Title

A Novel Measure to Assess Variation in Hepatitis C Prevalence Among Homeless and Unstably Housed Veterans, 2011-2016.

Journal

Public Health Reports, 134(2)

Authors

Byrne, Thomas

Troszak, Lara

Midboe, Amanda

et al.

Publication Date

2019

DOI

10.1177/0033354918821071

Peer reviewed

PUBLIC
HEALTH
REPORTS

Public Health Reports
2019, Vol. 134(2) 126-131

DOI: 10.1177/0033354918821071
journals.sagepub.com/home/phr
SAGE

A Novel Measure to Assess Variation in Hepatitis C Prevalence Among Homeless and Unstably Housed Veterans, 2011-2016

Thomas Byrne, PhD[1,2]; Lara Troszak, MA[3]; Amanda M. Midboe, PhD[3]; B. Graeme Fincke, MD[1,4]; Michael Shwartz, PhD[5]; Allen L. Gifford, MD[4,5]; and D. Keith McInnes, ScD, MS[1,4]

Abstract

We constructed a novel measure of homelessness to examine differences in hepatitis C virus (HCV) prevalence across 3 categories of unstably housed and homeless veterans and across US Department of Veterans Affairs Medical Center facilities. We used Veterans Affairs administrative data to classify a cohort of 434 240 veterans as at risk of homelessness, currently homeless, or formerly homeless, and we examined variation in HCV prevalence by using descriptive measures and mixed-effect logistic regression models. HCV prevalence was highest among veterans who were formerly homeless (16.7%; 32 490 of 195 000), followed by currently homeless (12.4%; 22 050 of 178 056) and at risk of homelessness (8.2%; 5015 of 61 184). Veterans Affairs Medical Center–level prevalence ranged from 5.4% to 21.5%. Differences in HCV prevalence were significant by sex, race/ethnicity, and age. Targeting specific populations of homeless veterans for tailored HCV interventions and allocating additional resources to certain Veterans Affairs Medical Centers may be warranted.

Keywords

hepatitis, homelessness, housing, veterans' health, health care delivery

Homelessness is associated with a range of chronic health conditions and leads to substantial disease management challenges.[1,2] For example, the estimated prevalence of hepatitis C virus (HCV) infection among persons experiencing homelessness is higher than that of their nonhomeless counterparts.[3] However, little is known about how the prevalence of HCV infection varies among homeless adults and whether various indicators of homelessness and unstable housing may be associated with differences in the rates of HCV infection.

Several studies[4,5] have relied on a broad and binary definition of homelessness, which groups together persons who are at risk of homelessness, currently homeless, and formerly homeless. Such measures likely mask differences in the prevalence of HCV infection among persons experiencing various types of unstable housing (eg, living in unaffordable, poor quality, or "doubled-up" [ie, in which individuals cannot maintain their own housing for economic or other reasons and are living with family or friends] housing) that may place them at risk of homelesness, persons actually experiencing homelessness (ie, meeting the federal definition of homelessness[6]), and persons who are formerly homeless. Assessing the nature and extent of such differences may provide actionable information for refining clinical care and population health strategies to improve the engagement and retention in HCV care for people experiencing homelessness and unstable housing.

We used data from the US Department of Veterans Affairs (VA) health care system to construct a novel 3-category measure that identifies veterans who are at risk of homelessness, veterans who are currently homeless, and veterans who are formerly homeless. We used these data to examine differences in HCV prevalence across these

[1] Center for Healthcare Organization and Implementation Research, Edith Nourse Rogers Memorial Veterans Hospital, Bedford, MA, USA
[2] Boston University School of Social Work, Boston MA, USA
[3] Center for Innovation to Implementation (Ci2i), VA Palo Alto Health Care System, Stanford University, Palo Alto, CA, USA
[4] Departments of Medicine, and Health Law, Policy, and Management, Boston University Schools of Medicine and Public Health, Boston, MA, USA
[5] Center for Healthcare Organization and Implementation Research, Boston VA Healthcare System, Boston MA, USA

Corresponding Author:
Thomas Byrne, PhD, Research Health Scientist, Center for Healthcare Organization and Implementation Research, Edith Nourse Rogers Memorial Veterans Hospital, 200 Springs Rd, Bedford, MA 01730, USA.
Email: thomas.byrne@va.gov

categories and across the 128 VA Medical Center (VAMC) facilities nationwide to inform system-level efforts to improve the effectiveness of HCV care for this population. We also compared HCV prevalence within each category by sex, age, and race/ethnicity to inform the potential targeting of interventions to subgroups of veterans.

Methods

Our sample included 434 315 veterans who were identified as at risk of homelessness, currently homeless, or formerly homeless and had an HCV antibody test, RNA test, or genotype test taken at any point from January 1, 2011, through December 31, 2016. Our study period coincided with a concerted increase in efforts to prevent and end homelessness among veterans[7] and with the introduction of direct-acting antiretroviral drugs for HCV within the VA.[8] Homelessness data came from 3 VA sources: records from the Homeless Operations Management and Evaluation System[9] and Supportive Services for Veteran Families program[10]; responses to the Veterans Health Administration's (VHA's) Homelessness Screening Clinical Reminder[11]; and electronic medical records from the VHA's Corporate Data Warehouse[12] indicating receipt of care at VHA specialized homeless programs through clinic stop or bed section codes, both of which indicate service type. This study was approved by the Bedford VA Medical Center institutional review board (IRB) and the Stanford University IRB.

We used these data to create a categorical measure of homelessness and unstable housing. We classified veterans as at risk of homelessness if they screened positive for risk (by reporting concern they would lose housing in <60 days) when responding to the Homelessness Screening Clinical Reminder or if they accessed Supportive Services for Veteran Families homelessness prevention services. We classified veterans as currently homeless by using federal statutory definitions,[6] and we included veterans who accessed a VA residential homeless program[13] (based on the Homeless Operations Management and Evaluation System), used Supportive Services for Veteran Families rapid rehousing services (which requires literal homelessness as an eligibility criteria), or reported current homelessness when responding to the Homelessness Screening Clinical Reminder. We classified veterans as formerly homeless and in long-term supportive housing if they received services from the US Department of Housing and Urban Development/VA Supportive Housing (HUD-VASH) program, which provides HUD housing vouchers and VA supportive services to permanently house highly vulnerable, chronically homeless veterans. This designation reflects the fact that, once housed, veterans residing in HUD-VASH housing are no longer considered homeless per the federal definition. For veterans who met multiple criteria, we created a hierarchy in which former homelessness superseded current homelessness and current homelessness superseded risk of homelessness. Former homelessness superseded current homelessness in this hierarchy because a veteran had to be homeless to be eligible for the HUD-VASH services we used to identify formerly homeless veterans. We assigned veterans to the VAMC where they accrued the most outpatient visits during the study period.

We considered veterans to have HCV infection if, during the study period, they received a positive HCV RNA test or an HCV genotype test, which implies the presence of HCV viremia. We identified HCV RNA and HCV genotype tests by searching for relevant phrases in VHA laboratory test names (eg, "HCV RNA" or "HCV geno") in veterans' laboratory records. We ascertained positive RNA tests by inspecting the results of identified RNA tests for evidence of detectable viral load. We obtained data on age, sex, and race/ethnicity from the Corporate Data Warehouse, and we calculated age as of the end of the study period.

We used several descriptive measures (mean, median, range, and interquartile range [IQR]) to compare HCV prevalence among veterans who were at risk of homelessness, veterans who were currently homeless, and veterans who were formerly homeless across VAMCs. We calculated VAMC-level HCV prevalence as the proportion of veterans assigned to a particular VAMC who received a positive HCV RNA test or an HCV genotype test during the study period. We also estimated a series of empty mixed-effect logistic regression models—1 model for all veterans in the sample and separate models for veterans who were at risk of homelessness, veterans who were currently homeless, and veterans who were formerly homeless. In these models, HCV status was the dependent variable, and a random intercept term for VAMC was included. From these models, we calculated the median odds ratio, which quantifies the odds of an unstably housed or homeless veteran having HCV at 1 randomly selected VAMC relative to the odds at of an unstably housed or homeless veteran having HCV at another randomly selected VAMC.[14] In addition, we calculated frequencies to describe HCV prevalence within each homeless category by age group, sex, and race/ethnicity. Finally, we estimated a mixed-effect logistic regression model predicting HCV as a function of whether veterans were at risk of homelessness, currently homeless, or formerly homeless, in which we controlled for age, sex, and race/ethnicity.

Results

We excluded 75 veterans who had missing data on sex or invalid data on age, resulting in a final analytic sample of 434 240 veterans. Of these, 61 184 (14.1%) were at risk of homelessness, 178 056 (41.0%) were currently homeless, and 195 000 (44.9%) were formerly homeless and in permanent supportive housing. Among the full sample of 434 240 veterans, 59 555 (13.7%) veterans were identified as HCV positive. HCV prevalence was highest among veterans who were formerly homeless (n = 32 490, 16.7%), followed by currently homeless (n = 22 050, 12.4%) and at risk of homelessness (n = 5015, 8.2%; Table).

HCV prevalence among homeless and unstably housed veterans varied across VAMCs (Figure). Among all veterans identified as at risk of homelessness, currently homeless, or

Table. Prevalence of hepatitis C virus (HCV) infection among veterans at risk of homelessness, currently homeless, and formerly homeless, by demographic characteristics, 2011-2016[a]

Characteristic[f]	At Risk of Homelessness[b]		Currently Homeless[c]		Formerly Homeless[d]		Any Homeless[e]	
	No.	No. (%) HCV Positive[g]	No.	No. (%) HCV Positive[g]	No.	No. (%) HCV Positive[g]	No.	No. (%) HCV Positive[g]
Total	61 184	5015 (8.2)	178 056	22 050 (12.4)	195 000	32 490 (16.7)	434 240	59 555 (13.7)
Sex								
Female	7107	188 (2.6)	18 332	779 (4.2)	22 576	1345 (6.0)	48 015	2312 (4.8)
Male	54 077	4827 (8.9)	159 724	21 271 (13.3)	172 424	31 145 (18.1)	386 225	57 243 (14.8)
Age, y								
18-29	4872	55 (1.1)	14 202	451 (3.2)	10 839	490 (4.5)	29 913	996 (3.3)
30-39	9684	134 (1.4)	27 977	1094 (3.9)	26 656	1350 (5.1)	64 317	2578 (4.0)
40-49	8624	184 (2.1)	24 882	979 (3.9)	26 870	1524 (5.7)	60 376	2687 (4.5)
50-59	16 290	1641 (10.1)	51 216	7488 (14.6)	71 105	13 549 (19.1)	138 611	22 678 (16.4)
60-69	17 332	2760 (15.9)	49 372	11 176 (22.6)	51 948	14 653 (28.2)	118 652	28 589 (24.1)
≥70	4382	241 (5.5)	10 407	862 (8.3)	7582	924 (12.2)	22 371	2027 (9.1)
Race/ethnicity								
White	35 714	2782 (7.8)	94 724	11 165 (11.8)	89 950	14 939 (16.6)	220 388	28 886 (13.1)
Black/African American	15 384	1623 (10.5)	60 007	8865 (14.8)	80 546	14 379 (17.9)	155 937	24 867 (15.9)
Asian	737	7 (0.9)	1253	36 (2.9)	1019	55 (5.4)	3009	98 (3.3)
American Indian/Alaska Native	626	55 (8.8)	1761	161 (9.1)	2082	262 (12.6)	4469	478 (10.7)
Native Hawaiian/other Pacific Islander	568	26 (4.6)	1141	86 (7.5)	1166	153 (13.1)	2875	265 (9.2)
Multiple races	666	53 (8.0)	1951	199 (10.2)	2226	358 (16.1)	4843	610 (12.6)
Hispanic or Latino (of any race)	5278	322 (6.1)	12 139	1119 (9.2)	13 404	1815 (13.5)	30 821	3256 (10.6)
No response	2211	147 (6.6)	5080	419 (8.2)	4607	529 (11.5)	11 898	1095 (9.2)

[a]Data sources: Veterans Health Administration (VHA) electronic medical record data,[12] records from VHA specialized homeless programs,[9] and responses to the VHA's Homelessness Screening Clinical Reminder.[11]
[b]Includes veterans identified as at risk of homelessness in these data sources.
[c]Includes veterans identified as currently homeless in these data sources.
[d]Includes veterans identified as formerly homeless and in supportive housing in these data sources.
[e]Includes veterans identified as at risk of homelessness, currently homeless, or formerly homeless in these data sources.
[f]Chi-square tests for sex, age, and racial/ethnic differences in HCV prevalence within each category (ie, at risk of homelessness, currently homeless, formerly homeless, and any homeless) were all significant at $P < .001$.
[g]HCV prevalence was calculated as the proportion of veterans in each sex, age, or racial/ethnic category who received a positive HCV RNA test or an HCV genotype test in the study period.

formerly homeless and who were tested for HCV, VAMC-level prevalence of HCV ranged from 5.4% to 21.5% (mean, 13.5%; median, 13.7%; IQR, 11.0%-15.5%). The comparable ranges were 2.5%-16.5% (mean, 8.0%; median, 7.9%; IQR, 6.2%-9.1%) for veterans at risk of homelessness; 3.9%-26.6% (mean, 12.2%; median, 12.0%; IQR, 9.7%-14.8%) for currently homeless veterans; and 8.1%-26.3% (mean, 16.5%; median, 16.2%; IQR, 13.3%-19.5%) for formerly homeless veterans.

The mixed-effect model estimated using the full sample yielded a median odds ratio of 1.30; the median odds ratios from models estimated separately by type of homelessness were identical. This median odds ratio value indicates that the odds of a homeless veteran having HCV were 30% higher at 1 randomly selected VAMC than at another randomly selected VAMC.

Differences in HCV prevalence were significant by sex, age, and race/ethnicity among all categories of homelessness (all $P < .001$), and HCV rates increased by category of homelessness in each demographic subgroup (Table). HCV prevalence was 6 to 12 percentage points higher among men (14.8%) than among women (4.8%). Veterans who were aged 50-69 in 2016 (born between 1947 and 1966) had rates of HCV infection that were several times higher than rates among veterans in other age brackets; nearly 30% of formerly homeless veterans aged 60-69 were HCV positive. HCV prevalence was higher among African Americans than among any other racial/ethnic group across all 3 categories of homelessness.

The mixed-effect logistic regression model predicting HCV status found that, controlling for age, sex, and race/ethnicity, currently homeless veterans were 1.55 (adjusted odds ratio = 1.55; 95% confidence interval [CI], 1.50-1.61) times as likely and formerly homeless veterans were 2.16 (adjusted odds ratio = 2.16; 95% CI, 2.09-2.33) times as likely as veterans at risk of homelessness to be HCV positive.

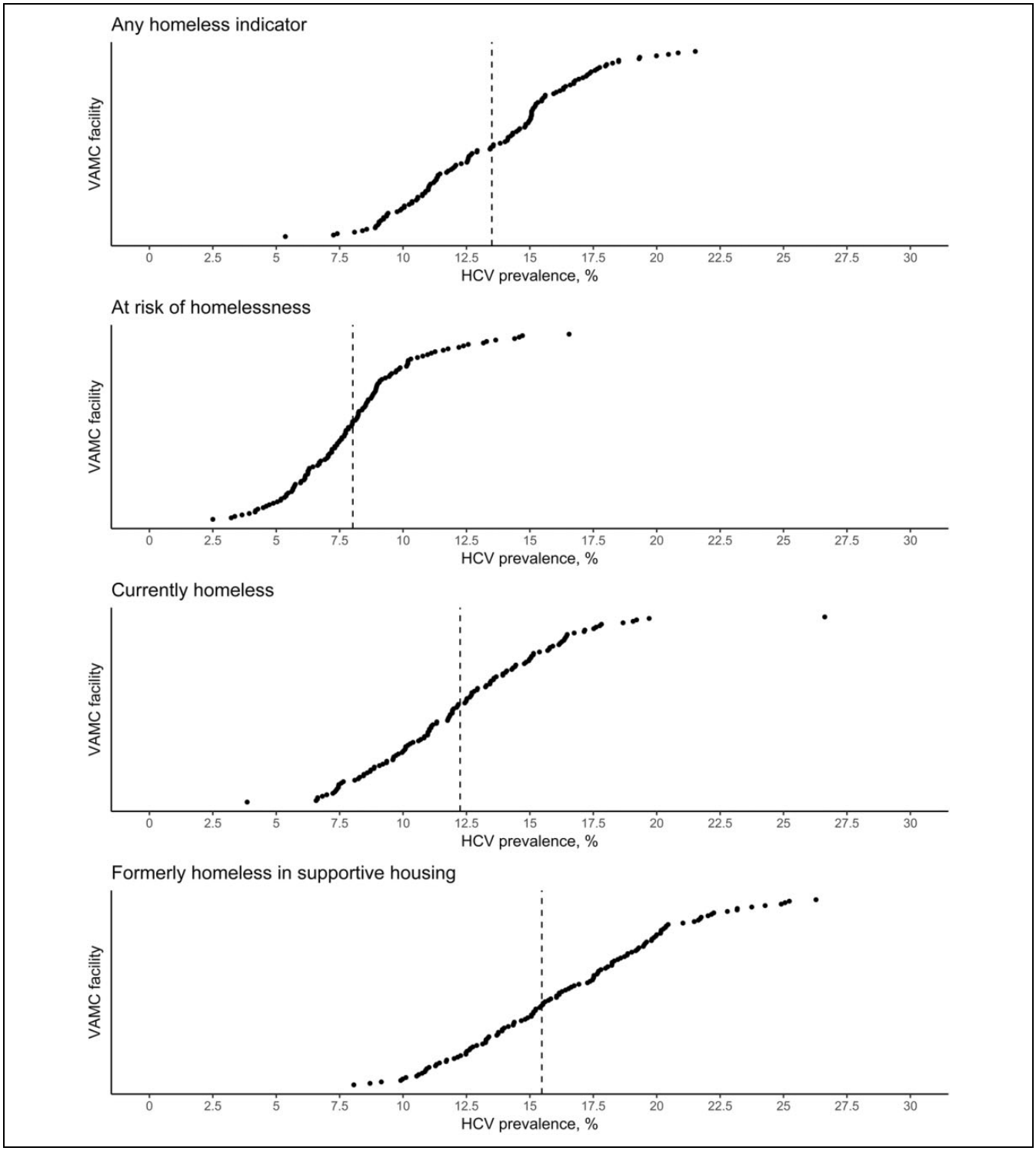

Figure. Variation in hepatitis C virus (HCV) prevalence among homeless veterans across 128 Veterans Affairs Medical Center (VAMC) facilities, 2011-2016. Each dot equals 1 VAMC. Dashed line indicates mean VAMC-level HCV prevalence among veterans who are homeless. VAMC-level HCV prevalence was calculated as the proportion of veterans assigned to a particular VAMC who received a positive HCV RNA test or an HCV genotype test during the study period. Figure is based on data from the following Veterans Health Administration (VHA) sources: electronic medical record data,[12] records from VHA specialized homeless programs,[9] and responses to the VHA's Homelessness Screening Clinical reminder.[11] The group at risk of homelessness includes 61 184 veterans identified as at risk of homelessness in these data sources. The currently homeless group includes 178 056 veterans identified as currently homeless in these data sources. The formerly homeless in supportive housing group includes all 195 000 veterans identified as formerly homeless and in supportive housing in these data sources. The group with any indicator of homelessness includes all 434 240 veterans who were identified as at risk of homelessness, currently homeless, or formerly homeless in these data sources.

Discussion

Three key findings emerged from our study. First, we identified an increasing gradient in HCV prevalence by type of homelessness; veterans at risk of homelessness had the lowest rates of HCV infection, and formerly homeless veterans had the highest rates of HCV infection. We observed this same gradient in all demographic subgroups, and the gradient persisted in mixed-effect models predicting HCV status that controlled for age, sex, and race/ethnicity (results available upon request). Elevated HCV rates among formerly homeless veterans may reflect the measure that captured data on duration of homelessness and the complex health problems that are more common among veterans with an extended history of homelessness than among veterans who experience relatively brief episodes of homelessness.[15] Selection criteria for HUD-VASH prioritizes high-need chronically homeless veterans, who are likely to have more exposure to HCV risk factors such as injection drug use than veterans with more limited histories of homelessness.[15,16] More generally, the observed increasing gradient in HCV infection by homeless status suggests that distinguishing between types of homelessness can illuminate meaningful differences in HCV prevalence that are relevant to clinical practice and public health policy. Specific populations of homeless veterans, particularly formerly homeless veterans residing in HUD-VASH housing, could be targeted for HCV screening and treatment interventions.

Second, we found a 4-fold difference in HCV prevalence among homeless and unstably housed veterans between VAMCs with the highest prevalence of HCV and VAMCs with the lowest prevalence of HCV. This finding contrasts with previous research showing minimal regional variation in HCV prevalence among homeless veterans[4] and points to the potential benefit of allocating additional resources or targeted support to VAMCs with elevated rates of HCV infection among homeless veterans. It is unclear if HCV care outcomes also vary across VAMCs and, thus, profiling VAMCs by their outcomes could improve the quality of HCV care for veterans experiencing homelessness. Such a comparison is an important goal for future research.

Third, we identified differences in HCV prevalence by age, sex, and race/ethnicity that mirrored differences observed in the broader HCV-positive veteran population.[17] The high rates of HCV observed among veterans aged 50-69 in 2016 were likely the product of an age–cohort effect in HCV among veterans born between 1945 and 1965.[18] Veterans in this age group also composed most of our study sample, which was likely due to a separate age–cohort effect in the homeless population affecting the same age group.[19,20] As a result of the combination of these 2 cohort effects, this age group accounted for most of the HCV cases among unstably housed and homeless veterans and should be targeted for interventions. However, a 2018 study found that the largest increase in HCV incidence was among adults aged 18-39, and it associated this increase with the growing opioid epidemic.[21] Therefore, interventions for younger homeless veterans may also be important.

Our study was limited in that our homelessness measure did not fully account for transitions into or out of homelessness or the timing of HCV diagnosis relative to homeless experiences, although it was an advancement from the previous use of binary measures. Future research examining HCV prevalence and other health conditions among veterans experiencing homelessness should consider using a more nuanced definition of homelessness, such as the one we used. A better definition may be particularly important when examining the relationship between homelessness and progress along the HCV care cascade, because evidence suggests that homeless veterans are more likely than their nonhomeless counterparts to be diagnosed with HCV and linked to care but less likely to receive antiviral therapy.[5]

As a large, integrated health care system, the VHA is responsible for providing HCV care to a substantial number of veterans experiencing homelessness. Results from this study can be used to refine efforts at VAMC facilities and among veterans to improve the effectiveness of HCV care for this vulnerable population.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This material is based upon work supported by the Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, Health Services Research and Development grant IIR 15-026. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the United States government. The funder had no role in the study design, data collection and analysis, decision to publish, or preparation of the article.

References

1. Fazel S, Geddes JR, Kushel M. The health of homeless people in high-income countries: descriptive epidemiology, health consequences, and clinical and policy recommendations. *Lancet*. 2014;384(9953):1529-1540. doi:10.1016/S0140-6736(14)61132-6
2. Hwang SW. Homelessness and health. *CMAJ*. 2001;164(2): 229-233.
3. Beijer U, Wolf A, Fazel S. Prevalence of tuberculosis, hepatitis C virus, and HIV in homeless people: a systematic review and meta-analysis. *Lancet Infect Dis*. 2012;12(11):859-870. doi:10.1016/S1473-3099(12)70177-9
4. Noska AJ, Belperio PS, Loomis TP, O'Toole TP, Backus LI. Prevalence of human immunodeficiency virus, hepatitis C virus, and hepatitis B virus among homeless and nonhomeless United States veterans. *Clin Infect Dis*. 2017;65(2):252-258. doi:10.1093/cid/cix295

5. Noska AJ, Belperio PS, Loomis TP, O'Toole TP, Backus LI. Engagement in the hepatitis C care cascade among homeless veterans, 2015. *Public Health Rep*. 2017;132(2):136-139. doi: 10.1177/0033354916689610
6. General definition of a homeless individual. 42 USC § 11302 (2010). https://www.govinfo.gov/app/details/USCODE-2010-title42/USCODE-2010-title42-chap119-subchapI-sec11302. Accessed December 19, 2018.
7. US Interagency Council on Homelessness. *Opening Doors: Federal Strategic Plan to Prevent and End Homelessness*. Washington, DC: US Interagency Council on Homelessness; 2015.
8. Ioannou GN, Beste LA, Chang MF, et al. Effectiveness of sofosbuvir, ledipasvir/sofosbuvir, or paritaprevir/ritonavir/ombitasvir and dasabuvir regimens for treatment of patients with hepatitis C in the Veterans Affairs National Health Care System. *Gastroenterology*. 2016;151(3):457-471.e5. doi:10.1053/j.gastro.2016.05.049
9. US Department of Veterans Affairs. Homeless Operations Management and Evaluation System (HOMES) user manual—phase 1: final draft. 2011. https://www.va.gov/HOMELESS/docs/Center/HOMES_Manual.pdf. Accessed September 23, 2018.
10. US Department of Veterans Affairs. Supportive Services for Veteran Families. https://www.va.gov/homeless/SSVF. Accessed September 23, 2018.
11. Montgomery AE, Fargo JD, Byrne TH, Kane VR, Culhane DP. Universal screening for homelessness and risk for homelessness in the Veterans Health Administration. *Am J Public Health*. 2013;103(suppl 2):S210-S211. doi:10.2105/AJPH.2013.301398
12. US Department of Veterans Affairs Information Resource Center. VA Corporate Data Warehouse. http://vaww.virec.research.va.gov/CDW/RG-CDW-CY12-RA.pdf. Published 2013. Accessed September 23, 2018.
13. US Department of Veterans Affairs. VA programs for homeless veterans. https://www.va.gov/homeless/for_homeless_veterans.asp. Published 2018. Accessed September 23, 2018.
14. Merlo J, Chaix B, Ohlsson H, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Health*. 2006;60(4):290-297. doi:10.1136/jech.2004.029454
15. Kuhn R, Culhane DP. Applying cluster analysis to test a typology of homelessness by pattern of shelter utilization: results from the analysis of administrative data. *Am J Community Psychol*. 1998;26(2):207-232. doi:10.1023/A:1022176402357
16. Austin EL, Pollio DE, Holmes S, et al. VA's expansion of supportive housing: successes and challenges on the path toward Housing First. *Psychiatr Serv*. 2014;65(5):641-647. doi:10.1176/appi.ps.201300073
17. Backus LI, Belperio PS, Loomis TP, Yip GH, Mole LA. Hepatitis C virus screening and prevalence among US veterans in Department of Veterans Affairs care. *JAMA Intern Med*. 2013;173(16):1549-1552. doi:10.1001/jamainternmed.2013.8133
18. Rein DB, Smith BD, Wittenborn JS, et al. The cost-effectiveness of birth-cohort screening for hepatitis C antibody in U.S. primary care settings. *Ann Intern Med*. 2012;156(4):263-270. doi:10.7326/0003-4819-156-4-201202210-00378
19. Culhane DP, Metraux S, Byrne T, Stino M, Bainbridge J. The age structure of contemporary homelessness: evidence and implications for public policy. *Anal Soc Issues Public Policy*. 2013;13(1):1-17. doi:10.1111/asap.12004
20. Gamache G, Rosenheck R, Tessler R. The proportion of veterans among homeless men: a decade later. *Soc Psychiatry Psychiatr Epidemiol*. 2001;36(10):481-485. doi:10.1007/s001270170012
21. Zibbell JE, Asher AK, Patel RC, et al. Increases in acute hepatitis C virus infection related to a growing opioid epidemic and associated injection drug use, United States, 2004 to 2014. *Am J Public Health*. 2018;108(2):175-181. doi:10.2105/AJPH.2017.304132