6-22-2021

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Citation Details

IDSA — Infectious Diseases Society of America · hivma hiv medicine association · OXFORD

Social Determinants of Health and Care Outcomes Among People With HIV in the United States

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Background. Fewer than 70% of people with HIV (PWH) in the United States have achieved durable viral suppression. To end the HIV epidemic in the United States, clinicians, researchers, and public health practitioners must devise ways to remove barriers to effective HIV treatment. To identify PWH who experience challenges to accessing health care, we created a simple assessment of social determinants of health (SDOH) among PWH and examined the impact of cumulative social and economic disadvantage on key HIV care outcomes.

Methods. We used data from the 2015–2019 Medical Monitoring Project, a yearly cross-sectional survey of PWH in the United States (n = 15 964). We created a 10-item index of SDOH and assessed differences in HIV care outcomes of missed medical appointments, medication adherence, and durable viral suppression by SDOH using this index using prevalence ratios with predicted marginal means.

Results. Eighty-three percent of PWH reported at least 1 SDOH indicator. Compared with PWH who experienced none of the SDOH indicators, people who experienced 1, 2, 3, and 4 or more SDOH indicators were 1.6, 2.1, 2.6, and 3.6 as likely to miss a medical appointment in the prior year; 11%, 17%, 20%, and 31% less likely to report excellent adherence in the prior 30 days; and 2%, 4%, 10%, and 20% less likely to achieve durable viral suppression in the prior year, respectively.

Conclusions. Among PWH, cumulative exposure to social and economic disadvantage impacts care outcomes in a dose-dependent fashion. A simple index may identify PWH experiencing barriers to HIV care, adherence, and durable viral suppression in need of critical supportive services.

Keywords. adherence; HIV; missed appointments; social determinants of health; viral suppression.

Major biomedical advances in HIV care have improved the lives of people with HIV (PWH); the life expectancy of PWH receiving effective HIV antiretroviral therapy (ART) is now nearly equivalent to people without HIV [1]. However, even within high-resource contexts like the United States, disparities in HIV care outcomes by race and ethnicity, age, and gender persist [2–4]. For example, Black/African American PWH are less likely to receive adequate medical care, including ART, and achieve viral suppression compared with PWH from other racial/ethnic groups [4]. Compared with elders with HIV, youth with HIV are less likely to be diagnosed with HIV, be linked to and retained in care, and experience viral suppression [5]. Transgender PWH are less likely to report excellent adherence to ART and achieve viral suppression compared with cisgender PWH [6, 7]. Comprehensive services, like those provided through the Ryan White HIV/AIDS Program (Ryan White),

have been effective at reducing some disparities, but not all [8]. Understanding, measuring, and addressing the fundamental causes of HIV-related disparities are essential [9–11].

Social determinants of health (SDOH) are fundamental causes of health disparities and, according to the US Centers for Disease Control and Prevention (CDC), refer to the "conditions in the environments in which people are born, live, learn, work, play, worship and age that affect a wide range of health, functioning, and quality of life outcomes and risks" [12]. SDOH reflect the social, political, and economic contexts and social hierarchies whereby populations are stratified according to attributes such as income, gender, race, ethnicity, education, occupation, and other factors [13]. These hierarchies, in turn, determine an individual's exposure to material conditions, biological and behavioral factors, psychosocial factors, and interactions with the health care system (ie, SDOH) that may either promote or compromise wellness. In Healthy People 2020, the CDC recognized 5 key areas of SDOH: economic stability, education, social and community context, health and health care, and neighborhood and built environment [12].

The relationship between SDOH and HIV care outcomes (eg, adherence to ART, attendance to medical appointments, and viral suppression) is largely recognized [14], but most research and reporting has focused on associations between a single factor (eg, poverty, food insecurity, incarceration, or homelessness) and clinical outcomes [9, 15, 16]. Similarly, the

CDC reported on county-level social determinants among PWH, but examined only 4 items—poverty, education level, median household income, and health insurance coverage [17]. However, SDOH are complex, intersecting, and reinforcing [11].

The best method to assess the cumulative effects of SDOH on health outcomes has not yet been determined. However, the additive nature of SDOH is clearly reflected in medical case management for PWH [18]. Nationwide, Ryan White case managers base the level of prescribed client support and services on a cumulative assessment of biopsychosocial factors, or acuity scale. Still, a thorough acuity scale can be time-intensive, and case management may not be available for all PWH or incorporated into all HIV-related health encounters. Furthermore, to date, no SDOH scales have been validated for use in large-scale surveillance or research designed to identify PWH at risk for poorer HIV care outcomes. A short, easily constructed index of SDOH could provide clear clinical and public health benefits.

We explored how the accumulation of SDOH across several relevant domains influences the health outcomes of PWH and propose an index that can be used to measure the effect of SDOH on key HIV care outcomes of missed appointments, treatment adherence, and viral suppression. In addition, we explored how this index performs in the presence of demographic variables of age, race/ethnicity, and a combined measure of gender and gender of sex partners that are associated with the HIV care outcomes of interest. Finally, we assessed the residual associations between demographic characteristics and care outcomes after accounting for SDOH.

METHODS

Data Set

We used data from the CDC Medical Monitoring Project (MMP), which produces nationally and locally representative data to assess the clinical and behavioral characteristics of adults with diagnosed HIV infection in the United States and Puerto Rico [5]. MMP uses a complex survey sample selected in 2 consecutive stages. First, 16 states and 1 territory were selected from all US states, the District of Columbia, and Puerto Rico. Next, simple random samples of adults with diagnosed with HIV infection aged ≥18 years were taken within each sampled jurisdiction from the National HIV Surveillance System (NHSS), a census of PWH in the US MMP whose data are collected annually from June of each cycle year through May of the following year. For this analysis, we used 4 cycle years of pooled national data, collected during June 2015 through May 2019, for these analyses (n = 15 964). Demographic, clinical, and behavioral data were collected through face-to-face or phone interviews. Relevant clinical data (eg, prescription of antiretroviral therapy [ART] medications and laboratory results) were abstracted from medical records. The annual response rate for

jurisdictions was 100%, and for sampled persons it ranged from 40% to 46% for the data cycle years included in the study [5].

Patient Consent

In accordance with guidelines for defining public health research, the Centers for Disease Control and Prevention determined that the Medical Monitoring Project was public health surveillance used for disease control, program, or policy purposes. Local institutional review board approval was obtained within participating jurisdictions when required. Informed consent was obtained from all interviewed participants.

Measures

We constructed the Oregon Social Determinants of HIV Health Index (OSHI) using the 5 domains of Healthy People 2020—education, economic stability, health, neighborhood and built environment, and social and community context—as a framework [12]. We chose 2 items from the MMP core survey that best mapped to each of the 5 domains (Table 1). All data used to construct the 10-item OSHI were collected through participant interviews. We then summed the number of items reported by the participant to create the OSHI, which has a range of 0 to 10, where higher scores indicate that the respondent was experiencing a higher level of social, environmental, or economic disadvantage. From

Table 1. Oregon Social Determinants of HIV Health Index Items and Definitions Derived From the CDC Medical Monitoring Project

OSHI Item	Definition
Education	
Education level	Less than high school (vs all other)
Health literacy	Somewhat/a little bit/not a bit confident in filling out medical forms by yourself (vs extremely or quite a bit confident)
Economic stability	
Poverty	Income at or below the federal poverty guideline
Food insecurity	Past-year experiences of being hungry but didn't eat because there wasn't enough money for food
Health	
Gap in health coverage	Past-year gap in health insurance
ER visit	Past-year visit to emergency room for own health reason
Neighborhood and built environment	
Homelessness	Past-year experience of homelessness (defined as lived in a shelter/car/single room occupancy hotel)
Need for transportation help	Needing transportation assistance in past year
Social and community context	
Criminal justice involvement	Past-year experience of being arrested and put in jail/detention/prison for longer than 24 h
History of sexual/physical IPV	Any history of sexual or physical intimate partner violence

Abbreviations: CDC, Centers for Disease Control and Prevention; ER, emergency room; IPV, intimate partner violence.

the continuous OSHI, we created a 5-level ordinal OSHI variable based on the distribution of the 10 individual indicators: 0 SDOH indicators, 1 SDOH indicator, 2 SDOH indicators, 3 SDOH indicators, and 4 or more SDOH indicators.

We examined 3 dichotomous HIV care continuum measures: missed appointments, adherence to ART, and durable viral suppression. Missed appointments and ART adherence data were collected through patient interviews; viral suppression data were collected through medical record abstraction. Missed appointments were defined as whether participants had missed any HIV-related medical appointments in the past year (yes/no). An analysis of a US clinical cohort of PWH engaged in care showed that patients who missed appointments experienced greater mortality than those who did not [19]. Excellent ART adherence was defined as not missing any doses of HIV medications in the past 30 days (yes/no). Durable viral suppression was defined as having all (not just the most recent) viral loads undetectable or <200 copies/mL in the past 12 months. Durable viral suppression prevents HIV-related complications, extends life expectancy, and prevents secondary HIV transmission [1, 20].

We examined 4 key sociodemographic covariates associated with the care outcomes of interest and SDOH: age (measured in years as a categorical variable: 18–29, 30–39, 40–49, and ≥50); race/ethnicity (White, non-Hispanic; Black, non-Hispanic; Hispanic/Latinx; and an "other race" category to capture the relatively low numbers of American Indian/Alaska Native, Asian, Pacific Islander, and multiracial participants); and a combined variable indicating gender and sex partner gender (any men who have sex with men [MSM], men who have sex with women only [MSW], any women who have sex with men [WSM], and an "other" category that includes the relatively low numbers of transgender individuals and women who have sex with women).

Statistical Analysis

We calculated weighted percentages and corresponding 95% confidence intervals of the sociodemographic variables and the individual OSHI items and the 5-level categorical OSHI overall and by HIV care outcome. We also calculated the mean and median OSHI and corresponding 95% CIs overall and by care outcome.

We estimated unadjusted prevalence ratios (PRs) with predicted marginal means using logistic regression to examine the associations between individual OSHI items and missed appointments, excellent ART adherence, and durable viral suppression. We then estimated unadjusted prevalence ratios to assess the associations between the 5-level categorical OSHI and missed appointments, excellent ART adherence, and durable viral suppression, respectively (Models 1–3). Models 4–6 examined the associations between the categorical OSHI variable and the 3 outcomes of interest, with each model adjusted for age, race/ethnicity, and a combined measure of gender and sex partner gender.

Data were weighted based on known probabilities of selection at state or territory and person levels. In addition, data were weighted to adjust for person nonresponse and poststratified to known population totals by age, race/ethnicity, and gender from NHSS [5]. Statistical tests with $P < .05$ were considered significant. All analyses were conducted using survey procedures in SAS 9.4 and SAS-callable SUDAAN 11.0.1.

RESULTS

Characteristics and Distribution of Social Determinants of Health Among PWH in the United States

Among PWH in the United States, half were 50 years of age or older, and half were MSM. Forty-one percent were non-Hispanic Black, nearly one-third were non-Hispanic White, and 22% were Hispanic/Latinx (Table 2). Seventeen percent (17%) experienced none of the SDOH indicators, 23% 1 indicator, 20% 2 indicators, 16% 3 indicators, and 25% 4 or more indicators. The most frequently reported SDOH indicator was poverty (43%), followed by a past-year visit to the emergency room (39%). One-third had experienced intimate partnet violence (IPV; 33%) or needed transportation assistance (32%), and almost one-quarter (24%) reported needing help completing medical forms. About 1 in 5 PWH had less than a high school diploma (18%) or were experiencing food insecurity (21%); 1 in 10 experienced homelessness (9%) or had a gap in health insurance (12%). Five percent experienced criminal justice involvement. The mean OSHI was 2.30 (95% CI, 2.25–2.35) with a median of 1.52 (95% CI, 1.45–1.59).

Clinical Outcomes by the Oregon Social Determinants of HIV Health Index

Twenty-four percent missed HIV medical appointments in the prior year, 60% had excellent adherence to their HIV medications in the prior 30 days, and 63% had achieved durable viral suppression in the prior 12 months (Table 3). All 10 SDOH indicators were associated with a missed HIV medical appointment, all SDOH indicators except for education level were associated with excellent ART adherence, and all SDOH indicators except for health literacy and history of IPV were associated with viral suppression. The mean and median OSHI were 3.13 (95% CI, 3.05–3.21) and 2.49 (95% CI, 2.39–2.59), respectively, for those who missed an appointment in the prior year, compared with 2.04 (95% CI, 1.98–2.09) and 1.25 (95% CI, 1.17–1.32), respectively, for those who did not miss an appointment. The mean and median OSHI were 2.01 (95% CI, 1.96–2.06) and 1.22 (95% CI, 1.14–1.29), respectively, for those who reported excellent adherence and 2.57 (95% CI, 2.50–2.64) and 1.79 (95% CI, 1.70–1.89), respectively, for those who did not report excellent adherence. Finally, the mean and median OSHI were 2.12 (95% CI, 2.06–2.17) and 1.34 (95% CI, 1.27–1.41), respectively, for those who were durably virally suppressed compared with 2.64 (95% CI, 2.56–2.73) and 1.89 (95% CI, 1.77–2.02), respectively, for those who were not durably virally suppressed.

Table 2. Sociodemographic Characteristics and Oregon Social Determinants of HIV Health Index Items Among People With HIV in the United States, Medical Monitoring Project, 2015–2019

	Total	
	No.	Col % (95% CI)
Total	15 964	100
Sociodemographics		
Age group, y		
18–29	1327	8.9 (8.2–9.6)
30–39	2553	16.6 (15.9–17.3)
40–49	3781	24.2 (23.3–25.1)
≥50	8303	50.3 (49.1–51.6)
Race/ethnicity		
Black, non-Hispanic	6734	41.1 (36.4–45.9)
White, non-Hispanic	4662	29.5 (26.4–32.6)
Hispanic or Latinx	3477	22.3 (18.5–26.2)
Other	1091	7.0 (6.2–7.9)
Gender and sex partner type		
Any MSM	7805	49.8 (47.9–51.7)
MSW only	3558	23.1 (22.0–24.2)
Any WSM	3981	23.0 (21.8–24.3)
Other	616	4.1 (3.7–4.4)
OSHI items		
Education		
Education level		
Less than high school	2851	17.6 (16.5–18.7)
High school or more	13 050	82.4 (81.3–83.5)
Health literacy		
Low confidence in completing health forms	3779	24.0 (23.1–24.9)
High confidence in completing health forms	12 083	76.0 (75.1–76.9)
Economic stability		
Poverty		
Yes	6553	43.2 (41.2–45.3)
No	8253	56.8 (54.7–58.8)
Food insecurity		
Yes	3304	20.8 (20.0–21.7)
No	12 600	79.2 (78.3–80.0)
Health		
Gap in insurance		
Yes	1665	11.5 (10.4–12.6)
No	14 064	88.5 (87.4–89.6)
ER visit		
Yes	6189	38.7 (37.3–40.1)
No	9661	61.3 (59.9–62.7)
Neighborhood & built environment		
Homelessness		
Yes	1460	8.9 (8.3–9.4)
No	14 452	91.1 (90.6–91.7)
Need for transportation help		
Yes	5283	31.7 (30.7–32.7)
No	10 553	68.3 (67.3–69.3)
Social & community context		
Criminal justice involvement		
Yes	780	5.1 (4.6–5.6)
No	15 122	94.9 (94.4–95.4)
History of sexual/physical IPV		
Yes	5231	33.1 (31.6–34.5)
No	10 491	66.9 (65.5–68.4)
OSHI score categorized		

Table 2. Continued

	Total	
	No.	Col % (95% CI)
0 indicators	2354	16.6 (15.7–17.6)
1 indicator	3212	22.7 (21.6–23.8)
2 indicators	2938	20.4 (19.5–21.3)
3 indicators	2273	15.6 (14.8–16.4)
≥4 indicators	3659	24.6 (23.6–25.7)

Abbreviations: ART, antiretroviral therapy; ER, emergency room; IPV, intimate partner violence; MSM, men who have sex with men; MSW, men who have sex with women; WSM, women who have sex with men.

We observed a dose–response relationship between SDOH indicators and clinical outcomes in unadjusted analysis (Table 4, Models 1–3). Compared with those with an OSHI of 0, those with a score of 1, 2, 3, and 4 or greater were 1.6, 2.2, 2.9, and 4.0 times as likely to miss an appointment, respectively. Compared with those with an OSHI of 0, those with a score of 1, 2, 3, and 4 or greater were 11%, 17%, 20%, and 31% less likely to report excellent ART adherence and were 3%, 6%, 12%, and 23% less likely to achieve durable viral suppression, respectively.

In the models adjusted for sociodemographic characteristics (Table 5, Models 4–6), the categorical OSHI remained significantly associated with each of the HIV clinical outcomes in a dose-dependent fashion. Compared with those with an OSHI of 0, PWH with an index of 1, 2, 3, and 4 or greater were 1.6, 2.1, 2.6, and 3.6 times as likely to miss a medical appointment, respectively. Compared with those with an OSHI of 0, those with a score of 1, 2, 3, and 4 or greater were 11%, 17%, 20%, and 31% less likely to report excellent adherence and were 2%, 4%, 10%, and 20% less likely to achieve durable viral suppression, respectively.

In adjusted models, PWH younger than 50 years of age were more likely to miss an appointment and less likely to report excellent adherence and to achieve durable viral suppression compared with those aged 50 years or older. The experiences of PWH who identify as Black and Hispanic/Latinx were associated with missing an appointment in the prior year. In addition, the experiences of Black PWH were associated with an 11% lower prevalence of excellent adherence and durable viral suppression. MSM, transgender people, and WSW (the "other" category of the combined gender and sex partner variable) were 12% less likely to report excellent adherence than MSW.

In a post hoc analysis, we modified the OSHI to create an 8-item score by omitting health literacy and history of IPV from the index; these 2 items were not statistically significantly associated with durable viral suppression in bivariable models. Seventy-one percent of PWH experienced at least 1 of the SDOH indicators of the 8-item score. In a model adjusted for age, race/ethnicity, and gender and sex partner, prevalence ratios comparing durable viral suppression among those with a score of 0 with those with a score of 1, 2, 3, and 4 or greater were 0.95 (95% CI, 0.91–0.99; *P* = .008), 0.89 (95% CI, 0.85–0.94;

Table 3. Sociodemographic Characteristics and Oregon Social Determinants of HIV Health Index Items by Care Outcomes Among People With HIV in the United States, Medical Monitoring Project, 2015–2019

	Total No.	Missed Appointment				Excellent Adherence				Durable Viral Suppression			
		No.	Row % (95% CI)	PR (95% CI)	P Value	No.	Row % (95% CI)	PR (95% CI)	P Value	No.	Row % (95% CI)	PR (95% CI)	P Value
Total	15964	3770	24.1 (23.1–25.1)			8940	59.5 (58.5–60.6)			10791	63.3 (61.9–64.8)		
Sociodemographics													
Age group, y													
18–29	1327	489	37.5 (34.0–41.0)	1.99 (1.80–2.21)	<.001	524	45.4 (41.7–49.0)	0.70 (0.65–0.76)	<.001	717	47.8 (44.4–51.1)	0.70 (0.65–0.75)	<.001
30–39	2553	780	31.4 (29.3–33.5)	1.67 (1.55–1.81)	<.001	1198	51.7 (49.2–54.2)	0.80 (0.76–0.84)	<.001	1557	57.1 (54.7–59.5)	0.83 (0.80–0.87)	<.001
40–49	3781	957	25.2 (23.6–26.9)	1.34 (1.24–1.46)	<.001	2058	58.4 (56.5–60.2)	0.90 (0.87–0.94)	<.001	2528	62.2 (59.7–64.7)	0.91 (0.87–0.94)	<.001
≥50	8303	1544	18.8 (17.7–19.8)	Ref		5160	64.6 (63.3–65.9)	Ref		5989	68.7 (67.1–70.2)	Ref	
Race/ethnicity													
Black, non-Hispanic	6734	1849	27.6 (26.0–29.1)	1.70 (1.55–1.87)	<.001	3468	55.6 (53.7–57.5)	0.86 (0.82–0.89)	<.001	4158	57.0 (55.3–58.7)	0.82 (0.79–0.85)	<.001
White, non-Hispanic	4662	721	16.2 (14.9–17.6)	Ref		2893	64.8 (62.9–66.6)	Ref		3470	69.8 (67.4–72.3)	Ref	
Hispanic or Latinx	3477	947	28.0 (26.1–30.0)	1.73 (1.55–1.93)	<.001	1983	59.7 (57.9–61.4)	0.92 (0.89–0.96)	<.001	2435	66.9 (64.1–69.7)	0.96 (0.91–1.01)	.119
Other	1091	253	24.5 (21.3–27.7)	1.51 (1.30–1.75)	<.001	596	58.6 (55.4–61.9)	0.91 (0.85–0.96)	.001	728	61.7 (56.9–66.4)	0.88 (0.83–0.94)	.006
Gender and sex partner type													
Any MSM	7805	1677	21.9 (20.6–23.1)	0.88 (0.81–0.97)	.008	4313	58.6 (57.1–60.1)	0.93 (0.89–0.96)	<.001	5500	65.4 (63.7–67.2)	1.05 (1.01–1.09)	.006
MSW only	3558	853	24.8 (22.8–26.8)	Ref		2145	63.2 (61.2–65.2)	Ref		2340	62.2 (60.1–64.4)	Ref	
Any WSM	3981	1081	27.5 (25.9–29.0)	1.11 (1.01–1.22)	.027	2200	58.8 (56.9–60.7)	0.93 (0.89–0.97)	<.001	2560	60.6 (58.4–62.8)	0.97 (0.93–1.02)	.260
Other	616	159	28.0 (23.6–32.3)	1.13 (0.94–1.35)	.202	282	53.2 (48.4–58.1)	0.84 (0.76–0.93)	<.001	391	59.9 (55.2–64.6)	0.96 (0.88–1.05)	.372
OSHI items													
Education													
Education level													
Less than high school	2851	857	30.6 (28.5–32.8)	1.35 (1.24–1.47)	<.001	1567	58.6 (56.5–60.6)	0.98 (0.94–1.02)	.360	1826	60.4 (58.0–62.9)	0.94 (0.91–0.98)	<.001
High school or more	13050	2910	22.7 (21.6–23.8)	Ref		7363	59.7 (58.5–61.0)	Ref		8933	64.0 (62.5–65.5)	Ref	
Health literacy													
Low confidence in completing health forms	3779	1077	29.2 (27.3–31.1)	1.30 (1.20–1.40)	<.001	2003	55.4 (53.5–57.4)	0.91 (0.87–0.95)	<.001	2498	62.2 (59.9–64.6)	0.97 (0.94–1.01)	.115
High confidence in completing health forms	12083	2682	22.5 (21.4–23.6)	Ref		6924	60.8 (59.5–62.1)	Ref		8246	63.9 (62.5–65.4)	Ref	
Economic stability													
Poverty													

Table 3. Continued

		Missed Appointment				Excellent Adherence				Durable Viral Suppression			
	Total No.	No.	Row % (95% CI)	PR (95% CI)	PValue	No.	Row % (95% CI)	PR (95% CI)	PValue	No.	Row % (95% CI)	PR (95% CI)	PValue
Yes	6553	1972	30.4 (29.3–31.5)	1.62 (1.51–1.75)	<.001	3523	56.7 (55.1–58.4)	0.92 (0.89–0.96)	<.001	4172	60.0 (58.0–62.0)	0.90 (0.86–0.93)	<.001
No	8253	1512	18.7 (17.4–20.0)	Ref		4794	61.4 (60.0–62.8)	Ref		5900	66.9 (65.1–68.7)	Ref	
Food insecurity													
Yes	3304	1306	39.9 (38.0–41.8)	2.00 (1.87–2.13)	<.001	1414	47.0 (44.8–49.2)	0.75 (0.71–0.79)	<.001	1883	52.3 (50.2–54.5)	0.79 (0.76–0.82)	<.001
No	12600	2463	20.0 (18.9–21.0)	Ref		7524	62.6 (61.5–63.8)	Ref		8878	66.3 (64.7–67.9)	Ref	
Health													
Gap in insurance													
Yes	1665	598	36.5 (34.1–39.0)	1.62 (1.50–1.76)	<.001	678	47.6 (44.8–50.3)	0.78 (0.74–0.83)	<.001	880	48.8 (45.5–52.1)	0.74 (0.69–0.79)	<.001
No	14064	3139	22.5 (21.5–23.5)	Ref		8215	60.9 (59.9–62.0)	Ref		9820	66.2 (64.7–67.6)	Ref	
ER visit													
Yes	6189	1855	30.0 (28.4–31.6)	1.48 (1.38–1.58)	<.001	3104	54.5 (52.8–56.2)	0.87 (0.84–0.90)	<.001	3840	58.5 (56.4–60.6)	0.88 (0.85–0.91)	<.001
No	9661	1899	20.3 (19.3–21.4)	Ref		5813	62.6 (61.3–63.9)	Ref		6892	66.6 (65.2–68.1)	Ref	
Neighborhood & built environment													
Homelessness													
Yes	1460	649	45.4 (42.0–48.8)	2.06 (1.88–2.25)	<.001	601	45.6 (42.3–48.9)	0.75 (0.70–0.81)	<.001	722	44.6 (41.4–47.8)	0.68 (0.64–0.73)	<.001
No	14452	3120	22.0 (21.0–23.0)	Ref		8338	60.7 (59.6–61.8)	Ref		10045	65.2 (63.8–66.7)	Ref	
Need for transportation help													
Yes	5283	1756	33.4 (31.8–34.9)	1.69 (1.57–1.83)	<.001	2711	54.2 (52.5–55.9)	0.87 (0.84–0.91)	<.001	3308	59.0 (57.0–60.9)	0.90 (0.87–0.93)	<.001
No	10553	1992	19.7 (18.5–20.9)	Ref		6205	62.0 (60.7–63.3)	Ref		7424	65.7 (64.1–67.3)	Ref	
Social & community context													
Criminal justice involvement													
Yes	780	284	35.2 (30.8–39.6)	1.50 (1.31–1.71)	<.001	322	48.5 (43.9–53.1)	0.81 (0.73–0.89)	<.001	383	46.1 (41.2–50.9)	0.72 (0.64–0.80)	<.001
No	15122	3483	23.5 (22.5–24.5)	Ref		8612	60.1 (59.0–61.2)	Ref		10378	64.3 (62.9–65.8)	Ref	
History of sexual/physical IPV													
Yes	5231	1497	29.0 (27.4–30.6)	1.36 (1.27–1.45)	<.001	2564	52.3 (50.7–53.9)	0.83 (0.80–0.86)	<.001	3519	63.3 (61.2–65.4)	0.99 (0.96–1.02)	.610
No	10491	2208	21.4 (20.3–22.5)	Ref		6297	63.1 (61.9–64.4)	Ref		7151	63.9 (62.4–65.4)	Ref	

Abbreviations: ART, antiretroviral therapy; ER, emergency room; IPV, intimate partner violence; MSM, men who have sex with men; MSW, men who have sex with women; OSHI, Oregon Social Determinants of HIV Health Index; PR, prevalence ratio; Ref, referent; WSM, women who have sex with men.

$P < .001$), 0.84 (95% CI, 0.79–0.88; $P < .001$), and 0.73 (95% CI, 0.69–0.77; $P < .001$), respectively.

DISCUSSION

Among adults with diagnosed with HIV in the United States, social and economic disadvantage was highly prevalent. Our analysis demonstrated that SDOH are both individually and cumulatively associated with key HIV care outcomes. Controlling for age, race/ethnicity, and a combined measure of participant gender and gender of sex partners, social and economic disadvantage was associated with a greater likelihood of missing an appointment with a provider and a lower likelihood of excellent adherence and durable viral suppression. We specifically observed a dose–response relationship between the cumulative number of SDOH experienced and risk of poorer care outcomes. In addition, even when accounting for OSHI score, we found residual associations between demographic characteristics and HIV care outcomes.

Social and economic disadvantage was commonly reported; 83% of PWH reported at least 1 SDOH. This finding is consistent with a recent CDC report that illustrated frequent exposure to county-level measures of poverty, low educational attainment, low income, and low health insurance coverage among PWH and, like other studies [9, 15, 16], demonstrated associations between these individual SDOH and HIV care outcomes [17]. In our analysis, we found that reporting even 1 SDOH was associated with missed appointments and poorer ART adherence. As with tobacco use or lead exposure, there appears to be no "safe" level of exposure to social or economic disadvantage with respect to HIV care outcomes [21, 22].

The dose–response association between OSHI score and HIV care outcomes corresponds both with our conceptual understanding of SDOH and research from other fields; SDOH are overlapping and interconnected, contributing to cumulative stress, increased allostatic load, and heightened risk of chronic disease and further disadvantage over the life course [23]. However, to our knowledge, this is the first analysis to quantitatively demonstrate the relationship between cumulative SDOH and HIV care outcomes.

Still, despite strong associations between the OSHI and HIV care continuum measures, disparities by age, race/ethnicity, and combined gender and gender of sex partners persisted. Even after controlling for OSHI score and other demographics, compared with White PWH, PWH of color, and especially Black PWH, had poorer care outcomes. Racial and ethnic disparities are frequently attributed to differences in SDOH [24]; however, our results indicate that the OSHI does not adequately account for differences by race and ethnicity. Racism and other forms of discrimination have been conceptually and empirically linked to adverse health outcomes in general and in HIV care [25]. The CDC recognizes discrimination as a key issue in the social and community context domain of SDOH [12]. As such, the persistent differences across race and ethnicity may be at least partially attributable to anticipated racism, direct experiences of racism, and/or medical mistrust resulting from historical racism [15, 26]. Unfortunately, MMP only began collecting recent (ie, in the prior 12 months vs since testing HIV-positive) experiences of racism or discrimination related to HIV status, age, sexual orientation, or gender identity in 2018. Further refinement of the OSHI or use the OSHI in conjunction with existing measures of racism or other forms of discrimination, may more effectively capture SDOH relevant to racial and ethnic disparities in outcomes among PWH.

Similarly, after accounting for SDOH and other demographics, younger age remained associated with higher risk of poor HIV care outcomes. Existing research suggests that low self-efficacy and lack of perceived utility of treatment may contribute to poor adherence specifically among young PWH [2]. Alternatively, it is possible that older adults do not necessarily have better HIV outcomes than young adults. Rather, the association could be a product of survival bias; older adults with HIV have aged successfully *because* they have good appointment attendance, ART adherence, and viral suppression [27]. Regardless, our results reiterate the unique impact age has on HIV outcomes, potentially independent of SDOH.

Table 4. Unadjusted Prevalence Ratios Comparing Care Outcomes by the Oregon Social Determinants of HIV Health Index Among People With HIV in the United States, Medical Monitoring Project, 2015–2019

	Model 1 Missed Appointment			Model 2 Excellent Adherence			Model 3 Durable Viral Suppression		
	% (95% CI)	PR (95% CI)	P Value	% (95% CI)	PR (95% CI)	P Value	% (95% CI)	PR (95% CI)	P Value
OSHI score									
0 indicators	9.8 (8.2–11.3)	Ref		71.1 (68.9–73.4)	Ref		71.8 (69.2–74.4)	Ref	
1 indicator	15.8 (14.0–17.5)	1.62 (1.35–1.93)	<.001	63.3 (61.0–65.6)	0.89 (0.85–0.93)	<.001	69.8 (67.5–72.1)	0.97 (0.93–1.02)	.202
2 indicators	21.7 (19.8–23.7)	2.23 (1.86–2.67)	<.001	58.9 (56.5–61.2)	0.83 (0.79–0.87)	<.001	67.4 (64.6–70.1)	0.94 (0.89–0.99)	.028
3 indicators	28.5 (25.9–31.0)	2.92 (2.50–3.41)	<.001	56.8 (54.2–59.4)	0.80 (0.76–0.84)	<.001	63.1 (60.3–65.9)	0.88 (0.84–0.92)	<.001
≥4 indicators	39.0 (37.2–40.8)	4.00 (3.37–4.74)	<.001	49.4 (47.5–51.4)	0.69 (0.66–0.73)	<.001	55.1 (53.0–57.2)	0.77 (0.73–0.81)	<.001

Abbreviations: OSHI, Oregon Social Determinants of HIV Health Index; PR, prevalence ratio.

Table 5. Adjusted Prevalence Ratios Comparing Care Outcomes by the Oregon Social Determinants of HIV Health Index Among People With HIV in the United States, Medical Monitoring Project, 2015–2019

	Model 4 Missed Appointment		Model 5 Excellent ART Adherence		Model 6 Durable Viral Suppression	
	Apr (95% CI)	PValue	Apr (95% CI)	PValue	Apr (95% CI)	PValue
OSHI score						
0 indicators	Ref		Ref		Ref	
1 indicator	1.55 (1.30–1.85)	<.001	0.89 (0.85–0.94)	<.001	0.98 (0.94–1.02)	.344
2 indicators	2.06 (1.70–2.48)	<.001	0.83 (0.79–0.87)	<.001	0.96 (0.91–1.01)	.131
3 indicators	2.64 (2.25–3.11)	<.001	0.80 (0.76–0.84)	<.001	0.90 (0.86–0.95)	<.001
≥4 indicators	3.60 (2.99–4.33)	<.001	0.69 (0.65–0.73)	<.001	0.80 (0.76–0.84)	<.001
Age group, y						
18–29	1.73 (1.54–1.94)	<.001	0.76 (0.70–0.82)	<.001	0.74 (0.68–0.80)	<.001
30–39	1.52 (1.41–1.65)	<.001	0.82 (0.78–0.86)	<.001	0.85 (0.81–0.89)	<.001
40–49	1.27 (1.17–1.38)	<.001	0.92 (0.88–0.95)	<.001	0.91 (0.88–0.95)	<.001
≥50	Ref		Ref		Ref	
Race/ethnicity						
Black, non-Hispanic	1.35 (1.22–1.49)	<.001	0.89 (0.85–0.93)	<.001	0.89 (0.85–0.92)	<.001
White, non-Hispanic	Ref		Ref		Ref	
Hispanic or Latinx	1.40 (1.27–1.56)	<.001	0.97 (0.93–1.01)	.139	1.02 (0.97–1.08)	.361
Other	1.17 (1.00–1.38)	.056	0.95 (0.90–1.01)	.114	0.94 (0.89–1.01)	.060
Gender and sex partner type						
Any MSM	1.03 (0.92–1.15)	.621	0.88 (0.84–0.92)	<.001	1.02 (0.97–1.06)	.503
MSW only	Ref		Ref		Ref	
Any WSM	1.03 (0.92–1.15)	.588	0.96 (0.93–1.01)	.920	1.01 (0.96–1.06)	.647
Other	0.97 (0.78–1.20)	.787	0.88 (0.80–0.98)	.009	1.04 (0.96–1.13)	.349

Abbreviations: aPR, adjusted prevalence ratio; MSM, men who have sex with men; MSW, men who have sex with women; OSHI, Oregon Social Determinants of HIV Health Index; PR, prevalence ratio; WSM, women who have sex with men.

There are several limitations to this work. First, the SDOH and care outcomes were assessed cross-sectionally among a different sample of participants each year rather than longitudinally among the same participants over time. Second, the response rate among participants was suboptimal. However, the effect of nonresponse bias is mitigated by the complex survey design and poststratification weighting. Third, patient characteristics and SDOH measures were based on self-report and may be subject to misclassification, although we do not suspect any measurement error to be differential with respect to HIV care outcomes. Finally, the OSHI is derived from items from the core MMP interview questions, which may not effectively consider other risk factors associated with social inequities. Future iterations of OSHI could include facilitating factors and resilience measures that could potentially offset the impact of social and economic disadvantage on health [28].

Clinical and Public Health Implications

We demonstrated the utility of the OSHI, a simple index using 10 easily assessed items representing the 5 key domains of SDOH [12]. The strength of the associations between our composite SDOH measure and HIV care continuum outcomes indicates that the OSHI may be a useful tool for clinical assessment, planning and resource allocation, policy-making, and research and evaluation.

Our findings provide further evidence that the social and economic needs of PWH will affect care outcomes and reiterate the need to collect and consider data related to SDOH as part of comprehensive HIV care [8, 29]. HIV case managers frequently use acuity scales to assess the nonclinical needs of PWH, and based on this assessment, provide referrals to relevant services to support HIV clinical care [18]. However, even the most efficient of scales can be time-intensive. In addition, depending on the location of care or clinic resources, medical case management may not be part of all clinical encounters with PWH, including among newly diagnosed individuals. The OSHI, therefore, represents an opportunity for providers to conduct a brief assessment of SDOH that can inform appropriate active referrals to services and facilitate warm hand-offs to case managers, social workers, or community health workers. Similar SDOH assessment tools have been implemented in pediatric practices. Patients and families screened with evidence-based SDOH assessment tools and referred to services are more likely to be engaged with community resources on follow-up compared with those who are not [30, 31].

In practice, the 10-item OSHI may be operationalized and implemented through a face-to-face assessment, a self-completed questionnaire, or through an electronic system to collect patient-reported outcomes. Similar to assessment with a case management acuity scale, patients with a high OSHI could be prioritized for additional support services, referrals, and/or more frequent follow-up. Moreover, the brevity of the OSHI could make regular re-assessment of SDOH and routine clinical outcomes over time more feasible and may more quickly identify patients for whom support should be escalated or can be de-escalated. We also found that, with respect to durable viral suppression, an 8-item score performs similarly to our original 10-item score.

Important priorities for future evaluation include assessing how the OSHI predicts HIV care outcomes longitudinally and comparing the predictive power of the OSHI to the in-depth acuity scales that many Ryan White programs currently use. Further work is also required to evaluate the reliability and validity of the OSHI in other samples of PWH. Finally, the OSHI could be useful in future research studies at the individual and population levels, providing a composite measure of SDOH. In studies of small samples, such a composite measure can be used in statistical models without losing power.

Fewer than 70% of PWH in the United States have achieved durable viral suppression [4, 5]. As we pursue HIV elimination efforts at local, state, and national levels, we must focus on increasing viral suppression rates among those clients who have not equally benefitted from clinical advances in HIV care and prevention [32]. Indeed, removing barriers to HIV care and treatment may have the largest impact on HIV elimination efforts [33]. The integration of the OSHI into local, state, and federal HIV surveillance systems, like MMP, may provide a more robust, intersectional assessment of disparities in viral suppression. The identification of economic and social disadvantage at the population level can then be used to advocate for policy changes at the local, state, and federal levels. For example, the most common OSHI measure reported among US PWH was poverty. Thus, policies related to microfinance, a higher minimum wage, basic universal income, and other programs to lift people out of poverty may result in improved health outcomes [34].

In conclusion, data from a large surveillance study of US PWH provide empirical evidence that access to SDOH matters for the health of PWH and that cumulative exposure to social and economic disadvantage significantly impacts key care outcomes. The OSHI, a brief, easily constructed tool, has the potential to improve outcomes among PWH through the efficient assessment of SDOH in clinical, public health, and research contexts.

submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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