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ORIGINAL PAPER

Prevalence of Internalized HIV-Related Stigma Among HIV-Infected Adults in Care, United States, 2011–2013

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Abstract HIV-infected U.S. adults have reported internalized HIV-related stigma; however, the national prevalence of stigma is unknown. We sought to determine HIV-related stigma prevalence among adults in care, describe which socio-demographic groups bear the greatest stigma burden, and assess the association between stigma and sustained HIV viral suppression. The Medical Monitoring Project measures characteristics of U.S. HIV-infected adults receiving care using a national probability sample. We used weighted data collected from June 2011 to May 2014 and assessed self-reported internalized stigma based on agreement with six statements. Overall, 79.1% endorsed ≥1 HIV-related stigma statements (n = 13,841). The average stigma score was 2.4 (out of a possible high score of six). White males had the lowest stigma scores while Hispanic/Latina females and transgender persons who were multiracial or other race had the highest. Although stigma was associated with viral suppression, it was no longer associated after adjusting for age. Stigma was common among HIV-infected adults in care. Results suggest individual and community stigma interventions may be needed, particularly among those who are <50 years old or Hispanic/Latino. Stigma was not independently associated with viral suppression; however, this sample was limited to adults in care. Examining HIV-infected persons not in care may elucidate stigma's association with viral suppression.

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Resumen Individuos viviendo con el VIH en los EEUU experimentan internalización de estigma asociado con el VIH. No obstante, la prevalencia del estigma asociado con el VIH en los EEUU es desconocida. Este estudio intenta: determinar la prevalencia del estigma asociada con el VIH entre adultos recibiendo cuidado médico, describir cuales grupos socio-demográficos experimentan la carga mayor de estigma, y evaluar la asociación entre el estigma y la continua supresión viral del VIH. El Proyecto de Monitoreo Medico evalúa las características de adultos viviendo con VIH en los EEUU y que reciben atención médica. MMP utiliza una muestra probabilística con representatividad nacional. Los datos fueron coleccionados de junio 2011–mayo 2014. Medimos el estigma utilizando un cuestionario enfocado en los diferentes aspectos del estigma que sufren las personas viviendo con VIH. Todas las estimaciones fueron calculadas utilizando pesos estadísticos. En general, 79.1% estuvieron de acuerdo con ≥1 afirmaciones de estigma asociada con el VIH. El puntaje promedio de estigma fue 2.4 (de un puntaje posible de six). Hombres de raza blanca tuvieron el puntaje de estigma más bajo mientras mujeres Hispanas/Latinas y personas transgénero multirraciales o de otra raza tuvieron el puntaje de estigma más alto. Se detectó una asociación ente el nivel de estigma y la supresión viral del VIH, pero esta asociación dejó de ser significativa después de ajustar para la edad. Experiencias de estigma fueron comunes entre los adultos recibiendo cuidado médico para el VIH. Los resultados sugieren que intervenciones comunitarias e individuales pueden ser necesarias, especialmente entre aquellos <50 años de edad o entre Hispanos/Latinos. No hubo relación independiente entre la supresión viral y estigma. Sin embargo, nuestro muestreo está limitado a personas recibiendo cuidado médico. Esta asociación

podría ser más clara en individuos viviendo con VIH que no tienen acceso a cuidados médicos.

Keywords Stigma · HIV · Viral suppression · United States · Age

Palabras claves Estigma · VIH · Supresión viral · Los Estados Unidos · Edad

Introduction

HIV-infected persons in the United States may experience HIV-related stigma, a social process where HIV-infected persons are assumed to possess negative traits [1], resulting in stereotyping, rejection, assigning personal blame for disease, and discrimination [2–4]. Internalized HIV-related stigma is when an HIV-infected person believes these negative assumptions are true about themselves [1]. Internalized stigma has been linked to poor antiretroviral treatment (ART) adherence [5, 6], avoiding disclosure of HIV status [7, 8], depression [7, 9, 10], and poor physical and mental health [9, 10]. Reducing stigma is an objective of the National HIV/AIDS Strategy [11]. Despite this, we lack national estimates of the prevalence of HIV-related stigma among HIV-infected adults in medical care, nor do we have national data on which demographic groups have the highest internalized HIV stigma or whether stigma is associated with other social determinants of health. Determining whether HIV-related internalized stigma varies by socio-demographic factors, such as gender, race/ethnicity, education, or social support satisfaction, may be useful to direct stigma reduction efforts to those with the greatest burden.

Adherence to ART is essential for achieving viral suppression, a key indicator of treatment success for HIV-infected persons [12–16], and many studies have measured the relationship between stigma and ART adherence. A systematic review found that three out of four studies supported a relationship between internalized stigma and ART adherence, though in one study the relationship was attenuated in multivariate analyses [10]. However, few studies have measured the association between stigma and viral suppression. A study of unstably housed HIV-infected persons found no relationship between stigma and viral suppression, but it is unknown if the same result would remain among a representative sample of HIV patients in the United States. Our analysis will fill this gap in the literature by assessing the association between internalized HIV stigma and viral suppression using matched medical record and interview data from adults receiving HIV care.

The objectives of this analysis were to: (1) determine the national prevalence of HIV-related internalized stigma, (2) describe which socio-demographic groups had the highest proportions of HIV-related internalized stigma, (3) describe the social determinants of health associated with stigma, and (4) assess the relationship between HIV-related internalized stigma and sustained viral suppression after controlling for confounders.

Methods

Medical Monitoring Project

The Medical Monitoring Project (MMP) is an HIV surveillance system designed to collect nationally representative estimates of behavioral and clinical characteristics of HIV-infected adults receiving medical care in the United States. Detailed MMP methods, including weighting procedures, have been described elsewhere [17]. Briefly, MMP used a three-stage, probability-proportional-to-size sampling method, which sampled states and territories, then outpatient facilities providing HIV care, and finally HIV-infected adults 18 years or older who reported at least one medical care visit in a participating facility. This analysis used data from the 2011–2013 cycles. Data were collected through face-to-face and telephone interviews and medical record abstractions from June 2011 through May 2014.

All sampled jurisdictions participated in MMP. Facility response rates ranged from 83 to 85% and patient response rates ranged from 49 to 55%. MMP data were weighted to account for unequal selection probabilities and facility and patient nonresponse. Although characteristics associated with nonresponse varied over time, the following characteristics were generally associated with nonresponse and informed weighting classes: facility size, private practice, younger age, black race, Hispanic ethnicity, and shorter time since HIV diagnosis.

In accordance with guidelines for defining public health research [18, 19], the Centers for Disease Control and Prevention (CDC) determined MMP was public health surveillance. Participating states, territories, and facilities obtained local Institutional Review Board (IRB) approval to conduct MMP, if required locally.

Measures

Internalized HIV-related stigma was measured using the modified six-item Internalized AIDS-related stigma scale [1], in which respondents rated their agreement with six statements (Table 1). The stigma questions refer to the respondent's current attitude (e.g. "It is difficult to tell people about my HIV infection"). Respondents who did not answer all the stigma statements (n = 593) were

Table 1 Distribution of responses to stigma statements among HIV-infected adults in care, United States, Medical Monitoring Project 2011–2013 (n = 13,841)

Question	Agree[a] (Weighted%)	Neutral (Weighted%)	Disagree[a] (Weighted%)
It is difficult to tell people about my HIV infection	9064 (65.6)	268 (2.1)	4509 (32.3)
I hide my HIV status from others	8211 (58.8)	373 (3.0)	5257 (38.2)
I feel guilty that I am HIV-positive	4807 (34.5)	272 (2.1)	8762 (63.5)
I am ashamed that I am HIV-positive	4573 (32.9)	269 (2.1)	8999 (65.0)
Being HIV-positive makes me feel dirty	3164 (23.0)	279 (2.2)	10,398 (74.9)
I sometimes feel worthless because I am HIV-positive	3255 (23.6)	242 (1.9)	10,344 (74.6)

Limited to respondents who answered all stigma questions; Missing, n = 593

[a] Response options changed by year. The 2011 scale had "strongly agree," "agree," "neutral," "disagree," and "strongly disagree; the 2012–2013 scale had "agree" or "disagree"; "strongly agree" and "agree" options were combined and "strongly disagree" and "disagree" options were combined

excluded, leaving 13,841 persons included in the analysis. All "agree" responses were scored as "1", "disagree" responses were scored as "0", and neutral responses were scored as "0.5." Responses were summed into a single score with a possible range of 0 (low stigma)–6 (high stigma). The stigma scale had acceptable internal consistency (Cronbach's $\alpha = 0.78$).

Socio-demographic and social determinants of health factors, such as race/ethnicity, gender, and insurance type, were based on self-report (Table 2). The gender identity variable combined self-reported sex at birth and gender identity. Intersex individuals were excluded from the analysis due to small sample size. Individuals who reported multiple racial identities or a race/ethnicity other than non-Hispanic white, non-Hispanic black, or Hispanic/Latino were categorized as "other/multiracial." In order to determine which combination of race/ethnicity and gender groups experienced the greatest burden of stigma, we present the results stratified by each race/ethnicity and gender combination.

Sustained viral suppression was defined as all HIV viral load test results documented in medical records as undetectable or less than 200 copies/mL during the past 12 months. Self-reported ART use and adherence was defined as a three-level categorical variable: not taking ART; taking ART, but not adherent; and taking ART, adherent. Adherence was defined as self-reported 100% adherence to all HIV medicine doses in the past 3 days.

Analytic Methods

First, we report the distribution of the responses to the six stigma statements and the distribution of the range of stigma scores using weighted percentages. We assessed whether average stigma scores varied among socio-demographic groups using one-way ANOVA tests. Significance was defined as $p < 0.05$. Referent groups were determined by lowest average stigma score.

We used multivariate logistic regression models to assess the independent association between stigma and viral suppression. We used crude and adjusted prevalence ratios because our outcome was not rare. Stigma was modeled as a continuous variable because the relationship between stigma and viral suppression was linear. We assessed the following potential confounders: age, time since diagnosis, gender, race/ethnicity, poverty, and sexual orientation. Identified confounders were also tested as effect modifiers. If we found an independent association between stigma and sustained viral suppression, we would then test for mediators, such as ART adherence.

There were minor differences in the 2011 and the 2012/2013 stigma response options, where respondents could provide a "neutral" answer in 2011. To ascertain whether the inclusion of a "neutral" response option in 2011 influenced our results (>10% change in point estimates), we compared results from our final multivariable model using only 2011 data with that obtained using 2012 and 2013 data. If 2011 yielded significantly different results than 2012/2013, we would either stratify results by cycle year or consider dropping the 2011 data from the analysis. We found an adjusted prevalence ratio [aPR] of 0.99 (95% confidence interval [CI] 0.99–1.01) for stigma in the full model using only 2011 data and an aPR of 1.00 (95% CI 0.99–1.01) for the full model using 2012/2013 data. Because the stigma estimates did not meaningfully differ and the stigma score was not significantly associated with viral suppression in either model, we combined all cycle years for the final analysis.

All analyses accounted for the complex survey design and weights using PROC SURVEYFREQ, PROC SURVEYMEANS, and PROC SURVEYLOGISTIC in SAS 9.3 (SAS Institute, Cary, NC), as well as PROC RLOGIST in

Table 2 Average stigma scores by socio-demographic and clinical characteristics among HIV-infected adults in care, United States, Medical Monitoring Project, 2011–2013 (n = 13,841)

Characteristic	n	Weighted Column % (95% CI)	Average stigma score (μ (95%CI))	p value
Gender and race/Ethnicity groups				
Male				
Black/African American	3514	25.5 (21.4–29.6)	2.4 (2.3–2.4)	0.0046
Hispanic/Latino[a]	2151	14.3 (11.3–17.2)	2.6 (2.5–2.7)	<0.0001
White	3796	29.2 (24.1–34.3)	2.1 (2.0–2.3)	Ref
Other/Multiracial	468	3.5 (2.9–4.2)	2.6 (2.4–2.8)	<0.0001
Female				
Black/African American	2214	15.6 (12.7–18.9)	2.7 (2.6–2.8)	Ref
Hispanic/Latina	777	4.9 (3.3–6.5)	3.0 (2.8–3.1)	0.0019
White	591	4.6 (4.0–5.2)	2.8 (2.5–3.0)	0.80
Other/Multiracial	126	1.0 (0.7–1.2)	2.9 (2.5–3.4)	0.38
Transgender[b]				
Black/African American	93	0.7 (0.5–0.8)	2.6 (2.0–3.1)	0.26
Hispanic/Latino	56	0.3 (0.2–0.4)	2.8 (2.3–3.4)	0.07
White	30	0.2 (0.1–0.3)	2.0 (1.4–2.7)	Ref
Other/Multiracial	17	0.2 (0.1–0.2)	3.4 (2.5–4.4)	0.03
Age (years)				
18–29	1035	7.8 (7.0–8.5)	2.7 (2.5–2.9)	<0.0001
30–39	2070	15.5 (14.6–16.4)	2.7 (2.6–2.8)	<0.0001
40–49	4457	31.7 (30.9–32.8)	2.5 (2.4–2.6)	<0.0001
≥50	6279	45.0 (44.0–46.0)	2.3 (2.2–2.3)	Ref
Sexual identity				
Heterosexual	6858	48.4 (44.5–52.4)	2.7 (2.6–2.8)	<0.0001
Bisexual	1127	8.1 (7.4–8.7)	2.6 (2.4–2.7)	<0.0001
Homosexual, gay, or lesbian	5679	42.1 (38.1–46.2)	2.1 (2.0–2.2)	Ref
Other	177	1.4 (1.1–1.6)	2.5 (2.2–2.8)	0.02
Education				
<High school	2939	20.6 (18.5–22.7)	2.7 (2.6–2.8)	<0.0001
High school or equivalent	3769	27.1 (25.5–28.7)	2.5 (2.4–2.6)	0.0007
>High school	7125	52.3 (49.1–55.5)	2.3 (2.2–2.4)	Ref
Health insurance in past 12 months				
Private health insurance	3891	29.7 (26.4–33.0)	2.3 (2.2–2.5)	Ref
Public health insurance	7626	52.6 (59.6–55.7)	2.4 (2.4–2.5)	0.06
Ryan White insurance or uninsured	2285	17.7 (14.8–20.6)	2.6 (2.5–2.7)	0.0002
Poverty[c]				
Above poverty level	7106	54.7 (51.4–57.9)	2.3 (2.3–2.4)	Ref
At or below poverty level	6232	45.3 (42.1–48.6)	2.6 (2.5–2.7)	<0.0001
Homelessness[d]				
Homeless in past 12 months	1143	8.1 (7.5–8.9)	2.7 (2.5–2.9)	0.0008
Not homeless in past 12 months	12,698	91.9 (91.1–92.6)	2.4 (2.4–2.5)	Ref
Incarcerated in past 12 months				
Yes	669	4.9 (4.4–5.3)	2.6 (2.4–2.8)	0.04
No	13,168	95.1 (94.7–95.6)	2.4 (2.4–2.5)	Ref
Foreign born				
Born outside U.S.	1917	13.9 (12.2–15.6)	2.8 (2.7–2.9)	<0.0001
Born in U.S.	11,920	86.1 (84.4–87.8)	2.4 (2.3–2.5)	Ref

Table 2 continued

Characteristic	n	Weighted Column % (95% CI)	Average stigma score (μ (95%CI))	p value
Satisfaction with support from friends and family				
Very satisfied	8879	70.5 (69.3–71.6)	2.2 (2.1–2.2)	Ref
Somewhat satisfied	2526	20.0 (19.1–21.0)	3.0 (2.9–3.0)	<0.0001
Somewhat dissatisfied	561	4.4 (3.9–4.8)	3.3 (3.1–3.5)	<0.0001
Very dissatisfied	653	5.1 (4.6–5.6)	3.1 (2.9–3.3)	<0.0001
Time since HIV diagnosis				
Diagnosed with HIV <5 years ago	2707	21.1 (20.2–22.1)	2.9 (2.8–3.0)	<0.0001
Diagnosed with HIV ≥5 years ago	11,131	78.9 (77.9–79.8)	2.3 (2.3–2.4)	Ref
ART use and adherence				
Not taking ART	798	6.0 (5.5–6.6)	2.6 (2.4–2.8)	0.006
Taking ART, Not Adherent	1559	11.1 (10.1–12.1)	2.8 (2.7–3.0)	<0.0001
Taking ART, Adherent	11,107	82.9 (81.7–84.0)	2.4 (2.3–2.4)	Ref
Sustained viral suppression				
All viral load measures in the past year <200 copies/ml	9145	65.4 (64.0–66.9)	2.4 (2.3–2.5)	Ref
>1 viral load measure(s) in the past year ≥ 200 copies/ml	4696	34.6 (33.1–36.0)	2.5 (2.5–2.6)	0.0009
Clinical status				
AIDS or $CD4^+$ cell count 0–199 cells/μl (nadir)	9540	68.6 (67.2–70.0)	2.4 (2.3–2.5)	Ref
No AIDS and $CD4^+$ cell count 200–499 cells/μl (nadir)	3233	23.9 (22.8–24.9)	2.5 (2.4–2.6)	0.0009
No AIDS and $CD4^+$ cell count ≥ 500 cells/μl (nadir)	1015	7.5 (6.9–8.1)	2.6 (2.4–2.7)	0.02

CI confidence interval

[a] Hispanic/Latino/as might be of any race. Patients are classified in only one race/ethnicity category

[b] Patients were classified as transgender if sex at birth and gender reported by patient were different, or if patient chose transgender in response to the question about self-identified gender

[c] Poverty guidelines as defined by the Department of Health and Human Services (HHS). More information regarding the HHS poverty guidelines can be found at http://aspe.hhs.gov/poverty/faq.cfm

[d] Living on the street, in a shelter, in a single-room-occupancy hotel, or in a car

SAS-callable SUDAAN (RTI International, Research Triangle Park, NC).

Results

Overall, 79.1% (95% CI 77.4–80.7) of HIV-infected adults receiving medical care endorsed at least one stigma statement. The average stigma score was 2.4 (95% CI 2.4–2.5) out of a possible score of 6. The distribution of responses to each stigma statement is shown in Table 1, where 65.6% of persons agreed that it is difficult to tell others about their HIV infection and 58.8% reported hiding their HIV status from others. Figure 1 shows that 8.6% (95% CI 8.0–9.2) of persons agreed and 18.9% (95% CI 17.3– 20.4) disagreed with every stigma statement.

Table 2 presents the population distribution and average stigma score and 95% CI by socio-demographic and clinical characteristics. Among males, Hispanic/Latino (average = 2.6) and other/multiracial males (average = 2.6) had the highest stigma scores. Among females, Hispanic/Latina females had the highest average stigma scores (average = 3.0). Among transgender persons, other/multiracial transgender individuals had the highest stigma score (average = 3.4). Stigma scores were higher among persons who were younger than 50 years old compared to older persons, and those who had poorer social determinants of health, including less education, suboptimal health insurance status, homelessness, poverty, recent incarceration, and dissatisfaction with social support. Persons with poorer clinical outcomes, including not taking or adhering to ART and not achieving sustained viral suppression also had higher stigma scores.

Table 3 reports the results of the crude and adjusted logistic regression models assessing the association between internalized stigma and sustained viral suppression. In the crude model, a higher stigma score was significantly associated with lower sustained viral suppression (crude prevalence ratio = 0.99). All potential confounders were assessed, but only age met our criteria for confounding. When age was added to the model, the stigma score was no longer significantly associated with sustained

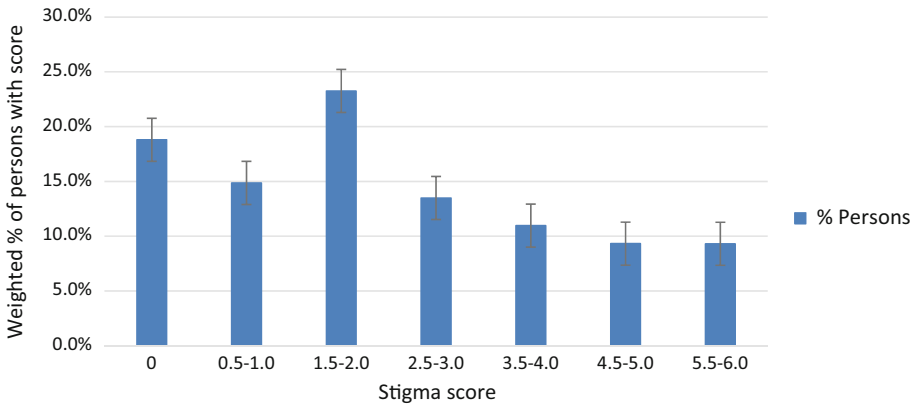

Fig. 1 Distribution of summed stigma scores among HIV-infected adults receiving care*, United States, Medical Monitoring Project, 2011–2013. *Limited to respondents who answered all six stigma questions

Table 3 The association between sustained viral suppression in the past 12 months and internalized HIV-related stigma, accounting for age among HIV-infected adults in care, United States, MMP 2011–2013 (n = 13,841)

Variable	Crude PR	95% CI	*p*-value	Adjusted PR[a]	95% CI	*p*-value
Internalized stigma[b]	0.99	0.98–0.99	0.001	0.99	0.99–1.00	0.053
Age[b]	1.02	1.02–1.02	<0.0001	1.02	1.02–1.02	<0.0001

PR Prevalence ratio, *CI* confidence interval

[a] Model adjusted for stigma and age

[b] Stigma and age were modeled as continuous variables

viral suppression (aPR = 0.99), indicating that age confounded the association. Further, inclusion of an interaction term for stigma and age indicated that age was not an effect modifier of the relationship between stigma and viral suppression (aPR = 1.0, 95% CI 1.0–1.0, $p = 0.63$, results not show in table). Since the relationship between stigma and sustained viral suppression was confounded by age, we did not test for any mediators, such as ART adherence. Overall, our results suggest that internalized stigma is not an independent predictor of viral suppression among persons receiving care for HIV.

Discussion

We present the first, to our knowledge, nationally representative prevalence estimates of internalized HIV-related stigma among HIV-infected adults in care. Average stigma scores among HIV-infected adults receiving HIV care (average = 2.4) were comparable to previous smaller studies using the same scale [1, 7, 20, 21], which ranged from 2.1 to 3.0 depending on the country; the U.S.-based studies found average stigma scores of 2.4 [1] and 2.1 [7]. Nearly eight out of ten persons receiving HIV care in the United States agreed with at least one stigma statement. Almost two-thirds said that it was difficult to tell others about their HIV infection, which could have implications for disclosing their HIV status to sex partners. This is consistent with previous literature that HIV-related stigma is associated with low disclosure of HIV status [7, 8].

Overall, women and transgender persons had higher stigma scores than men and, compared to non-Hispanic whites, all other racial/ethnic groups had higher stigma scores. Stratifying these estimates by combined race/ethnicity and gender groups revealed key differences. Among women, Hispanic/Latina women reported the highest average stigma scores, while non-Hispanic black women reported the lowest scores. Although the cell sizes are smaller, transgender persons identifying as other/multiracial reported the highest stigma scores overall, significantly higher than non-Hispanic white transgender persons. These racial/ethnic and gender differences in stigma burden may help inform stigma reduction efforts from public health practitioners, policymakers, and clinicians by identifying key groups in need of intervention.

We also found that higher stigma scores were associated with several social determinants of health. The findings from this nationally representative sample are consistent with results from smaller studies that found that persons who reported lower education [22], poverty [23], suboptimal health insurance [9], foreign born status [24], recent experiences with homelessness [8, 25], or incarceration [26] had higher stigma scores. This suggests that interventions to reduce stigma may need to consider the multiple challenges facing HIV-infected persons who experience internalized stigma, but further work may be

needed to elucidate the relationship between internalized stigma and poor social determinants of health.

One key finding from this analysis was that, after adjusting for age, there was no significant association between the stigma score and sustained viral suppression among persons receiving HIV care. Other studies have found a relationship between younger age and higher internalized stigma [4, 21], and some have hypothesized that this may be due to less knowledge of HIV [4]. Younger HIV-positive people are also less likely to adhere to ART [15, 27–29] and less likely to achieve viral suppression [27, 30]. Our results are consistent with this literature and contribute the finding that young age confounds the independent association between internalized stigma and sustained viral suppression among persons receiving HIV care. However, stigma may still be independently associated with other aspects of health among persons in care, such as adherence [6] and depression [10]. Our results suggest younger persons may be in need of tailored stigma-reduction interventions, for example those that address knowledge of HIV [4] and those designed to address stigma among youth [31].

Stigma scores were significantly higher among persons who were dissatisfied with their social support, an association supported by prior research [32]. Fearing rejection from family and friends can lead some HIV-infected people to not disclose their HIV status, which can deprive them of social support [2]. It may be helpful for persons experiencing internalized HIV-related stigma to be referred to HIV peer support groups. This may increase their social support [33], which has been associated with better quality of life [34], mental health [35], and adherence [36, 37] among HIV-infected persons.

Stigma reduction efforts may be needed to help normalize HIV at a community level and to help individuals who have internalized negative attitudes about having HIV. Previous interventions have had success in reducing internalized stigma. An intervention using videos and other technology that normalize HIV and empower HIV-infected women in the southern United States was effective in reducing internalized stigma and enhancing self-esteem and coping mechanisms [38]. Our findings suggest that other groups that have high risk of stigma, such as transgender or Hispanic/Latino individuals, may benefit from a similar tailored intervention. Another intervention that was effective in reducing internalized stigma emphasized skills-building in young adults recently diagnosed with HIV, including decreasing negative feelings towards oneself and others living with HIV, increased strategic disclosure of HIV to others, building supportive social networks, and building skills to combat HIV-related stigma [31]. Because we found that young age was related to higher stigma scores and poorer viral suppression, this intervention may benefit from adding an adherence component to help improve viral suppression among younger HIV-infected persons. Community-based interventions, such as anti-stigma media campaigns like CDC's Let's Stop HIV Together [39], can work to reduce stigma toward people living with HIV among the general population [40].

Limitations and Strengths

There were some limitations to this analysis. First, the stigma and adherence measures were self-reported and subject to social-desirability and recall biases. Second, due to the design of MMP, our analysis was restricted to HIV-infected adults who were in care. Thus, we cannot extrapolate our findings to HIV-infected adults who are out of care. In particular, our finding that age confounds the association between internalized stigma and viral suppression may be limited to only those who are in care, as it is possible that stigma could affect viral suppression through lack of linkage to and engagement in care. In 2015, MMP changed its sampling methods to include HIV-infected persons who are not in care; therefore, MMP has the potential to examine stigma among HIV-infected persons not in care in future analyses. Furthermore, our findings are limited to internalized stigma, though there are other forms of stigma that could be associated with viral suppression [10, 23]. For example, externalized stigma, which includes fear of discrimination or negative reactions from others upon disclosing status, could influence a person's decision to engage in care. In 2015, MMP started using a stigma scale that captures multiple stigma dimensions, so future MMP analyses may address these limitations. Third, the stigma statements have a current time frame, but viral suppression was based on the past 12 months, so it is unknown whether stigma and viral suppression were concurrent. Fourth, while significant differences in stigma scores were observed, the effect sizes were relatively small. However, the prevalence of internalized stigma was substantial among HIV-infected persons in care. Future work may examine whether differences in agreement with the stigma statements that make up the scale vary among specific subpopulations, which may produce information that could further inform development of stigma reduction interventions. Finally, while MMP's overall response rate is lower than optimal, low response rates are not necessarily indicative of nonresponse bias, particularly when probabilistic samples are drawn from rigorously constructed frames and adjusted for nonresponse, as is the case for MMP data [41, 42].

Despite these limitations, the strengths of this analysis include the probability-based sampling methodology; a large, geographically diverse sample size; use of a

previously validated stigma scale; and the linking of behavioral interview data with clinical information from medical records [43]. Finally, the MMP population was shown to share similar demographic characteristics with all HIV-diagnosed persons [43].

Internalized stigma continues to affect a substantial portion of HIV-infected persons in the United States, suggesting a need for individual and community-level stigma reduction interventions. Efforts to reduce stigma among HIV-infected persons may be tailored for specific populations such those who are younger; women, particularly Hispanic/Latina women; transgender; racial/ethnic minorities; or who have poorer social determinants of health. Future research may be helpful to understand the role that stigma plays among HIV-infected individuals who are not in care.

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Compliance with Ethical Standards

Conflict of interest All authors declare no conflicts of interest.

Ethical Approval The National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention determined that MMP was a public health surveillance activity and not subject to federal institutional review board review. However, some jurisdictions obtained approval from local Institutional Review Boards.

Informed Consent All participants provided informed consent.

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