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ORIGINAL PAPER

HIV Treatment Cascade by Housing Status at Enrollment: Results from a Retention in Care Cohort

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Abstract

Though housing instability is linked to poor HIV health outcomes, studies that assess the HIV treatment cascade by housing status are limited. Using data from a multi-site Retention in Care initiative we constructed HIV treatment cascades for participants (n = 463) of five grantee sites. We found no significant differences in viral suppression at follow-up among participants who were unstably housed at enrollment (49%) as compared to those who were stably housed at enrollment (54%). Among participants with available data at 6- or 12-month follow-up, 94% were engaged in care, 90% were retained in, 94% were on ART, and 71% had suppressed viral load. Some site-level differences were noted; at two of the sites participants who were stably housed were more likely to be retained in care and on ART. Overall, findings demonstrated that participants moved successfully through the HIV treatment cascade regardless of housing status at enrollment, suggesting that evidence-based support and services to help people living with HIV/AIDS can help mitigate barriers to engagement in care associated with lack of stable housing.

Keywords HIV treatment cascade · Housing instability · Homelessness · People living with HIV/AIDS · Retention in care

Introduction

The ultimate goal of HIV care is suppression of viral load to levels at which life expectancy is extended, health and wellbeing are dramatically improved, and transmission is virtually impossible [1–3]. Viral load suppression requires that people living with HIV (PLWH) remain engaged in care, which involves not only diagnosis and initial linkage to treatment but also receipt of antiretroviral treatment (ART) and retention in HIV care [1, 4]. However, PLWH drop off at every step of the engagement "cascade," resulting in less than 30% PLWH having viral suppression [1, 4, 5].

Initial estimates of the HIV treatment cascade in the U.S. included all PLWH, but recently researchers have characterized the treatment cascade for various subgroups of PLWH, including children, sex workers, migrant populations, men who have sex with men, transgender women, those involved with the criminal justice system, and a number of other subpopulations [6–25]. These subgroup analyses are critical for identifying and understanding disparities in access to HIV care. However, studies that assess the HIV treatment cascade by housing status are limited. A study recently examined treatment outcomes for PLWH who received housing supports via the federal Housing Opportunities for People with AIDS (HOPWA) program, comparing participants to a random sample of PLWH who were not HOPWA recipients. This study found significant increases in retention in care for the intervention group, however, no differences in rates of viral suppression were noted [26]. In addition, the study was limited to a

A list of the AIDS United Retention in Care Intervention Team is given in Acknowledgements section.

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specific subset of PLWH, namely, those receiving HOPWA support.

Understanding the impact of housing status on the HIV treatment cascade is important given well-documented associations between homelessness and HIV outcomes. There is significant evidence that housing instability is associated with poorer HIV health outcomes [2, 27–37]. A systematic review of studies published through March 2014 examining the relationship between HIV outcomes and housing status found that homelessness and/or unstable housing was associated with lower rates of HIV primary care use, less antiretroviral uptake, lower adherence to antiretroviral treatment regimens, and worse health outcomes (CD4 counts, viral load, HIV-related symptoms, opportunistic infections, and mortality) as compared to PLWH who were stably housed [29]. Increasing housing supports within a community is associated with improved survival among PLWH experiencing homelessness [38]. Moreover, housing instability has particularly detrimental effects on HIV outcomes among vulnerable or marginalized subpopulations of PLWH, such as transgender women [20, 39] and individuals who have experienced incarceration [40].

Given the strong link between HIV outcomes, homelessness, and continuing unmet housing needs for this population, housing remains the leading identified priority for PLWH [41]. Since homelessness is a barrier to engagement and viral load suppression, interventions to reduce homelessness have enormous public health potential [35, 42]. A recent modeling study demonstrated that eliminating homelessness among PLWH who use injection drugs would increase viral suppression by 82.3% (from 22.0 to 40.1%) among the homeless in that population [43]. Characterizing the HIV treatment cascade for PLWH who experience homelessness or housing instability and identifying whether the provision of housing supports increases movement to later stages in the cascade would be of great value in developing and targeting effective housing interventions for PLWH.

AIDS United's Retention in Care (RiC) Initiative was a 3-year partnership with the MAC AIDS Fund to develop and evaluate innovative models for HIV retention in care in the United States. This study outlines findings from a convenience sample of all study participants who were enrolled in the RiC programs. The aim of this paper is to describe results of the RiC interventions, to characterize participants who were stably and unstably housed at enrollment into the RiC program, and compare movement through the HIV treatment cascade for RiC participants by housing status at enrollment.

Methods

From 2013 to 2016, seven organizations throughout the U.S. were funded by AIDS United and the MAC AIDS Fund's retention in care (RiC) initiative to provide HIV-related retention in care services, particularly for PLWH living in poverty who were aware of their HIV status but not engaged in HIV care or support. RiC focused on marginalized populations with the goals of identifying their distal and proximal barriers to care, developing interventions to address identified barriers, and implementing innovative methods of engaging and retaining them in care. Funded programs were those that used innovative, evidence-based approaches to remove barriers to care, which are described in more detail in Table 1. The five participating sites for whom data were available for the analysis below were included in this paper.

Selection of sites was based on burden of need, geographic region, strength of approach, and ability to conduct rigorous evaluation. The interventions delivered by each site varied by local need, but each organization was required to provide strategies that had at least preliminary evidence of effectiveness. The most commonly used strategies included care coordination, peer and patient navigation, community health workers, and motivational interviewing. In addition, each of the sites developed collaborative networks to strengthen local systems of care. A description of RiC-funded services provided by each site is included in Table 1.

The programs served people living with HIV who faced significant barriers to HIV care, such as substance misuse or disorder, homelessness, trauma, or rural residence. Enrollment criteria varied by site based on the population served. Two sites limited enrollment to individuals who were newly diagnosed (defined as a diagnosis in the past 3 months) or out of care (defined as a gap in care for 6 months or failing to have two visits with a prescribing provider within 1 year at least 90 days apart). Outreach to community based organizations and medical providers, referrals from partner agencies and in-reach were the most common recruitment strategies (Table 1). Four of the five grantee sites used RiC funds to mitigate structural barriers to care. For these sites, participants who identified housing stability as a barrier to care were supported through a range of supportive services including housing education and skills building, referrals to other providers, and assistance with completing housing assistance applications. Only one program, The Open Door, specified housing stability as its primary RiC goal. This organization provides client-centered representative payee services (financial management) to ensure that participants' rent and utility payments were made on a monthly basis in order to prevent eviction and homelessness.

Researchers from a large academic research institution oversaw a multi-site evaluation strategy wherein the sites conducted local evaluation, extracting data from electronic health records and participant self-report, which then were used as part of the national evaluation. Self-report data were collected via a client assessment tool, which was administered by program staff either in person or over the phone. Participant-level data collected at each site were related to

Table 1 RiC sites, program description, and housing-specific supports

Organization, *program,* location	Population served	Eligibility criteria	Recruitment	Description of RiC-funded services	Housing supports offered by program
BOOM!Health, *Bronx Health Connect*, Bronx, NY	Individuals who use substances and the homeless	People living with HIV who were 18 years of age or older, newly diagnosed or out of care with a history of substance use or homelessness	Medical outreach by a registered nurse, in-reach, partnership with mobile testing services, referrals	An intensive outreach program that used a harm reduction approach to provide a range of services including health navigation, peer support, adherence reminders, and counseling	For clients with housing instability or homelessness, referrals were placed by the RiC team to an internal housing assistance program. This internal housing program, not funded by the RiC grant, facilitated placement and retention via external housing programs
Christie's Place, *CHANGE for Women*, San Diego, CA	Women who have experienced trauma	Women living with HIV who resided in San Diego county who self-report experiences of trauma	Community outreach by peers, referrals from partner agencies, in-reach	A program that built on trauma-informed and gender-responsive models of care to address the structural barriers to care faced by women living with HIV, by creating a network of partnership organizations and helping women to access medical care, social services, and substance use and mental health supports	Housing referrals provided via strong collaborations with other providers. Education and skills-building regarding housing access was provided as part of the work of case managers and peer navigators. These supportive services were funded by the RiC grant
Institute for Public Health Innovation, *Total Health Partners*, Prince George's County, MD	Individuals living in poverty and sub-optimally housed	People living with HIV who were newly diagnosed, out of care, or in care but low income, unemployed, or unstably housed	Referrals from case managers working at partner agencies	A Community Health Worker intervention that provided personalized assistance to PLWHA who had dropped out of care or were sub-optimally engaged in care, to assist them in participating and remaining in medical care	Education regarding housing stability was part of the continuum of services provided by CHWs and funded by the RiC grant. Heart to Hand, the organization that housed the IPHI program, also operated a small transitional housing program that was not RiC funded

Table 1 (continued)

Organization, *program,* location	Population served	Eligibility criteria	Recruitment	Description of RiC-funded services	Housing supports offered by program
The Open Door, Inc., *Client-Centered Representative Payee*, Pittsburgh, PA	Individuals who use substances and the homeless or unstably housed	People living with HIV who were over the age of 18 with histories of housing instability or homelessness	Referrals from partner organizations	A harm reduction housing stability program that provided client-centered representative payee services to help clients manage income and pay rent and bills on time, enabling them to reduce stress and chaos and thus prioritize medical care and adherence. Housing stability supported through financial management was a primary goal of this RiC site	All RiC participants received Client-Centered Representative Payee services. Transitional housing was provided to some RiC participants by the organization Additional housing education and referrals provided via collaborations with other providers (not RiC-funded)
University of Virginia, *Positive Links*, Charlottesville, VA	Rural residents	People living with HIV in rural Virginia who were treatment naïve or out of care	Referred by counselors affiliated with the UVA Health System or Virginal AIDS Service Organizations within the UVA Ryan White Clinic catchment area	A smartphone app that supported PLWH with HIV education and management tools, wellness promotion strategies, and support through: social support via a positive virtual community, self-monitoring of adherence and wellness behaviors, and warm technology that extends care beyond clinic visits	None, except incidental support through participant message boards. In addition, access to a smartphone simplified participants' abilities to complete housing and other applications

twelve overarching assessment domains including participant demographics, linkage to care, case management, participant needs and barriers, perceived stigma, general health, retention in care, viral load, CD4, and ART. Housing status was captured at baseline by asking "Which of the following best describes your current living situation?" If a respondent provided more than one answer, interviewers were instructed to ask "Where did you sleep last night?" [35]. All answers other than "Your own place" or a "Room, apartment or house that is your own" were coded as unstable housing.

To assess participant engagement in HIV care, we constructed HIV treatment cascades for each program individually and for all the RiC programs combined. We then assessed the outcomes along the HIV treatment cascade by housing status at enrollment into the RiC program. Engagement in HIV care was defined has having one visit with an HIV medical provider with prescribing privileges after enrollment into the program [44]. Retention in HIV care was defined as having two visits at least 90 days apart in the past 12 months [45]. To assess use of ART, participants were asked "Are you currently taking any antiretroviral medicines for your HIV?" [46]. Participants were considered virally suppressed if they had a viral load less than or equal to 200 copies/mL [47]. Data on HIV medical visits and viral suppression were abstracted from medical records and lab records. For construction of the HIV treatment cascades, participants were considered retained, on ART or virally suppressed if they met the above definitions at either 6- or 12-month follow-up. Client-level data were collected at each RiC program location, analyzed, entered into standardized Excel spreadsheets and then sent, in aggregate, to the external evaluator for the RiC programs. Differences in baseline characteristics by housing status and differences along the HIV treatment cascade by housing status were assessed using Chi squared and Fisher's exact tests. All analyses were completed in Microsoft Excel.

All data collection activities by sites independently underwent IRB review prior to execution. Evaluation activities conducted by the institution overseeing evaluation activities were determined to be non-human subjects research.

Results

Four hundred and sixty-three participants were enrolled in the five RiC programs included here. Participant descriptive data stratified by housing status at enrollment are shown in Table 2. The majority of participants were over the age of 40 (64%), Black or Hispanic race/ethnicity (79%), unemployed or disabled (73%) and reported that their most likely mode for HIV acquisition was heterosexual contact (52%). Forty-six percent of participants were male, 49% were female, and 4% were transgender (male-to-female). At enrollment, 56% of participants were retained in care and 54% of participants were virally suppressed. When we assessed differences by housing status at enrollment, we found differences by age, gender, and transmission category. Unstably housed participants were most likely to be younger, male, and report men who have sex with men (MSM) as their transmission category.

When we assessed movement along the HIV treatment cascade for all participants (Table 3), we found that 401 were engaged in HIV care, 321 were retained in HIV care at either 6 or 12 months follow-up, 296 had an ART prescription at either 6 or 12 months follow-up, and 240 were virally suppressed at either 6 or 12 months follow-up. We constructed the HIV treatment cascade in two ways. First, we assumed that individuals with missing data were not engaged in HIV care (e.g., Missing = No). Taking this approach, we calculated that 87% (401/463) were engaged in HIV care, 69% (321/463) were retained in HIV care, 64% (296/463) were on ART, and 52% (240/463) had a suppressed viral load. At either 6 or 12 months follow-up, retention in care data was not available for 23%, ART data was not available for 32%, and viral suppression was not available for 27% of participants. There were no significant differences in age, race, gender, or transmission category between those with and without missing data on viral suppression at follow-up. When we limited our analyses to participants with available data, we found that 94% (401/428) were engaged in HIV care, 90% (321/355) were retained in HIV care, 94% (296/316) were on ART, and 71% (240/336) had a suppressed viral load. A comparison of the HIV treatment cascade among those who were and were not unstably housed at enrollment did not yield any significant differences when we combined data across all RiC programs (Table 4). Among those who were unstably housed, 87% were engaged in care, 71% were retained in care, 63% were on ART, and 49% were virally suppressed. By way of comparison, 87% of stably housed participants were engaged in HIV care, 68% were retained in care, 65% were on ART, and 54% were virally suppressed. At the site level, there were differences in retention at one site (Christie's Place) and difference in ART at two sites (Christie's Place and BOOM! Health). Specifically, participants who were stably housed were more likely to be retained in care and on ART. These sites were two of the three programs that addressed housing more directly post-RiC enrollment.

Discussion

While many studies have documented that "housing is healthcare" for people living with HIV, our study adds to the existing literature by assessing differences in movement along the HIV treatment cascade among participants of a

Table 2 Characteristics of RiC participants by housing status (n = 452)

Participant characteristics	Unstably housed	Stably housed	Total
Total	163	289	452
Age[a]			
18–24	23 (0.14)	19 (0.07)	42 (0.09)
25–29	19 (0.12)	20 (0.07)	39 (0.09)
30–39	32 (0.20)	47 (0.16)	79 (0.17)
40–49	61 (0.37)	89 (0.31)	150 (0.33)
50 +	28 (0.17)	114 (0.39)	142 (0.31)
Missing	0 (0.00)	0 (0.00)	0 (0.00)
Race			
Black, non-Hispanic	80 (0.49)	150 (0.52)	230 (0.51)
Hispanic	51 (0.31)	74 (0.26)	125 (0.28)
White, non-Hispanic	22 (0.13)	37 (0.13)	59 (0.13)
Not Black, Hispanic, or White	9 (0.06)	28 (0.10)	37 (0.08)
Missing	1 (0.01)	0 (0.00)	1 (0.00)
Sex/gender[a]			
Male	95 (0.58)	115 (0.40)	210 (0.46)
Female	61 (0.37)	162 (0.56)	223 (0.49)
Transgender M to F	7 (0.04)	12 (0.04)	19 (0.04)
Missing	0 (0.00)	0 (0.00)	0 (0.00)
Employment			
Employed full time	15 (0.09)	38 (0.13)	53 (0.12)
Employed part-time	12 (0.07)	24 (0.08)	36 (0.08)
Disabled for work	47 (0.29)	93 (0.32)	140 (0.31)
Unemployed	78 (0.48)	113 (0.39)	191 (0.42)
Other	11 (0.07)	19 (0.07)	30 (0.07)
Don't know	0 (0.00)	2 (0.01)	2 (0.00)
Transmission category[a]			
MSM	53 (0.33)	61 (0.21)	114 (0.25)
IDU	21 (0.13)	17 (0.06)	38 (0.08)
Heterosexual	71 (0.44)	166 (0.57)	237 (0.52)
Other[b]	18 (0.11)	45 (0.16)	63 (0.14)
Retained in HIV care at enrollment			
Yes	85 (0.52)	168 (0.58)	253 (0.56)
No	21 (0.13)	43 (0.15)	64 (0.14)
Missing/unknown	57 (0.35)	78 (0.27)	135 (0.30)
Viral suppression at enrollment			
Yes	82 (0.50)	161 (0.56)	243 (0.54)
No	36 (0.22)	88 (0.30)	124 (0.27)
Missing/unknown	45 (0.28)	40 (0.14)	85 (0.19)

Total n = 452 for this analysis. 11 individuals were not included because of missing data on housing status

[a]Statistically different at $p < 0.05$, Chi Square with Fishers Exact, "Missing/unknown" data category excluded for significance testing

[b]Includes hemophilia, blood transfusion, perinatal exposure, and risk factor not reported or not identified

retention in care program who were and were not stably housed at enrollment. When we combined data across all program locations we found no differences in viral suppression at follow-up among participants who were unstably housed at program enrollment (49%) as compared to those who were stably housed at enrollment (54%). This finding was also seen at each of the five sites. In addition, all of the programs demonstrated viral suppression percentages among their marginalized client populations (range 61–91%) that compare favorably with other similar programs [48, 49]. It is important to note that for two sites, we did find significant differences in engagement in HIV care by housing

Table 3 HIV treatment cascade by RiC program site

	Engaged in care	Retained in care	ART	Suppressed viral load (SVL)
All sites combined (n = 463)				
Yes	401	321	296	240
No	27	34	20	96
Unknown/missing	35	108	147	127
BOOM! Health (n = 136)				
Yes	103	59	57	50
No	6	0	1	32
Unknown/missing	27	77	78	54
Christie's Place (n = 115)				
Yes	114	100	81	57
No	1	0	6	30
Unknown/missing	0	15	28	28
Institute for Public Health Innovation (n = 95)				
Yes	76	56	60	48
No	11	26	9	10
Unknown/missing	8	13	26	37
The Open Door (n = 40)				
Yes	34	36	35	29
No	6	1	2	3
Unknown/missing	0	3	3	8
University of Virginia (n = 77)				
Yes	74	70	63	56
No	3	7	2	21
Unknown/missing	0	0	12	0

status. At these sites, individuals who were stably housed were more likely to be retained and to be on ART. This finding is consistent with the literature, which has shown that unstable housing is associated with a lack of regular visits for HIV primary medical care and one of the most important factors limiting ART use [50]. Unfortunately our study was not designed to answer questions about the contextual, intervention, or implementation factors that might have contributed to these differences or why differences were seen in retention and adherence but not viral suppression. This represents an area where future inquiry is needed.

A recent study tracked treatment outcomes for PLWH who received housing supports via the federal Housing Opportunities for People with AIDS (HOPWA) program, comparing participants to a random sample of PLWH who were not HOPWA recipients. While this study found significant increases in retention in care for the intervention group, no differences were found in rates of viral suppression [26]. Nonetheless, a systematic review of 152 studies that examined associations between housing and clinical outcomes (including treatment adherence and viral suppression) found an independent effect of housing on HIV health outcomes for homeless or formerly homeless PLWH [29]. Clearly, housing instability is a structural factor that limits efforts to increase the number of PLWH who are virally suppressed. In the absence of full remediation of homelessness, other types of housing support such as financial management, health navigation, and warm handoffs to partner agencies that provide supportive housing may help unstably housed PLWH engage in HIV care in the short term. Additional information is needed to understand how to best integrate strategies to reduce unstable housing and homelessness into existing evidence-based engagement in HIV care interventions, even while we continue to find ways to end homelessness. Given the well-documented associations between housing instability and poor clinical outcomes for PLWH, there is also a need for larger-scale, well-controlled trials that study the efficacy of innovative structural interventions, such as representative payee services, on engagement in HIV care.

There are a number of limitations inherent to this study. Since nonprofit funding is often dependent on organizational factors [51], the degree of organizational capacity that enabled these agencies to compete for RiC funding may mean that they are not be representative of all HIV service organizations in the US. In addition, it is important to note that making direct comparisons across sites is not appropriate

Table 4 HIV treatment cascade by housing status

	Total	Engaged in HIV care	X^2, P value	Retained in HIV care	X^2, P value	ART	X^2, P value	Suppressed viral load	X^2, P value
All sites combined									
Housing status	(n = 463)	(n = 401)		(n = 321)		(n = 296)		(n = 240)	
Unstably housed	192 (0.41)	167 (0.87)	(0.00, 1.00)	136 (0.71)	(0.39, 0.54)	121 (0.63)	(0.12, 0.77)	95 (0.49)	(1.00, 0.34)
Stably housed	260 (0.56)	226 (0.87)		177 (0.68)		168 (0.65)		141 (0.54)	
Unknown/ missing	11 (0.02)	8 (0.73)		8 (0.73)		7 (0.64)		4 (0.36)	
BOOM! Health									
Housing status	(n = 136)	(n = 103)		(n = 59)		(n = 57)		(n = 50)	
Unstably housed	60 (0.44)	45 (0.75)	(0.03, 1.00)	21 (0.35)	(3.07, 0.09)	19 (0.32)	(4.63, 0.04)	18 (0.30)	(2.11, 0.16)
Stably housed	76 (0.56)	58 (0.76)		38 (0.50)		38 (0.50)		32 (0.42)	
Unknown/ missing	0 (0.00)	0 (0.00)		0 (0.00)		0 (0.00)		0 (0.00)	
Christies Place									
Housing status	(n = 115)	(n = 114)		(n = 100)		(n = 81)		(n = 57)	
Unstably housed	40 (0.35)	40 (1.00)	NA	27 (0.68)	(21.81, 0.00)	21 (0.53)	(8.88, 0.01)	16 (0.40)	(3.27, 0.08)
Stably housed	69 (0.60)	69 (1.00)		68 (0.99)		55 (0.80)		40 (0.58)	
Unknown/ missing	6 (0.05)	5 (0.83)		5 (0.83)		5 (0.83)		1 (0.17)	
Institute for Public Health Innovation									
Housing status	(n = 95)	(n = 76)		(n = 56)		(n = 60)		(n = 48)	
Unstably housed	27 (0.28)	22 (0.81)	(0.03, 1.00)	15 (0.56)	(0.28, 0.65)	16 (0.59)	(0.39, 0.63)	11 (0.41)	(1.31, 0.36)
Stably housed	65 (0.68)	52 (0.80)		40 (0.62)		43 (0.66)		35 (0.54)	
Unknown/ missing	3 (0.03)	2 (0.67)		1 (0.33)		1 (0.33)		2 (0.67)	
The Open Door									
Housing status	(n = 40)	(n = 34)		(n = 36)		(n = 35)		(n = 29)	
Unstably housed	16 (0.40)	13 (0.81)	(0.76, 0.63)	14 (0.88)	(0.11, 1.00)	14 (0.88)	(0.11, 1.00)	12 (0.75)	(0.02, 1.00)
Stably housed	22 (0.55)	20 (0.91)		20 (0.91)		20 (0.91)		16 (0.73)	
Unknown/ missing	2 (0.05)	1 (0.50)		2 (1.00)		1 (0.50)		1 (0.50)	
University of Virginia									
Housing status	(n = 77)	(n = 74)		(n = 70)		(n = 63)		(n = 56)	
Unstably housed	20 (0.26)	18 (0.90)	(2.69, 0.16)	18 (0.90)	(0.03, 1.00)	17 (0.85)	(0.18,1.00)	14 (0.70)	(0.10, 0.78)
Stably housed	57 (0.74)	56 (0.98)		52 (0.91)		46 (0.81)		42 (0.74)	

Table 4 (continued)

	Total	Engaged in HIV care	X^2, P value	Retained in HIV care	X^2, P value	ART	X^2, P value	Suppressed viral load	X^2, P value
Unknown/ missing	0 (0.00)	0 (0.00)		0 (0.00)		0 (0.00)		0 (0.00)	

given differences in program models, populations served, geographic locations, and variability in rental housing market conditions.

Two of the seven grantee sites did not have housing data available and therefore were not able to be included in the study. In addition, participants were recruited to the study via a convenience sample, introducing selection bias. The generalizability of our study findings beyond our study population is not known. Most programs had small sample sizes with considerable missing data at follow-up, further restricting our ability to accurately interpret results. In addition, our study was limited by missing data on treatment cascade variables at follow-up. Unfortunately it was beyond the scope of this study to ascertain why these data were missing. Prior research suggests that incomplete data on engagement in HIV care are due to a number of reasons, including out-of-care status, seeking care at different locations locally, relocating to a new area, death, and incarceration [8]. Our study looked at housing status at a fixed point in time, program enrollment. Housing status is not a fixed trait and changes over time. Therefore, it is likely that participants who were unstably housed at enrollment became stably housed during the program and it is also possible that participants who were stably housed at enrollment may have become unstably housed. Longitudinal studies are needed to better understand the relationship between housing status and HIV care engagement over time.

Furthermore, it was beyond the scope of these analyses to be able to assess if there were differences in housing status between those with and without missing data on the measures of the HIV care continuum. This could bias our results, as individuals without housing at follow-up may be more likely to have missing data at follow-up. In addition, our study might be subject to misclassification bias due to the survey question used to assess housing status. Feedback from program representatives suggests that the criteria for "stable housing" is not consistently understood or used. For example, The Open Door provided transitional housing directly to some participants and while some residents referred to this as "my own place" (which would be interpreted as stably housed), others called this "transitional housing" (unstably housed). Validated standardized housing measures that are incorporated into a full range of HIV care and supportive service programs are needed to fully understand the interplay between housing and optimal clinical outcomes.

With each study that addresses housing instability and health outcomes it becomes increasingly clear that there is a strong relationship between social determinants of health and HIV clinical outcomes [2, 26, 29, 32, 34, 52]. While many urban areas have housing programs, these are often not sufficient to meet the prevailing need [53]. Cities with multi-year waitlists for housing support typically have numerous PLWH who are not only unstably housed, but also likely to be highly infectious [54, 55], which means that stable housing is important to improving clinical outcomes for PLWH and reducing secondary transmission of HIV.

Conclusion

Until housing is assured for all individuals it will be important to provide additional structural interventions to mitigate the effects of unstable housing. Our findings indicate that participants in the RiC program successfully moved through the HIV treatment cascade regardless of housing status at the start of the program. This suggests that programs such as RiC which provide evidence-based support and services to help PLWH can help mitigate barriers to engagement in care associated with lack of stable housing.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent All data collection activities by sites independently underwent IRB review prior to execution. Evaluation activities conducted by the institution overseeing evaluation activities were determined to be non-human subjects research.

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