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Permalink

https://escholarship.org/uc/item/55k6k576

Journal

Open Forum Infectious Diseases, 9(4)

ISSN

2328-8957

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Publication Date

2022-04-01

DOI

10.1093/ofid/ofac103

Peer reviewed

Formal Hepatitis C Education Increases Willingness to Receive Therapy in an On-site Shelter-Based HCV Model of Care in Persons Experiencing Homelessness

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Background. The objective of this study was to evaluate the effectiveness of formal hepatitis C virus (HCV) education on engagement in therapy in persons experiencing homelessness in an on-site shelter-based model of care. As policies to eliminate Medicaid access restrictions to HCV treatment are expanded, patient education is paramount to achieving HCV elimination targets in difficult-to-engage populations including persons experiencing homelessness.

Methods. This prospective study was conducted at 4 shelters in San Francisco and Minneapolis from August 2018 to January 2021. Of the 162 HCV Ab–positive participants, 150 participated in a 30-minute HCV education session. Posteducation changes in knowledge, beliefs, barriers to care, and willingness to accept therapy scores were assessed.

Results. Following education, knowledge scores (mean change, 4.4 ± 4.4; $P < .001$) and willingness to accept therapy (70% to 86%; $P = .0002$) increased. Perceived barriers to HCV care decreased (mean change, -0.8 ± 5.2; $P = .001$). Higher baseline knowledge was associated with lesser gain in knowledge following education (coef., -0.7; $P < .001$). Posteducation knowledge (odds ratio, 1.2; $P = .008$) was associated with willingness to accept therapy.

Conclusions. An HCV educational intervention successfully increased willingness to engage in HCV therapy in persons experiencing homelessness in an on-site shelter-based HCV model of care.

Keywords. hepatitis C; direct-acting antiviral therapy; substance use; HCV education; homelessness.

Hepatitis C virus (HCV) infection has undergone epidemiologic shifts in the last decade [1]. In 2016, the World Health Assembly pledged to eliminate HCV as a public health threat with a goal of 90% reduction in HCV incidence and 65% reduction in HCV mortality by 2030. As part of this pledge, core intervention strategies have focused on harm reduction for people who inject drugs through education campaigns [2]. In the United States, HCV and injection drug use disproportionately affect people experiencing homelessness (PEH) [3]. HCV prevalence among PEH ranges from 9.8% to 52%, vs 1.3% in the general population [3–5]. Experiencing homelessness is associated with known risk factors for HCV and transmission, such as substance use, injection drug use, syringe sharing, mental illness, and history of incarceration [6–9].

PEH are not only at increased risk for acquisition and transmission of HCV, but also encounter heightened barriers to care including perceived stigma and medical mistrust and competing priorities such as securing housing or employment [6, 10–12]. Barriers to care and lack of awareness of HCV have led to both underdiagnoses and undertreatment in this patient population [13, 14]. As policies to eliminate Medicaid access restrictions for HCV treatment across states are enacted, access to care for PEH is projected to be cost-effective and paramount to HCV elimination goals [15, 16]. Strategies to strengthen the hepatitis C cascade of care in PEH have included implementation of screening and linkage-to-care protocols as well as shelter-based direct antiviral therapy in this population [17–19]. As direct antiviral therapy becomes possible in a shelter-based model for PEH, identification of barriers to care is critical to successful outcomes.

Prior studies have identified low baseline HCV knowledge scores among PEH [20]. Studies conducted during the interferon era of HCV therapy have demonstrated the critical role

of education in vulnerable populations by improving HCV knowledge, enhancing HCV care coordination, expediting HCV treatment, and improving antiviral response [21–23]. In the era of direct-acting anti-HCV therapy, key principles identified in the interferon era should be evaluated when creating new models of care for vulnerable populations including PEH. In 1 study where greater than one-third of the study participants were experiencing homelessness, a 15-minute HCV educational intervention improved knowledge scores regarding HCV transmission, disease progression, and expected treatment outcomes [24].

Our prior work in 4 geographically diverse shelters in San Francisco and Minneapolis supports the critical need for implementation of an HCV education intervention as part of a shelter-based model of care for HCV-infected PEH [12, 25]. When interviewing shelter clients, we identified misconceptions and limited HCV knowledge including themes surrounding screening, transmission, and treatment, as well as social stigma against PEH [12]. Prior theoretical models such as the health behavior framework (HBF) provide useful tools for guiding exploration of the complex interplay of factors that can help shape HCV disease understanding and management. The efficacy of the HBF as a guide for community-level intervention has been validated among multiple communities, including those at risk of viral hepatitis infection [26]. This framework is a multidimensional model that synthesizes multiple models of health behavior, social theory, and change to map factors that influence intentions [27]. The HBF assumes that individual, support system, and community cues influence health behavior, for example, willingness to accept HCV therapy. In this study, we used the established HBF constructs to assess HCV knowledge, beliefs, and perceived barriers to HCV care across geographically diverse shelter populations and evaluated the impact of a comprehensive formal HCV educational intervention on changes in these parameters and willingness to accept HCV treatment.

METHODS

Population
This prospective study was conducted by a multidisciplinary team at 4 large homeless shelters, 2 in San Francisco, California, and 2 in Minneapolis, Minnesota, from August 1, 2018, to January 30, 2021 [28]. Shelters for PEH included in this study provide support services on a daily basis to >600 residents in San Francisco and between 170 and 350 residents in Minneapolis. Following informed consent, adults ≥18 years of age seeking shelter services with the ability to read and write in English, and who were either treatment naïve or had not received prior HCV treatment within the prior 12 weeks, were enrolled. Patients with significant medical or psychiatric conditions that prevented participation in the study were excluded.

For this analysis, participants who were hepatitis C antibody (HCV Ab) positive (based on point-of-care testing or serologic testing) were included.

Study Intervention
Participants meeting study eligibility criteria completed a formal 30-minute HCV education session using a standardized Power Point slide format presented by a designated HCV coordinator (RN, PharmD, or advanced practice provider). Education was provided on-site and offered to participants on the same day as screening or at another convenient time and included up to 10 participants. The content of our education session consisted of information related to HCV epidemiology, transmission, diagnosis, natural history, HCV therapy, and vaccination for hepatitis A and hepatitis B, as well as resources for substance use disorder therapy (alcohol and injection drug use), syringe access services, and linkage to liver disease care. In addition, efforts were made to specifically address previously identified potential common perceived barriers and misconceptions about HCV infection and treatment [12]. A pre-education questionnaire and a posteducation questionnaire were completed to assess the participants' demographic and substance use characteristics, risk factors for HCV, and internalized HCV stigma, as well as knowledge of, attitudes toward, and barriers to HCV care. Participants were given a $25 incentive for completion of the HCV education and questionnaires.

Patient Consent
Institutional review board approvals were obtained from the University of California San Francisco and Hennepin Healthcare Human Subjects Research Committee, and all participants provided written consent.

Questionnaire Design and Measures
The questionnaire instrument was developed using the Health Behavior Framework with input from expert hepatologists and behavioral scientists experienced in health behavior change research and information from published studies in patients with hepatitis and substance use disorders [12, 21, 27, 29–31]. In addition, the rigorous questionnaire development process also included engagement with shelter stakeholders and participants experiencing homelessness through qualitative interviews [12, 25]. The final questionnaire items were then organized into 3 domains: (1) HCV knowledge, (2) beliefs about HCV infection, and (3) barriers to HCV care (Supplementary Table 1). We then performed the Cronbach's alpha test to assess for internal consistency and the scale reliability coefficient (alpha) of each of these domains in our questionnaire instrument. Cronbach's alpha test score for the HCV knowledge domain was 0.9, for the beliefs domain it was 0.8, and for the barriers domain it was 0.95, indicating good to excellent scale reliability of our questionnaire.

Data Analysis

Descriptive analyses of patient characteristics were performed to obtain frequency (%) for categorical variables and median (interquartile range [IQR]) or mean (SD) for continuous variables. We then compared patient characteristics between patients who had detectable and undetectable HCV RNA. Categorical variables were compared using the chi-square (χ^2) test or the Fisher exact test (if appropriate), while continuous variables were compared using the Mann-Whitney test.

Questionnaire responses were summarized using frequencies and percentages. Composite scores for each of the domains and subdomains were calculated from responses to questions designed to assess these factors as follows: (Domain 1) Knowledge score was computed as the number of correct responses to 21 questions (1 for correct, 0 for incorrect or do not know; max score 21); (Domain 2) Beliefs about HCV infection score were determined by summing numerical codes (1 or 0) assigned to the responses for the corresponding subdomains: perceived severity (max score of 5), stigma (max score of 5), treatment efficacy (max score of 1), perceived susceptibility to disease risk (max score of 3); (Domain 3) Barriers to HCV treatment (max score of 21) was assessed using a Likert Scale and coded as 0 for extremely confident, 1 for moderately confident, 2 for slightly confident, and 3 for not confident, with higher scores representing higher perceived barriers. Willingness to accept therapy was also assessed using a 5-point Likert scale and coded as 1 for extremely likely and 0 for not at all. Mean scores between pre-education and posteducation were examined using the Wilcoxon signed-rank test.

Univariate and multivariate forward linear regression (for linear scale) and logistic regression (for dichotomous scale) modeling were used to assess factors associated with 2 outcomes following educational intervention: (1) change in knowledge (linear scale) and (2) willingness to accept hepatitis C treatment (dichotomous scale: 1 = extremely likely, 0 = all other categories). Predictors included those selected a priori. The multivariable model for the outcome of change in knowledge was adjusted for age, sex, race, and education and included baseline predictors with a *P* value <.05 on forward regression. The multivariable model for the outcome of willingness to accept hepatitis C treatment was adjusted for age, sex, and race and included both baseline predictors along with posteducation predictors of knowledge, beliefs, and barriers with a *P* value <.05 on forward regression. All analyses were performed using Stata 15 statistical software (Stata Corp LP, College Station, TX, USA).

RESULTS

Participants

Availability of HCV testing sessions was advertised in the shelters, and in addition 1199 shelter clients were directly approached for HCV Ab testing. A total of 772 clients agreed to participate in the study, of whom 766 were deemed eligible. Of the 766 participants, a total of 162 were HCV antibody positive and eligible to receive HCV education. Of these,155 agreed to receive education and completed the pre-education questionnaire (99 in San Francisco and 56 in Minneapolis), and 150 received education and completed the posteducation questionnaire. One participant who did not complete a pre-education questionnaire completed a posteducation questionnaire. Table 1 summarizes patient characteristics (n = 155). The median age of the participants was 56, and 75% were men. Nearly two-thirds of the study population identified as racial/ethnic minorities. The education level among the study population varied, with 25% completing less than a high school education. The overall median length of homelessness was 18 months. With respect to substance use, >80% of the participants had used illicit drugs in the past year, one-third had heavy alcohol consumption, and approximately two-thirds had a history of injection drug use or had received substance use disorder therapy in the past. Nearly 60% had a history of psychiatric illness, most participants reported having a health care provider (78.7%), and nearly 90% were publicly insured. Overall, two-thirds of the participants had a detectable HCV RNA. There was a significant difference in the proportion of participants with detectable HCV RNA by shelter location: 57.3% were from San Francisco, and 42.7% were from Minneapolis. A higher proportion of those with undetectable HCV RNA had a history of psychiatric illness compared with those who had detectable HCV RNA (70.0% vs 52.9%), but this did not quite reach statistical significance (*P* = .054). There were no other significant differences in other participant characteristics by HCV RNA status (Table 1).

Change in HCV Knowledge, Beliefs, and Perceived Barriers to HCV Care and Willingness to Accept Therapy Following Education

The mean baseline knowledge score before education was 12.4. The most common (>50% of respondents) knowledge deficit was related to HCV treatment, followed by modes of transmission of HCV. Following education, there was an increase in knowledge score to 16.9, with the mean change in score following education being 4.4 points (*P* < .001) (Table 2). When evaluating knowledge scores across shelter sites, San Francisco participants had higher baseline HCV knowledge scores compared with Minneapolis participants (mean score ± SD, 13.3 ± 4.3 vs 10.9 ± 4.9; *P* < .001), and the mean change in knowledge score following education was higher among Minneapolis participants compared with San Francisco participants (mean score ± SD, 5.4 ± 4.2 vs 3.9 ± 4.4; *P* = .04). With respect to beliefs about HCV and barriers to HCV care, the most common (>50% of respondents) belief was related to feelings of self-blame or blame by others for having HCV infection, and the most commonly perceived barriers to HCV care was keeping doctors' appointments and adherence to HCV medication when actively using substances (alcohol or drug use).

Table 1. Demographics of Participants Completing Pre-education Questionnaire

	Total (n = 155)	Detectable HCV RNA (n = 103)	Undetectable HCV RNA (n = 52)	P Value[a]
Age, median, y	56.1	55.7	56.6	.6
[IQR], y	[49.7–63]	[48.8–62.7]	[51–63.2]	
(range), y	(21.2–82.1)	(21.2–82.1)	(31.7–75.4)	
Male, No. (%)	116 (74.8)	80 (77.7)	36 (69.2)	.3
Race, No. (%)	n = 154		n = 51	.1
White, non-Hispanic	60 (39.0)	46 (44.7)	14 (27.5)	
Black/African American	64 (41.6)	41 (39.8)	23 (45.1)	
Hispanic	14 (9.1)	8 (7.8)	6 (11.8)	
Other	16 (10.4)	8 (7.8)	8 (15.7)	
Education level, No. (%)	n = 154	n = 102		.2
Less than HS	38 (24.7)	22 (21.6)	16 (30.8)	
High school	60 (39.0)	45 (44.1)	15 (28.9)	
More than high school/GED	56 (36.4)	35 (34.3)	21 (40.4)	
Shelter location, No. (%)				**.02**
San Francisco	99 (63.9)	59 (57.3)	40 (76.9)	
Minneapolis	56 (36.1)	44 (42.7)	12 (23.1)	
Length of homelessness	n = 149	n = 99	n = 50	.4
Median, mo	18.0	17.2	24.0	
[IQR], mo	[5.0–60.0]	[5.0–60.0]	[8.0–60.0]	
Illicit drug use within the past year, No. (%)	n = 154	n = 102	46 (88.5)	.4
	130 (84.4)	84 (82.4)		
History of injection drug use ever, No. (%)	n = 152	n = 102	34 (68)	.9
	101 (66.5)	67 (65.7)		
History of substance use disorder therapy, No. (%)	n = 150	n = 99	n = 51	1.0
	95 (63.3)	63 (63.6)	32 (62.8)	
Alcohol use within the past year, No. (%)	n = 153	n = 101	n = 52	1.0
None/minimal	65 (42.5)	42 (41.6)	23 (44.2)	
Moderate	37 (24.2)	25 (24.8)	12 (23.1)	
Heavy	51 (33.3)	34 (33.7)	17 (32.7)	
HIV co-infection, No. (%)	n = 147	n = 101	n = 46	.7
	6 (4.1)	5 (5.0)	1 (2.2)	
History of psychiatric illness, No. (%)	n = 152	n = 102	n = 50	.054
	89 (58.6)	54 (52.9)	35 (70.0)	
Has a health care provider, No. (%)	n = 141	n = 98	n = 43	.3
	111 (78.7)	80 (81.6)	31 (72.1)	
Insurance type, No. (%)	n = 145	n = 96	n = 49	1.0
Public	129 (89.0)	85 (88.5)	44 (89.8)	
Private	6 (4.1)	4 (4.2)	2 (4.1)	
Uninsured	10 (6.9)	7 (7.3)	3 (6.1)	

[a]Categorical variables were compared using the chi-square (χ^2) test or Fisher exact test (if appropriate), while continuous variables were compared using the Mann-Whitney test ($P < .05$ considered significant).

Bolded values in the table reflect statistically significant values where $P < .05$.

Abbreviations: HCV, hepatitis C virus; IQR, interquartile range.

Table 2. Knowledge, Beliefs, and Barrier Scores Before and After Education

	Pre-education		Posteducation		Mean Change		
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD	P Value
Domain 1: Knowledge	150	12.4 ± 4.7	146	16.9 ± 3.4	141	4.4 ± 4.4	**<.001**
Domain 2: Beliefs about HCV infection							
(a) Perceived severity	152	3.7 ± 1.3	134	4.6 ± 0.6	130	0.9 ± 1.3	**<.001**
(b) Stigma	152	2.9 ± 1.5	148	2.6 ± 1.5	145	0.0 ± 1.3	1.0
(c) Treatment efficacy	154	0.7 ± 0.5	150	0.9 ± 0.3	148	0.2 ± 0.5	**<.001**
(d) Perceived susceptibility to disease risk	154	2.6 ± 0.8	145	2.9 ± 0.3	143	0.3 ± 0.8	**<.001**
Domain 3: Barriers to HCV treatment	151	4.6 ± 6.3	146	3.6 ± 5.7	142	−0.8 ± 5.2	**.001**

Bolded values in the table reflect statistically significant values where $P < .05$.

Abbreviation: HCV, hepatitis C virus.

For all participants, in beliefs about HCV infection there was an increase in perceived severity (mean score, 3.7 to 4.6 out of max score 5; $P < .001$), perceived susceptibility to disease risk (mean score, 2.6 to 2.9 out of max score 3; $P < .001$), and treatment efficacy (0.7 to 0.9 out of max score 1; $P < .001$) following education. There was a reduction in perceived barriers to HCV treatment following education (pre-education mean score, 4.6; posteducation mean score, 3.6 out of max score 21; $P = .001$). The reduction in stigma following education did not reach statistical significance (2.9 to 2.6 out of max score 5; $P = 1.0$) (Table 3). Before education, the proportion of participants who were extremely likely to accept HCV therapy if needed was 70.8%. Following education, the proportion was 86% ($P = .0002$).

Baseline Factors Associated With Change in Knowledge
On univariate analysis, shelter site (Minneapolis vs San Francisco; coef., 1.5; 95% CI, 0.01 to 2.9; $P = .048$) and heavy alcohol use within the past year (coef., 2.0; 95% CI, 0.4 to 3.7; $P = .02$) were associated with higher change in knowledge. Baseline knowledge score (coef., –0.7; 95% CI, –0.78 to –0.56; $P < .0001$), baseline scores of perceived severity (coef., –1.2; 95% CI, –1.6 to –0.7; $P < .001$), treatment efficacy (coef., –2.6; 95% CI, –4.1 to –1.0; $P = .001$), and perceived susceptibility to disease risk (coef., –2.6; 95% CI, –3.4 to –1.8; $P < .001$) were associated with lesser change in knowledge (Table 3).

On multivariate analysis, when adjusting for age, sex, race/ethnicity, and education, higher baseline knowledge score was associated with lesser change in knowledge (coef., –0.7; 95% CI, –0.8 to –0.6; $P < .0001$), and a history of substance use disorder therapy was associated with greater change in knowledge (coef., 1.4; 95% CI, 0.3 to 2.5; $P = .01$) (Table 3). To address any possible differential influence of HCV RNA–positive and –negative status on change in knowledge, a sensitivity analysis was performed that limited the analysis to HCV RNA–positive participants and showed that baseline HCV knowledge was the only independent predictor of change in knowledge (coef., –0.74; 95% CI, –0.96 to –0.51; $P < .0001$) following education on adjusted analysis.

Factors Associated With Willingness to Accept HCV Treatment
On univariate analysis, posteducation knowledge score (OR, 1.2; 95% CI, 1.0 to 1.3; $P = .008$) was positively associated with a willingness to accept HCV treatment, and posteducation stigma score (OR, 0.7; 95% CI, 0.5 to 0.95; $P = .03$) and posteducation barrier score (OR, 0.9; 95% CI, 0.8 to 0.97; $P = .006$) were negatively associated with a willingness to accept HCV treatment (Table 4).

On multivariate analysis, when adjusting for age, sex, and race/ethnicity, the posteducation knowledge score was associated with 1.2 times greater odds of willingness to accept therapy (OR, 1.2; 95% CI, 1.03 to 1.3; $P = .02$), and higher posteducation stigma score was associated with lower odds of willingness to

accept therapy (OR, 0.7; 95% CI, 0.5 to 0.95; $P = .03$) (Table 4). When including the posteducation barrier score in the final model, while the direction of the estimated effect of both posteducation knowledge and stigma scores remained the same, the estimated effect size of the posteducation knowledge score decreased slightly, and the P value was no longer statistically significant (OR, 1.1; 95% CI, 0.98 to 1.3; $P = .1$). In a sensitivity analysis that was limited to HCV RNA–positive participants, posteducation HCV knowledge was the only independent predictor of willingness to accept therapy, with the same effect size as the whole cohort (OR, 1.21; 95% CI, 1.00 to 1.46; $P = .049$) following education on adjusted analysis.

DISCUSSION

This is the first study to evaluate the impact of formal HCV education on willingness to accept therapy in an on-site shelter-based HCV model of care for PEH. In this study, we conducted a targeted HCV educational intervention for this high-risk population. We demonstrated the effectiveness of an educational intervention in scores across all questionnaire domains of knowledge, beliefs about HCV infection, and barriers to HCV treatment. We showed that while HCV knowledge increased and barriers to care decreased following education, the presence of stigma regarding HCV did not change with education and was associated with decreased willingness to accept therapy. Conversely, posteducation knowledge score was the only predictor of increased willingness to accept therapy that was independent of perceived barriers to HCV care and beliefs about HCV, including perceived HCV stigma.

Our education session was specifically designed to encompass all aspects of HCV disease including prevention and management given our prior evaluation of knowledge gaps in shelter stakeholder and client perspectives [12, 25], as well as prior patient HCV interventions in at-risk populations [20–24]. Baseline knowledge scores across our participant population were low, which is consistent with prior literature that assessed vulnerable populations and included participants experiencing homelessness [20, 22, 24]. These gaps in knowledge highlight the imperative of a patient-centered education pillar as part of a comprehensive HCV shelter-based model of care. Indeed, our study population was high-risk for active HCV infection and part of marginalized groups associated with lower linkage to HCV care due to barriers in accessing care. The majority of our study participants had a history of illicit drug use, active heavy alcohol use, and a history of psychiatric illness [9, 32]. Despite this, HCV knowledge increased across all groups following our formal HCV education.

In addition, our study examined 2 geographically distinct regions. Though there were no differences in participant education levels across shelter sites, participants from Minneapolis had lower baseline HCV knowledge than participants from San

Table 3. Univariable and Multivariable Analysis of Factors Associated With Change in Knowledge Score Following Education

		Univariable Analysis			Multivariable Analysis (n = 137)		
	No.	Coef.	95% CI	PValue	Coef.	95% CI	PValue[a]
Age	141	0.02	−0.05 to 0.08	.6	0.01	−0.5 to 0.5	1.0
Female sex	141	−1.5	−3.2 to 0.12	.07	−0.5	−1.8 to 0.7	.4
Race, No. (%)	140						
White, non-Hispanic		Ref.					
Black/African American		0.4	−1.3 to 2.0	.7	−1.1	−2.4 to 0.10	.1
Hispanic		2.6	−0.3 to 5.4	.08	0.1	−1.9 to 2.1	.9
Other		−0.7	−3.2 to 1.8	.6	−0.8	−2.6 to 1.0	.4
Education level, No. (%)	140						
Less than HS		Ref.					
High school		0.5	−1.4 to 2.4	.6	0.3	−0.9 to 1.5	.6
More than high school/GED		0.2	−1.8 to 2.1	.9	—	—	—
Shelter location, No. (%)	141						
San Francisco		Ref.					
Minneapolis		1.5	0.01 to 3.0	**.048**	—	—	—
Length of homelessness, mo	136	−0.001	−0.01 to 0.01	.8	—	—	—
Illicit drug use within the past year, No. (%)	140	−0.9	−2.9 to 1.2	.4	—	—	—
History of injection drug use ever, No. (%)	140	−0.9	−2.9 to 1.2	.4	—	—	—
History of substance use disorder therapy, No. (%)	138	−0.1	−1.6 to 1.4	.9	1.4	0.3 to 2.5	**.01**
Alcohol use within the past year, No. (%)	139						
None/minimal/moderate		Ref.			—		
Heavy		1.1	−0.7 to 3.0	.2	—		
		2.0	0.4 to 3.7	**.018**	—		
HIV co-infection, No. (%)	135	−2.9	−6.7 to 1.0	.1	—	—	—
History of psychiatric illness, No. (%)	139	−1.1	−2.6 to 0.4	.2	—	—	—
Has a health care provider, No. (%)	128	−0.05	−2.0 to 1.9	1.0	—	—	—
Domain 1: Baseline knowledge	141	−0.7	−0.8 to −0.6	**<.001**	−0.7	−0.8 to −0.6	**<.001**
Domain 2: Baseline							
Beliefs About HCV infection							
(a) Perceived severity	139	−1.2	−1.6 to −0.7	**<.001**	—		
(b) Stigma	138	0.2	−0.3 to 0.7	.4	—		
(c) Treatment efficacy	141	−2.5	−4.1 to −1.0	**.001**	—		
(d) Perceived susceptibility to disease risk	141	−2.6	−3.4 to −1.8	**<.001**	—		
Domain 3: Baseline							
Barriers to HCV treatment	138	0.004	−0.1 to 0.1	.9	—		

Abbreviation: HCV, hepatitis C virus.

Bolded values in the table reflect statistically significant values where $P < .05$.

[a]Mean scores were compared using Wilcoxon signed-rank test ($P < .05$ considered significant).

Table 4. Univariable and Multivariable Analysis of Factors Associated With Willingness to Accept Therapy Following Education: San Francisco and Minneapolis, Aug 2018–Jan 2021

	No.	Univariable Analysis			Multivariable Analysis (n = 144)		
		OR	95% CI	PValue	OR	95% CI	PValue
Age	150	0.8	0.5 to 1.2	.3	1.0	0.5 to 1.6	.9
Female sex	150	2.2	0.5 to 1.2	.2	2.1	0.5 to 9.2	.3
Race, No. (%)	149						
White, non-Hispanic		Ref.					
Black/African American		0.5	0.2 to 1.5	.2	0.7	0.2 to 2.4	.6
Hispanic		1.3	0.1 to 12.3	.7	1.7	0.2 to 18.2	.6
Other		0.5	0.1 to 2.2	.4	0.5	0.1 to 2.8	.5
Education level, No. (%)	149						
Less than HS		Ref.					
High school		2.0	0.6 to 7.3	.3	—	—	—
More than high school/GED		1.0	0.3 to 3.0	1.0	—	—	—
Shelter location, No. (%)	150						
San Francisco		Ref.					
Minneapolis		0.9	0.3 to 2.4	.9	—	—	—
Length of homelessness, mo	144	1.0	0.99 to 1.0	.5	—	—	—
Illicit drug use within the past year, No. (%)	149	0.5	0.1 to 2.5	.4	—	—	—
History of injection drug use ever, No. (%)	147	1.2	0.4 to 3.2	.7	—	—	—
History of substance use disorder therapy, No. (%)	145	1.8	0.7 to 4.8	.2	—	—	—
Alcohol use within the past year, No. (%)	148						
None/minimal		Ref.					
Moderate		2.1	0.5 to 8.1	.3	—	—	—
Heavy		1.1	0.4 to 3.2	.8	—	—	—
HIV co-infection, No. (%)	143	0.7	0.1 to 6.3	.7	—	—	—
History of psychiatric illness, No. (%)	148	0.8	0.3 to 2.1	.7	—	—	—
Has a health care provider, No. (%)	137	1.5	0.5 to 4.7	.5	—	—	—
Domain 1: Posteducation knowledge score	147	1.2	1.04 to 1.3	**.008**	1.2	1.0 to 1.3	**.02**
Domain 2: Posteducation							
Beliefs About HCV infection score							
(a) Perceived severity	134	1.8	0.9 to 3.8	.1	—	—	—
(b) Stigma	148	0.7	0.5 to 0.95	**.03**	0.7	0.5 to 0.96	**.03**
(c) Treatment efficacy	150	0.9	0.2 to 4.4	.9	—	—	—
(d) Perceived susceptibility to disease risk	145	1.6	0.3 to 6.7	.5	—	—	—
Domain 3: Posteducation barriers to HCV treatment	146	0.9	0.8 to 0.97	**.006**	—	—	—

Bolded values in the table reflect statistically significant values where *P* < .05.

Abbreviations: HCV, hepatitis C virus; OR, odds ratio.

Francisco. The baseline differences in knowledge may reflect public health efforts in the respective cities. For example, San Francisco launched the EndHepC SF campaign in 2016, allocating public funds for testing, treatment, and education regarding HCV infection [33]. Participants in both sites, however, had an increase in mean knowledge score following education.

We identified specific baseline factors that were independently associated with change in knowledge. As expected, having a higher baseline knowledge score was associated with lesser gain in knowledge post education. This likely reflects that education has a greater influence in enhancing knowledge among those with lower baseline knowledge scores. Interestingly, on univariate analysis heavy alcohol use was associated with higher change in knowledge. This subpopulation is uniquely vulnerable given the known heightened risks of alcohol consumption in cirrhosis [34]. In addition, prior literature highlights a knowledge gap in patients with heavy alcohol consumption and disease risk and may demonstrate potential for greater change in knowledge following education in this population [35]. While heavy alcohol use and other substance use were not independent predictors of change in knowledge in our multivariable analysis, a history of substance therapy was associated with a higher posteducation knowledge score. This suggests that these clients may significantly benefit from integration of formal HCV education in substance use programs and thus represents a patient-centered opportunity to enhance HCV care in this population.

We have shown that higher posteducation knowledge is associated with greater odds of willingness to accept HCV therapy, emphasizing the importance of formal education in linkage to HCV care, and consequently HCV elimination efforts in PEH. Stigma represents an additional component in health behavior frameworks where perceived stigma is a determinant of health behaviors [36]. In our study, a higher stigma score despite education was negatively associated with willingness to accept HCV therapy. Public health interventions in this area aimed at positive outcomes of treatment should directly address patients' perceived and self-stigma. This may enhance willingness to accept therapy and prevent liver disease progression. Willingness to undergo therapy may be enhanced by integration of HCV care on-site at shelters. Previous studies have identified that the likelihood of linkage to care increases for PEH when they have an assigned shelter bed for the evening before an appointment and that PEH also cite distance and cost of traveling to the clinic as predominant barriers to HCV care [18]. Although we also observed that higher posteducation perceived barrier scores were associated with lower odds of willingness to accept HCV therapy, this was no longer statistically significant when accounting for other factors including posteducation HCV knowledge and stigma scores.

Our study has several limitations. Despite inclusion of 2 geographically distinct regions, our findings may not be generalizable to other populations of PEH. About three-quarters of our population had completed at least a high school education, and HCV education was conducted in English. In addition, participants who engaged in HCV education may have been more motivated than those who did not receive HCV education, which may have influenced their willingness to subsequently engage in HCV therapy. While the assessment of the internal consistency of the domains in our questionnaire instrument showed good to excellent consistency, further studies are needed to validate the use of this questionnaire in other settings. Nonetheless, our study demonstrated the efficacy of an educational intervention across participants of diverse geographic and racial/ethnic backgrounds.

In summary, we provide evidence for the effectiveness of formal HCV education to enhance willingness to engage in HCV therapy as part of an HCV shelter model of care for PEH. Formal HCV education is a key component of the comprehensive HCV model of care delivery based on the health behavior framework [27]. Here, we demonstrate that formal HCV education is critical in engaging a particularly vulnerable and high-risk population of patients in HCV therapy as part of a novel, comprehensive, and on-site shelter-based HCV model of care for PEH.

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