle metropolitan area were eligible to participate. We recruited residents and staff who were present at each shelter on a single day during July 12 - August 2, 2021 to participate and recall attitudes at various seasonal timepoints. Sites included mixed-age adult, family, and young adult shelters which were strategically selected to be sociodemographically representative of King County's sheltered PEH [16]. Survey data was collected electronically in Research Electronic Data Capture (REDCap) on tablets. Most participants completed surveys independently; however, all were offered assistance in reading the questions by a study staff member. If the participant's primary language was not English, real-time translation was provided (in-person: Spanish, Amharic, or Tigrinya; telephone translation service: all other languages). Each participant was offered a gift card to compensate for their time and effort. This study was approved by the Human Subjects Division of the University of Washington Institutional Review Board (STUDY00007800).

Measures

The primary outcome of this study was change in COVID-19 vaccination intent over time. We asked all participants the ques-

tion "Overall, how have your feelings about getting a COVID-19 vaccine changed since beginning of the pandemic (Spring 2020)?", with responses categorized as more positive ("I feel increasingly positive about receiving a vaccine"), more negative ("I feel increasingly negative about receiving a vaccine"), change back and forth ("My feelings about receiving a vaccine changed back and forth"), or no change ("My feelings about receiving a vaccine have not changed"). Among participants who felt more positive or more negative about COVID-19 vaccination over time, we evaluated motivators for feeling increasingly positive or reasons for deliberation or reluctance. We also asked participants about vaccines in general, including their thoughts on effectiveness, safety, access, and seasonal influenza vaccine receipt. Topics specific to COVID-19 included risk perceptions, experiences during the pandemic and how it impacted life, and information and educational events received at each participant's respective shelter ([Supplementary Materials](#)).

To further understand changes over the pandemic, we asked participants to reflect on and self-report their perceived risk of COVID-19 and intent to receive a COVID-19 vaccine across four different seasonal time points since the beginning of the pandemic— Spring 2020 (March-May), Winter 2020 - 2021 (November-February), Spring 2021 (March-May), Summer 2021 (June-August). We used a Likert scale (1: strongly disagree to 5: strongly agree) to assess personal risk perception ("I was worried about getting COVID-19") and community risk perception ("I was worried about people in my community getting COVID-19 (e.g., friends, family, people around me)"). For COVID-19 vaccination intent, we categorized responses included vaccine accepting ("yes" or "already vaccinated"); vaccine deliberative ("undecided"); vaccine reluctant ("no"); or prefer not to say ("Prefer not to say") [1]. For each experience the participant identified (e.g., testing positive for COVID-19, being hospitalized for COVID-19, lost job or financial situation changing for the worse), we asked about the time period(s) when the experience occurred across five seasonal time points— Spring 2020 (March-May), Summer-Fall 2020 (June-October), Winter 2020 - 2021 (November-February), Spring 2021 (March-May), Summer 2021 (June-August).

Survey data also included self-reported general demographics including participant date of birth, gender, race, ethnicity (Hispanic or Latinx vs non-Hispanic or Latinx), income, marital status, number of children in household, level of highest education (a proxy for health literacy) [17], health insurance status, employment status, status as shelter staff versus resident, and experience with homelessness. Additionally, residents reported duration of homelessness; we defined chronic homelessness as duration ≥ 1 year.

Statistical analysis

To identify factors associated with change in COVID-19 vaccine intent becoming more positive overall compared to other attitudes (more negative, change back and forth, no change) between March 2020 - August 2021, we utilized a Poisson model to calculate Risk Ratios (RRs) with robust standard errors. This model adjusted for shelter site as a covariate to account for confounding by shelter location. We determined other variables to adjust for *a priori*, including age group, race, ethnicity, gender, employment, and participant type (resident vs staff). In addition to the model examining the relationship between becoming more positive vs all other attitudes, we conducted a secondary model excluding those who remained positive with no change in vaccine intent over time. All analyses were performed using R Statistical Software Version 4.0.3.

Results

Participant characteristics

During July 12 - August 2, 2021, 97 residents and 20 staff participated in surveys across six shelters in Seattle King County, Washington (Table 1a, 1b). Nine to 36 surveys were completed at each site with 46.2 % of participants (n = 54) from two adult mixed-gender shelters, 26.5 % (n = 31) from two family shelters, 19.7 % (n = 23) from one older adult male shelter, and 7.7 % (n = 9) from one young adult shelter. The median age of residents and staff was 46 years (range: 18 - 73 years) and 33 years (range: 21 - 81 years), respectively. Approximately 54.7 % of participants (n = 64) identified as cisgender men, 26.5 % (n = 31) as cisgender women, 6.8 % (n = 8) as gender non-binary, and 1.7 % (n = 2) as transgender men. Most participants identified as White (32.5 %, n = 38) or Black/African American (30.8 %, n = 36). About 13.7 % of participants (n = 16) identified as Hispanic or Latinx.

Among residents and staff, 83.5 % (n = 81) and 95.0 % (n = 19) indicated that they had a high school education or higher, respectively. The majority of residents (62.9 %, n = 61) were unemployed, however 10.3 % (n = 10) indicated part-time work and 6.2 % (n = 6) indicated full-time work. Among the 20 staff, 16 worked full-time and four worked part-time. While 45.0 % of staff (n = 9) had employer sponsored health insurance, the majority of residents (63.9 %, n = 62) were insured by Medicare, Medicaid (i.e., Washington Apple Health) or used coupons. Participants indicated usually receiving healthcare at a hospital (residents: 43.3 %, n = 42; staff: 20.0 %, n = 4), community clinic (residents: 33.0 %, n = 32; staff: 15.0 %, n = 3), and Doctor's or Nurse Practitioner's office (residents: 32.0 %, n = 31; staff: 85.0 %, n = 17). Most residents (55.7 %, n = 54) reported chronic homelessness with a duration of more than one year. Among staff, 35.0 % (n = 7) mentioned previously experiencing homelessness of which one mentioned current homelessness.

Vaccine perceptions and COVID-19 vaccination intent over time

Most participants agreed or strongly agreed that vaccines in general are effective (residents: 76.3 %, n = 74; staff: 80.0 %, n = 16), safe (residents: 66.0 %, n = 64; staff: 70.0 %, n = 14), and accessible (residents: 71.1 %, n = 69; staff: 80.0 %, n = 16). Thirty-four percent of residents (n = 33) and 50.0 % of staff (n = 10) reported receiving the seasonal influenza vaccine every year. Seventy-three percent (n = 71) of residents and 70.0 % (n = 14) of staff indicated that they had already received at least one dose of a COVID-19 vaccine.

When recalling vaccine attitudes in Spring 2020, 45.3 % (n = 53) of all participants described that they were vaccine accepting, 35.0 % (n = 41) were reluctant, and 17.1 % (n = 20) were deliberative (Fig. 1). By August 2021, 74.4 % (n = 87) were vaccine accepting, 17.9 % (n = 21) were reluctant, and 6.8 % (n = 8) were deliberative at that time. Many participants (43.6 %, n = 51) indicated feeling increasingly accepting about receiving a COVID-19 vaccine since March 2020, while 13.7 % (n = 16) changed back and forth, 10.3 % (n = 12) became more hesitant, and 32.5 % (n = 38) had no change in intent.

COVID-19 risk perceptions

We found a decrease in risk perception of COVID-19 during March 2020 - August 2021. We observed a 35.0 % decrease in the proportion of participants that were worried about getting COVID-19 (residents: 52.6 % to 16.5 %; staff: 65.0 % to 35.0 %) and 16.2 % decrease in the proportion of participants that were

worried about people in their community getting COVID-19 (residents: 68.0 % to 52.6 %; staff 80.0 % to 60.0 %) (Fig. 2). Both those who received at least one dose of COVID-19 vaccine (n = 85) and those unvaccinated (n = 27) at the time of the data collection had a decrease in personal risk perception of COVID-19 during March 2020 - August 2021, with a 40.0 % decrease (60.0 % to 20.0 %) and 25.9 % decrease (44.4 % to 18.5 %), respectively.

Reasons for vaccine deliberation or reluctance

Of those who indicated feeling more positive about receiving a COVID-19 vaccine over time (n = 51), the most commonly cited reasons among both residents and staff were deciding the vaccine was safe (58.8 %, n = 30) and effective at preventing COVID-19 (52.9 %, n = 27) (Fig. 3a). Other reasons included deciding that there was enough research (27.5 %, n = 14), receiving encouragement by family/friends (23.5 %, n = 12), receiving encouragement by a healthcare provider (19.6 %, n = 10), no longer being concerned about short-term side effects (19.6 %, n = 10), and receiving encouragement by a respected community leader (11.8 %, n = 6).

Of those who indicated feeling more negatively about receiving a COVID-19 vaccine over time (n = 12), the most common reasons were not trusting government or authorities (58.3 %, n = 7), worry about side effects (50.0 %, n = 6), and waiting to see how the vaccine affects others (50.0 %, n = 6) (Fig. 3b). Additional reasons included not thinking they need the vaccine (33.3 %, n = 4) and thinking COVID-19 is not dangerous (25.0 %, n = 3).

COVID-19 experiences and Information/education events

During March 2020 - August 2021, 43.6 % (n = 51) and 31.6 % (n = 37) of participants indicated that their mental or physical health worsened, respectively (Fig. 4). While self-reported worsening mental health trended downwards overall since Spring 2020, there was a slight rise in Winter 2020-2021 (14.5 %, n = 17) and again in Summer 2021 (9.4 %, n = 11). While 50.6 % of individuals vaccinated with at least one dose of a COVID-19 vaccine (n = 43) indicated that their mental health worsened at some point during the pandemic, this was only the case for 22.2 % of those unvaccinated (n = 6). Three residents self-reported hospitalization due to COVID-19, and 15 participants (12 residents, 3 staff) indicated testing positive for COVID-19. Approximately 32.5 % (n = 38) of participants knew someone with a bad outcome or who had died due to COVID-19, of whom 73.7 % (n = 28) were vaccine accepting, 18.4 % (n = 7) reluctant, and 7.9 % (n = 3) deliberative. In terms of change of COVID-19 vaccination intent over time among these 38 participants, 36.8 % (n = 14) felt increasingly positive, 13.2 % (n = 5) felt increasingly negative, 15.8 % (n = 6) changed back and forth, and 34.2 % (n = 13) had no change. Forty-three participants (36.8 %) lost their job or had their financial situation change for the worse, while 41 (35.0 %) began experiencing homelessness.

During March 2020 - August 2021, 48.7 % (n = 57) of participants indicated that they had received COVID-19 vaccine information/materials or attended a COVID-19 vaccine education event at the shelter (Fig. 4). Among these 57 participants, 75.4 % (n = 43) were vaccine accepting, 14.0 % (n = 8) reluctant, and 10.5 % (n = 6) deliberative by August 2021 with 47.4 % (n = 27) feeling increasingly positive, 8.8 % (n = 5) feeling increasingly negative, 15.8 % (n = 9) changing back and forth, and 28.1 % (n = 16) with no change in intent over time. The majority (n = 34) mentioned receiving this information or attending educational events in Spring 2021. Among all participants, 29.9 % (n = 35) indicated receiving written informational materials, followed by going to a walk-up information booth (12.8 %, n = 15), question and answer session (8.5 %, n = 10), and/or watching an educational video (2.6 %, n = 3) about COVID-19.

Table 1a
Unique survey responses among shelter residents, by change in COVID-19 vaccine intent between March 2020 - August 2021 (N = 97).

	Change in intent to be vaccinated against COVID-19 between March 2020 - August 2021, n(%) [†]					Total (n = 97)
	Change, more positive (n = 44, 45.4 %)	Change, more negative (n = 10, 10.3 %)	Change, back and forth (n = 13, 13.4 %)	No change, accepting (n = 19, 19.6 %)	No change, reluctant/deliberative (n = 11, 11.3 %)	
Age (years)						
Median [Min, Max]	47.0 [19, 73]	40.0 [22, 72]	36.0 [18, 60]	50.0 [19, 69]	47.0 [25, 71]	46.0 [18, 73]
Age group (years)						
18–49	24 (42.9 %)	6 (10.7 %)	11 (19.6 %)	9 (16.1 %)	6 (10.7 %)	56 (57.7 %)
50–64	17 (51.5 %)	2 (6.1 %)	2 (6.1 %)	8 (24.2 %)	4 (12.1 %)	33 (34.0 %)
65+	3 (37.5 %)	2 (25.0 %)	0 (0.0 %)	2 (25.0 %)	1 (12.5 %)	8 (8.3 %)
Gender						
Cisgender man	28 (50.9 %)	5 (9.1 %)	7 (12.7 %)	12 (21.8 %)	3 (5.5 %)	55 (56.7 %)
Cisgender woman	10 (43.5 %)	2 (8.7 %)	3 (13.0 %)	3 (13.0 %)	5 (21.7 %)	23 (23.7 %)
Transgender man	0 (0.0 %)	1 (50.0 %)	0 (0.0 %)	1 (50.0 %)	0 (0.0 %)	2 (2.1 %)
Transgender woman	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Gender non-binary	1 (20.0 %)	1 (20.0 %)	1 (20.0 %)	2 (40.0 %)	0 (0.0 %)	5 (5.2 %)
Other	2 (40.0 %)	1 (20.0 %)	1 (20.0 %)	0 (0.0 %)	1 (20.0 %)	5 (5.2 %)
Prefer not to say	3 (42.9 %)	0 (0.0 %)	1 (14.3 %)	1 (14.3 %)	2 (28.6 %)	7 (7.2 %)
Hispanic						
Yes	7 (53.8 %)	0 (0.0 %)	1 (7.7 %)	3 (23.1 %)	2 (15.4 %)	13 (13.4 %)
No	35 (44.3 %)	10 (12.7 %)	11 (13.9 %)	15 (19.0 %)	8 (10.1 %)	79 (81.4 %)
Prefer not to say	2 (40.0 %)	0 (0.0 %)	1 (20.0 %)	1 (20.0 %)	1 (20.0 %)	5 (5.2 %)
Race						
White	13 (39.4 %)	3 (9.1 %)	5 (15.2 %)	10 (30.3 %)	2 (6.1 %)	33 (34.0 %)
Black or African American	12 (44.4 %)	3 (11.1 %)	3 (11.1 %)	5 (18.5 %)	4 (14.8 %)	27 (27.8 %)
Asian	3 (60.0 %)	1 (20.0 %)	0 (0.0 %)	1 (20.0 %)	0 (0.0 %)	5 (5.2 %)
American Indian or Alaska Native	3 (75.0 %)	1 (25.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	4 (4.1 %)
Native Hawaiian or Pacific Islander	1 (50.0 %)	0 (0.0 %)	1 (50.0 %)	0 (0.0 %)	0 (0.0 %)	2 (2.1 %)
Multiracial	4 (30.8 %)	2 (15.4 %)	3 (23.1 %)	1 (7.7 %)	3 (23.1 %)	13 (13.4 %)
Prefer not to say	8 (61.5 %)	0 (0.0 %)	1 (7.7 %)	2 (15.4 %)	2 (15.4 %)	13 (13.4 %)
Highest education						
Less than high school graduate	6 (42.9 %)	3 (21.4 %)	3 (21.4 %)	1 (7.1 %)	1 (7.1 %)	14 (14.4 %)
Graduated high school/obtained GED	16 (41.0 %)	3 (7.7 %)	7 (17.9 %)	10 (25.6 %)	3 (7.7 %)	39 (40.2 %)
Some college	18 (56.2 %)	2 (6.2 %)	3 (9.4 %)	5 (15.6 %)	4 (12.5 %)	32 (33.0 %)
Bachelor's degree or higher	4 (40.0 %)	2 (20.0 %)	0 (0.0 %)	2 (20.0 %)	2 (20.0 %)	10 (10.3 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	1 (50.0 %)	1 (50.0 %)	2 (2.1 %)
Employment						
Full time	3 (50.0 %)	0 (0.0 %)	1 (16.7 %)	1 (16.7 %)	1 (16.7 %)	6 (6.2 %)
Part time	5 (50.0 %)	0 (0.0 %)	3 (30.0 %)	1 (10.0 %)	1 (10.0 %)	10 (10.3 %)
Contract/temp work, furloughed	3 (60.0 %)	1 (20.0 %)	0 (0.0 %)	1 (20.0 %)	0 (0.0 %)	5 (5.1 %)
Unemployed	28 (45.9 %)	7 (11.5 %)	5 (8.2 %)	15 (24.6 %)	6 (9.8 %)	61 (62.9 %)
Other	2 (40.0 %)	0 (0.0 %)	2 (40.0 %)	0 (0.0 %)	1 (20.0 %)	5 (5.2 %)
Prefer not to say	3 (30.0 %)	2 (20.0 %)	2 (20.0 %)	1 (10.0 %)	2 (20.0 %)	10 (10.3 %)
Health insurance						
Employer-sponsored	1 (50.0 %)	1 (50.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	2 (2.1 %)
Purchased outside of employer	0 (0.0 %)	0 (0.0 %)	1 (50.0 %)	0 (0.0 %)	1 (50.0 %)	2 (2.1 %)
Medicaid/care, coupons	27 (43.5 %)	5 (8.1 %)	10 (16.1 %)	12 (19.4 %)	8 (12.9 %)	62 (63.9 %)
Multiple Insurance types	6 (60.0 %)	1 (10.0 %)	1 (10.0 %)	2 (20.0 %)	0 (0.0 %)	10 (10.3 %)
Other	1 (14.3 %)	2 (28.6 %)	1 (14.3 %)	3 (42.9 %)	0 (0.0 %)	7 (7.2 %)
None	4 (57.1 %)	0 (0.0 %)	0 (0.0 %)	2 (28.6 %)	1 (14.3 %)	7 (7.2 %)
Prefer not to say	5 (71.4 %)	1 (14.3 %)	0 (0.0 %)	0 (0.0 %)	1 (14.3 %)	7 (7.2 %)
Duration of homelessness						
≤ 6 months	9 (39.1 %)	2 (8.7 %)	5 (21.7 %)	3 (13.0 %)	4 (17.4 %)	23 (23.7 %)
7–12 months	7 (41.2 %)	2 (11.8 %)	2 (11.8 %)	4 (23.5 %)	2 (11.8 %)	17 (17.5 %)
13–24 months	7 (50.0 %)	2 (14.3 %)	1 (7.1 %)	3 (21.4 %)	1 (7.1 %)	14 (14.4 %)
>24 months	19 (47.5 %)	4 (10.0 %)	4 (10.0 %)	9 (22.5 %)	4 (10.0 %)	40 (41.2 %)
Don't know	2 (66.7 %)	0 (0.0 %)	1 (33.3 %)	0 (0.0 %)	0 (0.0 %)	3 (3.09 %)
Received COVID-19 vaccine (1 + dose)						
Yes	40 (56.3 %)	4 (5.6 %)	7 (9.9 %)	19 (26.8 %)	1 (1.4 %)	71 (73.2 %)
No	3 (14.3 %)	5 (23.8 %)	4 (19.0 %)	0 (0.0 %)	9 (42.9 %)	21 (21.6 %)
Don't know	0 (0.0 %)	1 (50.0 %)	1 (50.0 %)	0 (0.0 %)	0 (0.0 %)	2 (2.1 %)
Prefer not to say	1 (33.3 %)	0 (0.0 %)	1 (33.3 %)	0 (0.0 %)	1 (33.3 %)	3 (3.1 %)
Current vaccination intent						
Accepting	42 (58.3 %)	4 (5.6 %)	7 (9.7 %)	19 (26.4 %)	0 (0.0 %)	72 (74.2 %)
Deliberative	0 (0.0 %)	1 (14.3 %)	5 (71.4 %)	0 (0.0 %)	1 (14.3 %)	7 (7.2 %)
Reluctant	2 (11.8 %)	5 (29.4 %)	0 (0.0 %)	0 (0.0 %)	10 (58.8 %)	17 (17.5 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	1 (100.0 %)	0 (0.0 %)	0 (0.0 %)	1 (1.0 %)
Received COVID-19 information/attended COVID-19 education event						
Yes	23 (45.1 %)	4 (7.8 %)	9 (17.6 %)	9 (17.6 %)	6 (11.8 %)	51 (52.6 %)
No	18 (46.2 %)	6 (15.4 %)	3 (7.7 %)	8 (20.5 %)	4 (10.3 %)	39 (40.2 %)
Don't know	2 (50.0 %)	0 (0.0 %)	1 (25.0 %)	1 (25.0 %)	0 (0.0 %)	4 (4.1 %)
Prefer not to say	1 (33.3 %)	0 (0.0 %)	0 (0.0 %)	1 (33.3 %)	1 (33.3 %)	3 (3.1 %)

[†] All columns apart from "Total" have calculated row percentages; "Total" column percentages calculated exclude missing response.

Table 1b
Unique survey responses among shelter staff, by change in COVID-19 vaccine intent between March 2020 - August 2021 (N = 20).

	Change in intent to be vaccinated against COVID-19 between March 2020 - August 2021, n(%) [†]					Total (n = 20)
	Change, more positive (n = 7, 35.0 %)	Change, more negative (n = 2, 10.0 %)	Change, back and forth (n = 3, 15.0 %)	No change, accepting (n = 6, 30.0 %)	No change, reluctant/deliberative (n = 2, 10.0 %)	
Age (years)						
Median [Min, Max]	48.0 [22, 81]	39.0 [24, 54]	33.0 [30, 34]	25.5 [21, 48]	37.0 [21, 53]	32.5 [21, 81]
Age group (years)						
18–49	4 (26.7 %)	1 (6.7 %)	3 (20.0 %)	6 (40.0 %)	1 (6.7 %)	15 (75.0 %)
50–64	1 (33.3 %)	1 (33.3 %)	0 (0.0 %)	0 (0.0 %)	1 (33.3 %)	3 (15.0 %)
65+	2 (100.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	2 (10.0 %)
Gender						
Cisgender man	2 (22.2 %)	2 (22.2 %)	1 (11.1 %)	3 (33.3 %)	1 (11.1 %)	9 (45.0 %)
Cisgender woman	4 (50.0 %)	0 (0.0 %)	2 (25.0 %)	2 (25.0 %)	0 (0.0 %)	8 (40.0 %)
Transgender man	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Transgender woman	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Gender non-binary	1 (33.3 %)	0 (0.0 %)	0 (0.0 %)	1 (33.3 %)	1 (33.3 %)	3 (15.0 %)
Other	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Hispanic						
Yes	1 (33.3 %)	1 (33.3 %)	0 (0.0 %)	0 (0.0 %)	1 (33.3 %)	3 (15.0 %)
No	6 (35.3 %)	1 (5.9 %)	3 (17.6 %)	6 (35.3 %)	1 (5.9 %)	17 (85.0 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Race						
White	3 (60.0 %)	0 (0.0 %)	0 (0.0 %)	2 (40.0 %)	0 (0.0 %)	5 (25.0 %)
Black or African American	4 (44.4 %)	1 (11.1 %)	1 (11.1 %)	1 (11.1 %)	2 (22.2 %)	9 (45.0 %)
Asian	0 (0.0 %)	1 (25.0 %)	1 (25.0 %)	2 (50.0 %)	0 (0.0 %)	4 (20.0 %)
American Indian or Alaska Native	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Native Hawaiian or Pacific Islander	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Multiracial	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	1 (50.0 %)	1 (50.0 %)	0 (0.0 %)	2 (10.0 %)
Highest education						
Less than high school graduate	0 (0.0 %)	0 (0.0 %)	1 (100.0 %)	0 (0.0 %)	0 (0.0 %)	1 (5.0 %)
Graduated high school/obtained GED	1 (33.3 %)	0 (0.0 %)	1 (33.3 %)	0 (0.0 %)	1 (33.3 %)	3 (15.0 %)
Some college	1 (16.7 %)	0 (0.0 %)	1 (16.7 %)	3 (50.0 %)	1 (16.7 %)	6 (30.0 %)
Bachelor's degree	4 (66.7 %)	0 (0.0 %)	0 (0.0 %)	2 (33.3 %)	0 (0.0 %)	6 (30.0 %)
Advanced degree	1 (25.0 %)	2 (50.0 %)	0 (0.0 %)	1 (25.0 %)	0 (0.0 %)	4 (20.0 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Employment						
Full time	6 (37.5 %)	2 (12.5 %)	3 (18.8 %)	3 (18.8 %)	2 (12.5 %)	16 (80.0 %)
Part time	1 (25.0 %)	0 (0.0 %)	0 (0.0 %)	3 (75.0 %)	0 (0.0 %)	4 (20.0 %)
Health insurance						
Employer-sponsored	2 (22.2 %)	2 (22.2 %)	1 (11.1 %)	3 (33.3 %)	1 (11.1 %)	9 (45.0 %)
Medicaid/care, coupons	2 (40.0 %)	0 (0.0 %)	0 (0.0 %)	2 (40.0 %)	1 (20.0 %)	5 (25.0 %)
Multiple Insurance types	2 (50.0 %)	0 (0.0 %)	1 (25.0 %)	1 (25.0 %)	0 (0.0 %)	4 (20.0 %)
Other	1 (100.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	1 (5.0 %)
None	0 (0.0 %)	0 (0.0 %)	1 (100.0 %)	0 (0.0 %)	0 (0.0 %)	1 (5.0 %)
Ever homeless						
Yes, past	3 (50.0 %)	1 (16.7 %)	1 (16.7 %)	0 (0.0 %)	1 (16.7 %)	6 (30.0 %)
Yes, currently	0 (0.0 %)	0 (0.0 %)	1 (100.0 %)	0 (0.0 %)	0 (0.0 %)	1 (5.0 %)
No	4 (30.8 %)	1 (7.7 %)	1 (7.7 %)	6 (46.2 %)	1 (7.7 %)	13 (65.0 %)
Received COVID-19 vaccine (1 + dose)						
Yes	7 (50.0 %)	0 (0.0 %)	1 (7.1 %)	6 (42.9 %)	0 (0.0 %)	14 (70.0 %)
No	0 (0.0 %)	2 (33.3 %)	2 (33.3 %)	0 (0.0 %)	2 (33.3 %)	6 (30.0 %)
Don't know	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Current vaccination intent						
Accepting	7 (46.7 %)	0 (0.0 %)	2 (13.3 %)	6 (40.0 %)	0 (0.0 %)	15 (75.0 %)
Deliberative	0 (0.0 %)	0 (0.0 %)	1 (100.0 %)	0 (0.0 %)	0 (0.0 %)	1 (5.0 %)
Reluctant	0 (0.0 %)	2 (50.0 %)	0 (0.0 %)	0 (0.0 %)	2 (50.0 %)	4 (20.0 %)
Prefer not to say	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Received COVID-19 information/attended COVID-19 education event						
Yes	4 (66.7 %)	1 (16.7 %)	0 (0.0 %)	1 (16.7 %)	0 (0.0 %)	6 (30.0 %)
No	3 (25.0 %)	1 (8.3 %)	2 (16.7 %)	4 (33.3 %)	2 (16.7 %)	12 (60.0 %)
Don't know	0 (0.0 %)	0 (0.0 %)	1 (50.0 %)	1 (50.0 %)	0 (0.0 %)	2 (10.0 %)

[†] All columns apart from "Total" have calculated row percentages; "Total" column percentages calculated exclude missing responses.

Factors associated with change in COVID-19 vaccination intent over time

In the primary model examining the relationship between becoming more positive about receiving a COVID-19 vaccine vs all other attitudes (n = 116), we found a 57.2 % increase in vaccine acceptability (RR 1.57; 95 % CI: 1.01, 2.45) among

those who reported worsening mental health since the start of the pandemic (Table 2). In the secondary model excluding those who remained positive with no change in vaccine intent over time (n = 91), we found a 57.9 % increase in vaccine acceptability (RR 1.58; 95 % CI: 1.06, 2.35) among those who reported worsening mental health since the start of the pandemic.

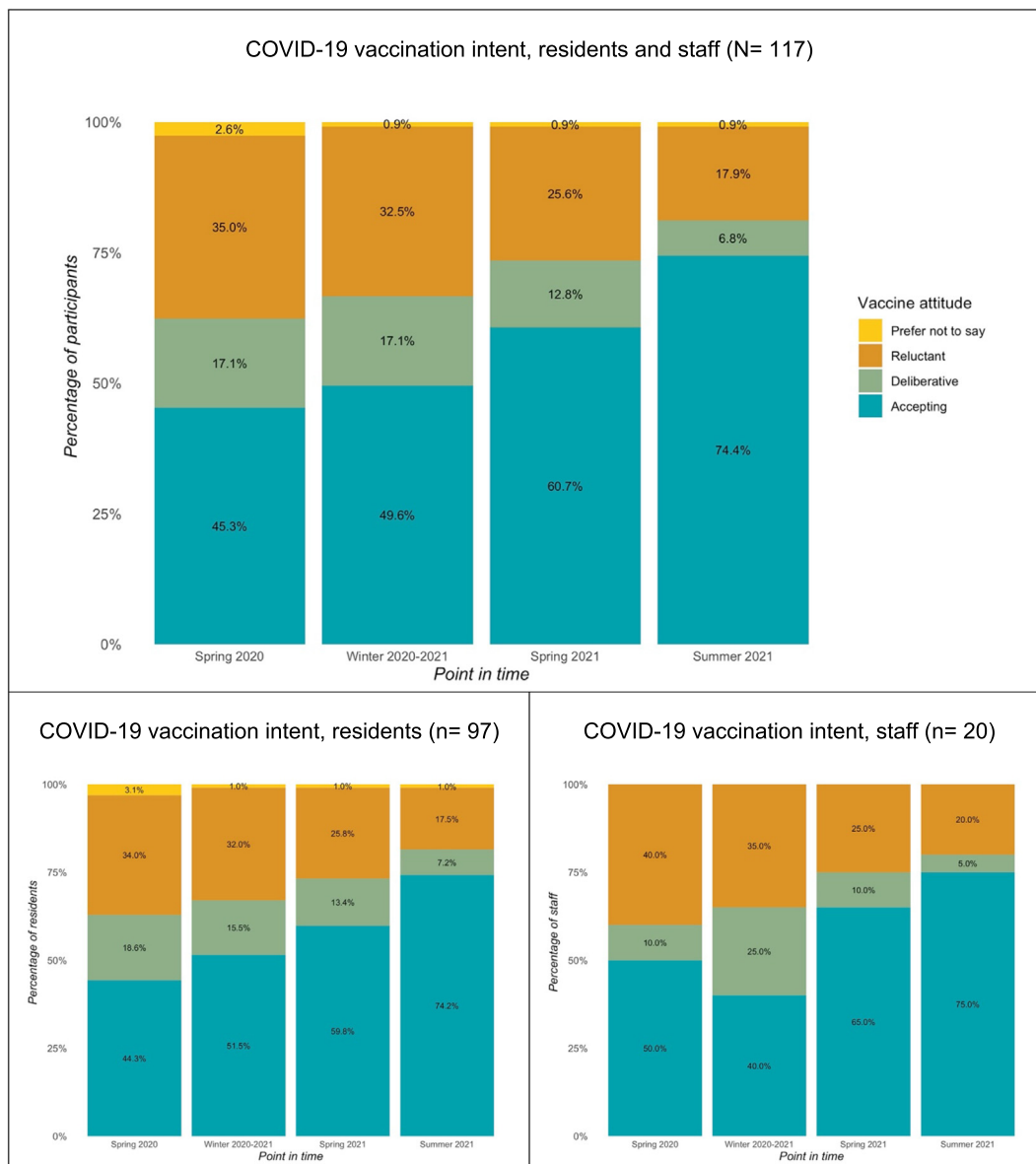


Fig. 1. COVID-19 vaccination intent among shelter residents and staff, March 2020 - August 2021 (N = 117).

Discussion

This study assessed change in intent to receive a COVID-19 vaccination, as well as reasons for change and factors associated with change, among adult shelter residents and staff in Seattle King County over time. Between the beginning of the pandemic and August 2021, intent to be vaccinated against COVID-19 increased and was similar among residents and staff. Overall, 74 % of residents and 75 % of staff were vaccine accepting, compared with 91 % of adults in the Seattle metropolitan area as of August 2, 2021 [18]. This represents a 19 % increase in COVID-19 vaccine acceptance among sheltered PEH in Seattle King County since February 2021. The majority of our study participants (68 %) had some change in intent over time, demonstrating potential points of intervention and opportunity to communicate information that may be useful for decision making.

Our study identifies reasons for change in residents and staff intent to be vaccinated against COVID-19. The two most common reasons cited for feeling more positive about receiving a COVID-19 vaccine over time included deciding the vaccine was safe and

that the vaccine was effective at preventing COVID-19. While risk perception of COVID-19 decreased over time, the proportion of respondents who were deliberative or reluctant about COVID-19 vaccine also decreased. This is similar to trends seen in vaccine hesitancy across the U.S., with a 24 % decrease in vaccine hesitancy in both King County and our population during January 1 to August 5, 2021 [19]. Interviews conducted among PEH in San Francisco found that people sought more information about vaccine efficacy and safety [20]. Other studies among veterans experiencing homelessness highlighted the importance of ensuring that information is delivered through trusted sources [21]. Thus, efforts to increase vaccine uptake among PEH should continue to include easy to understand data about efficacy and safety and prioritize delivery of clear, relevant, tailored information through trusted mechanisms.

The most common reasons for feeling more negative about receiving a COVID-19 vaccine over time were not trusting government or authorities, worry about side effects, and waiting to see how the vaccine affects others. Mistrust of government institutions has been observed to contribute to vaccine acceptability in both

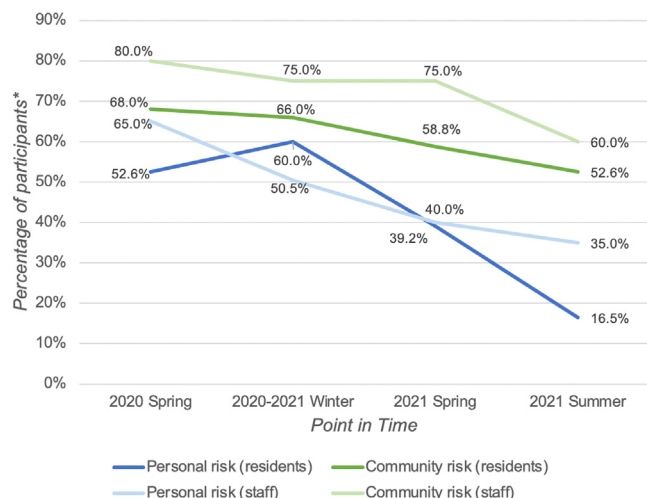


Fig. 2. Perception of individual and community COVID-19 risk by shelter residents and staff, March 2020 - August 2020. *Percentage of participants who agree or strongly agree with the statement “I was worried about getting COVID-19” (personal risk perception) and “I was worried about people in my community getting COVID-19 (e.g., friends, family, people around me)” (community risk perception).

the general population and PEH elsewhere, specifically related to experiences of racism [20,22]. Thus further exploration of how experiences with racism may impact vaccine mistrust may be key to tailoring future communications. Lack of the U.S. Food and Drug Administration (FDA)’s full approval of COVID-19 vaccines at the time of this study may have also contributed to mistrust and vaccine deliberation or reluctance [23]. As we previously observed a change in the reasons for vaccine deliberation or reluctance corresponding to the Emergency Use Authorization in shelter settings [1], FDA approval of COVID-19 vaccines may impact trust and reasons for vaccination moving forward [23]. A study among sheltered PEH in Detroit, Michigan in February 2021 also found primary reasons for COVID-19 vaccine hesitancy to be concern about side effects and fear of unknown long-term impacts of the vaccine

[5]. Utilizing qualitative methods to learn more about reasons why and factors associated with change will be key to designing public health programming around vaccination.

In the models evaluating factors associated with change in intent, the factor significantly associated with a more positive change in COVID-19 vaccination intent was worsening mental health since the start of the pandemic. Mental health decline among participants is likely situationally induced and associated with pandemic fatigue (i.e., repeated stress due to isolation, quarantine, etc.) and loss of autonomy [21,24]. Additionally, receiving the first dose of a COVID-19 vaccine has been shown to result in mental health improvements [25]. Therefore, vaccination against COVID-19 may have been a protective behavior due to increased vulnerability and isolation in shelters and viewed as a step in the right direction to mitigate mental health symptoms. Alternatively, mental health worsening and increasing vaccine acceptance may both be functions of time and not causally related to each other (i.e., time may be a confounder). Between the beginning of the pandemic and August 2021, over one-third of participants indicated that their mental health worsened; However, we observed a greater proportion of participants with worsening mental health at the start of the pandemic as compared to August 2021. This is similar to initial trends seen in a study among PEH between 16 and 24 years in the United Kingdom that found improved self-reported mental well-being between February and April 2020 [21].

Receiving COVID-19 vaccine information/materials or attending a COVID-19 vaccine education event at the shelter was not associated with more positive change in vaccine perception. Only approximately half of participants had received COVID-19 vaccine information or attended a COVID-19 vaccine education event at the shelter, leaving room for improvement towards creating a supportive environment to reach and communicate information about COVID-19 vaccines in shelters. Shelter management and public health entities may be best suited to provide COVID-19 information and lead educational events depending on residents’ level of trust of these sources [26]. Considering that most participants in our study cited commonly receiving healthcare at a hospital or in a clinic setting, these may be trusted locations where COVID-19 vaccine information can be disseminated to PEH. However, while

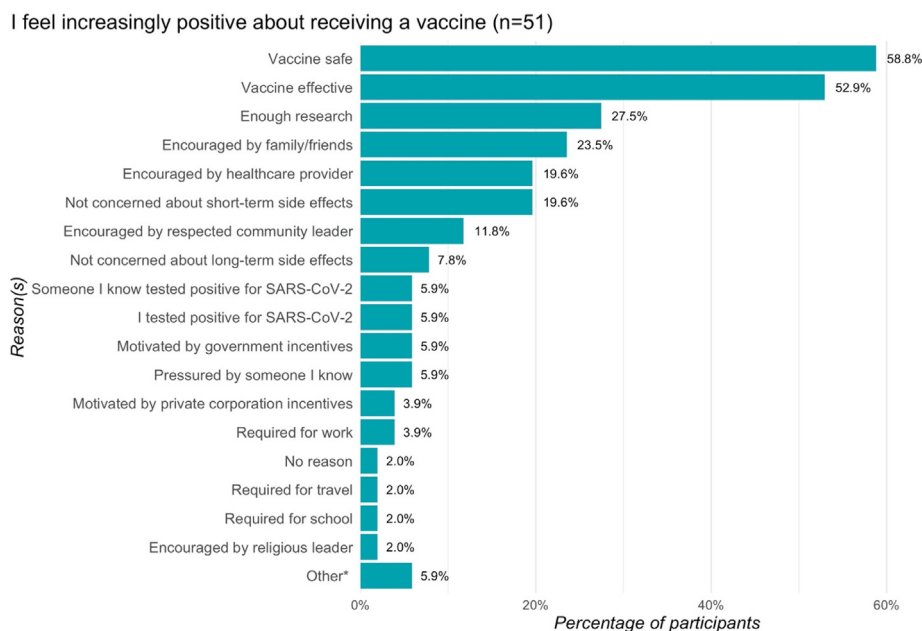


Fig. 3a. Shelter resident and staff reasons for more positive in vaccination intent, March 2020 - August 2021. *Other includes free-text responses: “I am high risk”, “Saw how COVID-19 vaccine affected others”, “Worried about spikes in cases”.

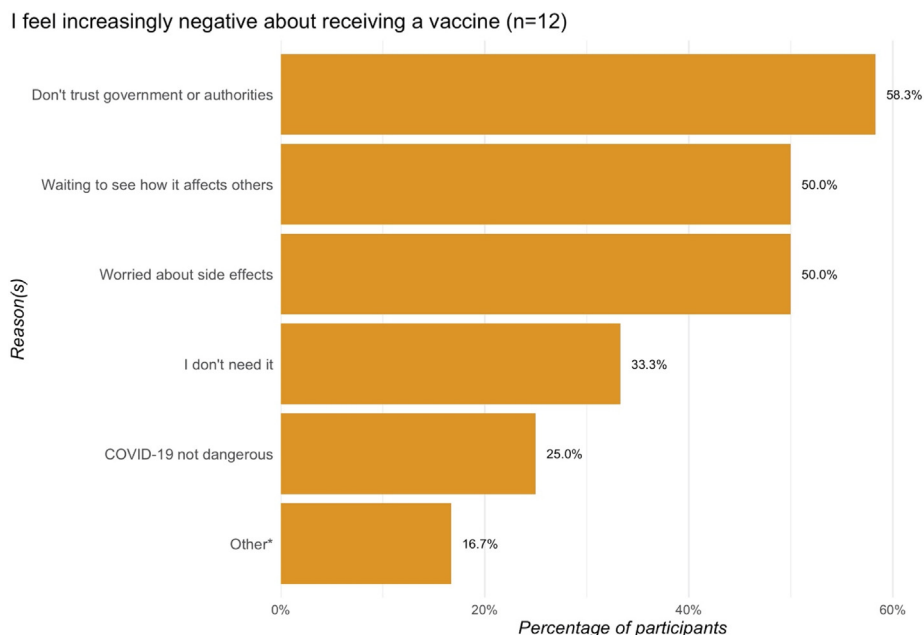


Fig. 3b. Shelter resident and staff reasons for more negative vaccination intent, March 2020 - August 2021. *Other includes free-text responses: "God will protect us"; "I had gotten the Flu shot and it gave me severe Pneumonia".

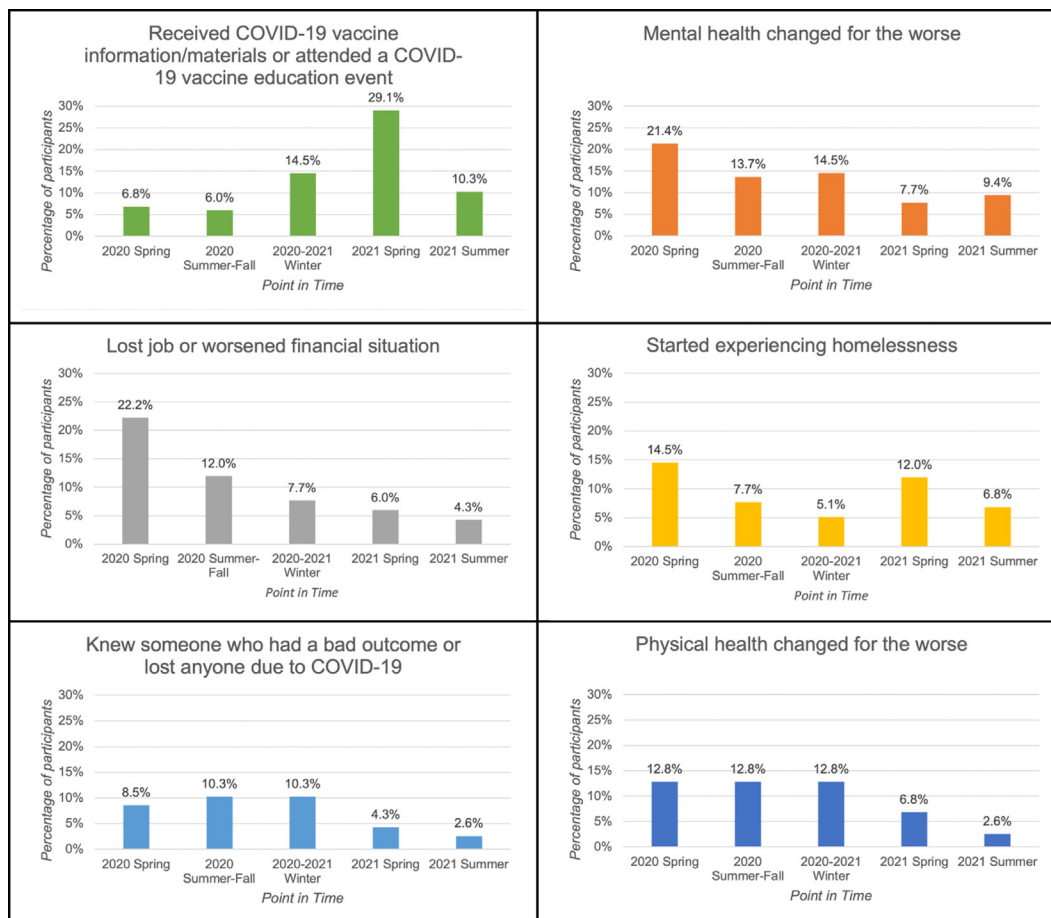


Fig. 4. Shelter resident and staff experiences across the COVID-19 pandemic, March 2020 - August 2021 (N = 117*). *The total unique individuals who mentioned a given experience at any point between March 2020 - August 2021 (n) are as follows: Received COVID-19 vaccine information/materials or attended a COVID-19 vaccine education event (n = 57), Mental health changed for the worse (n = 51), Lost job or financial situation changed for the worse (n = 43), Started experiencing homelessness (n = 41), Knew someone who had a bad outcome or lost anyone due to COVID-19 (n = 38), Physical health changed for the worse (n = 37).

Table 2
Factors associated with more positive overall change in COVID-19 vaccine intent, according to Poisson model between March 2020 - August 2021.

Characteristic	Model 1 More positive vs all others (n = 116)		Model 2 More positive vs other change + remain negative (n = 91)	
	aRR [†]	95 % CI	aRR [†]	95 % CI
Received COVID-19 information/attended COVID-19 education event				
Yes	1.30	(0.79, 2.14)	1.13	(0.74, 1.72)
No		Reference		Reference
Physical health changed for the worse				
Yes	0.88	(0.53, 1.47)	0.80	(0.47, 1.37)
No		Reference		Reference
Mental health changed for the worse				
Yes	1.57	(1.01, 2.45)	1.58	(1.06, 2.35)
No		Reference		Reference
Lost job or worsened financial situation				
Yes	1.53	(0.89, 2.62)	1.32	(0.77, 2.30)
No		Reference		Reference
Started experiencing homelessness				
Yes	0.81	(0.45, 1.45)	0.57	(0.31, 1.07)
No		Reference		Reference
Knew someone who had a bad outcome or lost anyone due to COVID-19 disease				
Yes	0.74	(0.44, 1.26)	0.84	(0.53, 1.31)
No		Reference		Reference
Age group				
18–49 y	0.92	(0.38, 2.23)	1.04	(0.52, 2.09)
50–64 y	0.81	(0.40, 1.82)	0.90	(0.46, 1.78)
≥ 65 y		Reference		Reference
Race				
American Indian/ Alaska Native	1.62	(0.58, 4.49)	1.10	(0.47, 2.61)
Asian	1.14	(0.42, 3.12)	1.04	(0.45, 2.41)
Black/African American	1.23	(0.79, 2.07)	1.10	(0.73, 1.66)
Multiracial	0.68	(0.28, 1.65)	0.55	(0.24, 1.28)
Native Hawaiian/ Pacific Islander	1.52	(0.24, 9.67)	1.16	(0.19, 6.98)
Prefer not to say	1.03	(0.46, 2.31)	1.01	(0.53, 1.91)
White		Reference		Reference
Ethnicity				
Hispanic	1.12	(0.52, 2.43)	1.06	(0.56, 2.00)
Non-Hispanic		Reference		Reference
Gender				
Cisgender women	1.05	(0.56, 1.97)	1.09	(0.63, 1.89)
Transgender or non-binary	0.47	(0.13, 1.67)	0.60	(0.21, 1.71)
Other, prefer not to say	1.03	(0.41, 2.59)	0.95	(0.41, 2.24)
Cisgender men		Reference		Reference
Unemployed				
Yes	0.94	(0.55, 1.60)	1.01	(0.60, 1.72)
No		Reference		Reference
Participant type				
Resident	1.03	(0.43, 2.46)	1.12	(0.54, 2.32)
Staff		Reference		Reference
Shelter site				
Site B	1.38	(0.69, 2.76)	1.27	(0.72, 2.21)
Site C	0.94	(0.41, 2.17)	0.79	(0.37, 1.69)
Site D	0.81	(0.34, 1.90)	1.15	(0.52, 2.54)
Site E	0.55	(0.22, 1.38)	0.75	(0.31, 1.74)
Site F	0.53	(0.15, 1.88)	0.76	(0.23, 2.55)
Site A		Reference		Reference

[†] aRR = adjusted risk ratio using robust standard errors.

COVID-19 vaccine recommendation from a provider can be a strong motivator to improve confidence and coverage [27], deep and often well-earned mistrust of established institutions (e.g., clinics or hospitals) may persist among some PEH [28]; thus, multiple channels of engagement may be important to provide the greatest cumulative effect to increase COVID-19 vaccine coverage. Our findings about reasons and factors associated with vaccination can be used to tailor programming to increase accessibility of information and vaccine uptake.

These findings are subject to several limitations. Information bias may be present due to self-report, such as social desirability bias. For example, there may be a tendency to respond favorably as vaccinated or planning to be vaccinated due to fear of losing access to shelter services or employment. To mitigate this limita-

tion and reduce potential misclassification, we provided options of “Don’t know” and “Prefer not to say,” as well as verbal and written assurances that data would remain anonymous to shelter administration. Furthermore, recall bias is likely present given the need for participants to remember perceptions and vaccination intent at previous timepoints. However, we used seasons to help with recall at various timepoints. As there was limited data available about the content and how actively residents and staff participated in COVID-19 educational events, understanding the relationship between these and change vaccination intent is challenging. Results may also be subject to selection bias as participation was voluntary and respondents may not be representative of the overall population of sheltered PEH. Given high levels of distrust of health care providers and documented low rates of health

care use in homeless populations [28–30] participants in our study may not reflect those unwilling to participate and interact with study staff. Thus, vaccine intent among participants may not reflect the intention of those unwilling to participate. Finally, these findings may not be representative of all King County shelters or generalizable to PEH in other locations. However, by including a range of different types of shelters, we attempted to broaden applicability. This study represents the first part of a sequential, two-phased collection and analysis of quantitative and qualitative data. Forthcoming qualitative findings aim to provide further insight on vaccine attitudes, reasons for vaccination, and recommendations to improve COVID-19 vaccine uptake among residents and staff.

Conclusion

We found an overall increase in COVID-19 vaccine acceptability among residents and staff between the beginning of the pandemic and August 2021. Findings highlight opportunities to improve communication with residents and staff about COVID-19 vaccination. While worsening mental health since the start of the pandemic was associated with increased vaccine acceptability over time, we did not identify any modifiable factors that may influence more positive change in COVID-19 vaccination intent. Our findings support a need for continued dialogue and a person-centered approach to understanding the sociocultural complexities and dynamism of vaccine attitudes at shelters. This, along with learnings from qualitative interviews in progress, are critical to successful implementation of programming that are accessible, trusted, and can optimize COVID-19 vaccine coverage.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: **Research Support:** Helen Y. Chu reports financial support was provided by Centers for Disease Control and Prevention. **Relationships:** Dr. Chu reports consulting with The Bill and Melinda Gates Foundation, Ellume, Glaxo Smith Kline, Merck, and Pfizer. She has received research funding from The Bill and Melinda Gates Foundation, Centers for Disease Control and Prevention, Defense Advanced Research Projects Agency, Gates Ventures, National Institutes of Health, Sanofi Pasteur, and support and reagents from Ellume and Cepheid outside of the submitted work. James P. Hughes reports research funding from the National Institutes of Health outside of the submitted work. **Patents and Intellectual Property:** There are no patents to disclose. **Other Activities:** There are no additional activities to disclose.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jvacx.2022.100232>.

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