



Social Determinants of Health Among Persons Living with HIV Impact Important Health Outcomes in Michigan

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Abstract

Addressing social determinants of health (SDOH) is a national priority for improving quality of life and addressing obstacles to accessing care for people living with HIV (PLWH). Utilizing the Oregon Social Determinants of HIV Health Index and CDC's Medical Monitoring Project, we examined the association between social determinants of health and various HIV clinical outcomes and quality of life indicators, including stigma and mental health, for people living with HIV in Michigan. We calculated estimates of SDOHs, clinical outcomes, stigma, and mental health using weighted percentages and prevalence ratios with predicted marginal means, adjusting for age, race/ethnicity, and gender/sexual orientation. Compared with PLWH reporting 0–1 SDOH challenges, those reporting ≥ 4 SDOH challenges were more likely to miss ≥ 1 HIV care appointment (aPR: 2.57, 95% CI 1.70–3.88), have symptoms of depression (aPR: 4.03, 95% CI 2.68–6.05) and anxiety (aPR: 3.55, 95% CI 2.25–5.61), and less likely to have 100% antiretroviral therapy (ART) adherence (aPR: 0.62, 95% CI 0.50–0.78) and sustained viral suppression (aPR: 0.77, 95% CI 0.65–0.90). Stigma scores were highest for those reporting ≥ 4 SDOH challenges. Our findings indicate significant associations between SDOH and adverse HIV health and quality of life outcomes which can inform and direct federal, state, and local strategies aimed at improving these outcomes. Linking PLWH to social support services and providing mental health screening and care services could benefit their mental and emotional well-being, leading to better healthcare outcomes.

Keywords Social determinants of health · SDOH · Stigma · Mental health · HIV · Care outcomes · HIV care · Michigan · United States

Introduction

Social determinants of health (SDOH) are the social, environmental, and economic systems in which people live that have a direct impact on their health and well-being. SDOH are defined by the complex interaction of larger

societal and political factors that influence an individual's day-to-day living conditions, creating a positive or negative effect on health [1, 2]. For people living with HIV (PLWH), the negative effects of SDOH are exacerbated by HIV-related stigma and discrimination, often stemming from false information and prejudicial beliefs surrounding the diagnosis, symptoms, or behaviors related to the transmission of HIV [3, 5–7]. This stigma, defined as a characteristic or attribute that devalues a person's identity or position in society, may contribute to negative views on HIV prevention strategies and HIV treatment, leading to worsening health outcomes for PLWH [4–6]. Research on HIV-related stigma and health has found that utilization of healthcare and social support resources, treatment adherence, and mental health measures are negatively impacted by enacted, internalized, and anticipated stigma [4–7]. PLWH in the U.S. also have a relatively high prevalence of anxiety and depression, which, combined with HIV-related stigma, can impact healthcare utilization and

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health outcomes [8–10]. In 2020, 14% of PLWH reported symptoms of depression, 18% reported symptoms of anxiety, and many reported experiencing stigma according to a report published by CDC using data from a national surveillance project [7]. In addition, 42% of PLWH had at least one detectable viral load measurement in the past 12 months and 16% of people who reported missing at least one ART dose did so because they felt depressed or overwhelmed [7].

In Michigan, HIV prevalence and care outcomes for PLWH are greatly affected by SDOH tied to geography and race. Over 1% of Black men in Michigan are living with HIV, which is 7.5 times greater than the number of White men living with HIV in Michigan, placing an unequal burden of the epidemic on the Black community [11]. Due to a history of racial residential segregation that continues to persist across Michigan and the U.S., this racial disparity overlaps with geographical HIV disparities. For example, the city of Detroit, which is 77% Black, has an HIV prevalence that is four times greater than that of the adjacent Oakland County (75% White), seven times greater than the county surrounding the city (Wayne County, 55% White), and 31 times greater than the county with the lowest HIV prevalence (Huron, 97% White) [11]. While the city of Detroit also has a relatively high concentration of HIV healthcare resources compared to other regions of the state, access to these resources is limited by known SDOH, such as a lack of extensive and accessible public transportation; structural injustices, such as red-lining and gentrification; the highest percentage of poverty in any major U.S. city (38%); and other SDOH, such as unemployment, substance abuse, mental illness, stigma, and discrimination [12].

Collecting data on SDOH is the first step towards recognizing the socioeconomic, cultural, emotional, and political factors that affect the health and well-being of PLWH and is supported by both the National HIV/AIDS Strategy and the Ending the HIV Epidemic initiative (EHE) to reduce health disparities and improve health outcomes among PLWH [13, 14]. The Oregon Social Determinants of HIV Health Index (OSHI) is a tool that utilizes data collected from the Medical Monitoring Project (MMP), a national survey on the behavioral and clinical characteristics of PLWH in the US [3, 15]. The index employs the following five domains from the Healthy People 2030 framework to characterize the SDOH with selected questions from the MMP survey—(1) economic stability, (2) education access and quality, (3) healthcare access and quality, (4) neighborhood and built environment, and (5) social and community context [3, 16]. SDOH assessment tools such as the OSHI can help public health programs, clinicians, and researchers identify PLWH who may be at the greatest risk of adverse HIV care indicators and implement interventions that will help mitigate

those risks, contributing to better healthcare access and overall better health outcomes.

The results from the first published application of the OSHI index showed that 83% of PLWH surveyed across the US between 2015 and 2019 reported at least one SDOH challenge, and those who reported one, two, three, or four or more challenges were 1.6, 2.1, 2.6 and 3.6 times as likely to have disruptions to regular medical care in the past year, respectively; 11%, 17%, 20%, and 31% less likely to have excellent adherence to ART in the past 30 days; and 2%, 4%, 10%, and 20% less likely to have maintained viral suppression in the past year [3]. These results highlight not only what is already known about the detrimental effects of SDOH on individual health outcomes, but more importantly how, when accumulated across several different domains, SDOH can magnify the likelihood for poor HIV care indicators for PLWH.

In this paper, we employed the OSHI index and analyzed MMP data from PLWH in Michigan to investigate the relationship between social determinants of health and various HIV clinical outcomes and quality of life indicators, including stigma and mental health. The aim is to gain insights on the specific challenges faced by PLWH in Michigan that contribute to negative clinical and quality of life outcomes. By doing so, we aim to inform strategies that can effectively address these issues and improve the well-being of PLWH in Michigan.

Methods

The CDC's Medical Monitoring Project (MMP) is an annual cross-sectional survey designed to produce nationally and locally representative estimates of the behavioral and clinical characteristics of PLWH in the United States. MMP data collection is part of routine public health surveillance, and is thus, determined to be non-research. MMP uses a two-stage sampling method, in which during the first stage, 16 states, six major cities and one U.S. territory are sampled from all states in the U.S., the District of Columbia, and Puerto Rico. During the second stage, simple random samples of PLWH aged 18 years and older are drawn for each participating state/territory from the National HIV Surveillance System (NHSS), a census of PLWH in the U.S. [17].

We included Michigan data from the 2015–2019 MMP cycles, which were collected via telephone or face-to-face interviews and medical record abstractions. Interviews were conducted with the sampled population to collect a wide range of information including demographics, clinical outcomes, and behavioral data. Certain clinical data such as ART prescription and laboratory results were acquired via medical record abstraction. Data collection began in June of each cycle and continued until May the following year.

The response rates by cycle year for PLWH ranged from 44.7 to 47.1% in Michigan. Data were weighted based on known probabilities of selection at the state, territory, or person levels. In addition, data were weighted to adjust for person nonresponse and post-stratified to known population totals by age, race/ethnicity, and sex at birth from the NHSS.

The analysis featured in this study utilized the OSHI to establish variables related to SDOH, which include variables related to (1) economic stability (living in a household with income at or below the federal poverty level during the past 12 months, food insecurity during the past 12 months), (2) access to education and quality (having less than a high school diploma, low confidence in completing health forms), (3) healthcare access and quality (having ≥ 1 emergency room [ER] visit during the past 12 months, having a gap in health insurance during the past 12 months), (4) neighborhood and built environment (need for transportation assistance during the past 12 months, homelessness during the past 12 months), and (5) social and community context (lifetime history of sexual or physical violence, incarceration during the past 12 months)¹. The 10-item OSHI quantifies SDOH disadvantage on a scale from 0 to 10, with higher scores indicating more disadvantages. Based on this health index, we created a 4-level SDOH variable to compare indicators across the population (1) 0–1 indicators, (2) 2 indicators, (3) 3 indicators, and (4) 4 or more indicators.

Three dichotomous HIV-related health outcomes were examined along with dichotomous outcomes for depression and anxiety based on the Patient Health Questionnaire-9 (PHQ-9) and General Anxiety Disorder-7 (GAD-7) scales, respectively [18, 19]. Symptoms of major or other depression were indicated by ≥ 2 symptoms of depression during the previous 2 weeks. Moderate or severe generalized anxiety disorder (GAD) was indicated by a score of ≥ 10 on the GAD-7. Scores for HIV-related stigma were calculated on a 100 point scale based on 10 components encompassing 4 domains: (1) personalized stigma, (2) current disclosure concerns, (3) current negative self-image, and (4) current perceived public attitudes about PLWH. Median scores and 95% confidence intervals (CIs) were used to describe the stigma. Other HIV-related health outcomes included missed appointments (if participants had missed ≥ 1 HIV-related medical appointment in the past 12 months), excellent ART adherence (whether participants had taken all ART doses in the past 30 days) and sustained viral suppression (defined as undetectable viral loads or < 200 copies/mL over the past 12 months). All measures were based on the 12 months prior to the interview unless otherwise stated.

Estimates of SDOH and clinical outcomes are presented for Michigan and nationally. For categorical variables,

weighted percentages with accompanying 95% confidence intervals (CIs) were presented. For HIV stigma, median scores with 95% CIs are presented. Health outcomes are presented using adjusted prevalence ratios (aPR) with 95% CIs. Associations between the number of SDOH components and outcomes of interest were adjusted, a priori, for age, race/ethnicity, and a combined variable describing gender and sexual behaviors during the past 12 months based on existing literature [20–23]. For HIV stigma, nonoverlapping CIs determined meaningful differences between groups.

All estimates were adjusted for person nonresponse and post-stratified to known population totals by age, race/ethnicity, and sex at birth from the NHSS. All analyses were conducted using SAS survey procedures and SAS-callable SUDAAN.

Results

Demographics and Social Determinants of Health

Almost half of all PLWH surveyed in Michigan were aged > 50 years (44.7%). A majority identified as Black, non-Hispanic (53.9%) and were men who have sex with men (MSM) (55.2%). Those who had less than a high school education accounted for 16.6% of PLWH and 24.3% had low confidence in completing the health forms. A total of 45.6% were in a household living at or below the federal poverty level, and 23.4% experienced food insecurity. In the past year, 19.9% had a gap in insurance, 51.5% had ≥ 1 ER visit, and 12.0% had experienced homelessness. Additionally, 34.4% needed transportation assistance, 6.1% had been incarcerated in the past year, and 36.4% had a lifetime history of sexual or physical intimate partner violence (Table 1).

The racial/ethnic distribution of PLWH in Michigan differs from that in the national reports. Specifically, the percentage of people who identified as non-Hispanic Black was higher (53.9% versus 41.2%) and the percentage of people who identified as Hispanic/Latino was lower (3.9% versus 22.4%) in Michigan versus nationally. More PLWH in Michigan had experienced a gap in insurance in the past year (19.9% Michigan versus 11.4% nationally), and more had an ER visit in the past year (51.5% Michigan versus 39.4% nationally) (Table 1).

HIV-Related Health Outcomes

After adjustment, the prevalence of missed HIV health-care appointments for Michigan-based PLWH who had 4+ SDOH indicators was 2.57 times as high as those with 0–1 indicators (95% CI 1.70–3.88). The prevalence of missed appointments among PLWH aged 18–29 years was

¹ OSHI scoring system's categories.

Table 1 Distribution of demographic characteristics and social determinants of health among PLWH in Michigan and the entire U.S.

	Michigan		National	
	Sample size, N	Weighted Column percent (95% CI)	Sample size, N	Weighted Column Percent (95% CI)
Overall	880		20,064	
Age				
18–29 years	111	12.3 (9.9–14.8)	1670	8.8 (8.2–9.4)
30–39 years	159	19.0 (16.0–22.0)	3199	16.8 (16.2–17.5)
40–49 years	205	24.0 (20.8–27.2)	4578	23.4 (22.6–24.2)
≥ 50 years	405	44.7 (41.0–48.3)	10,617	51.0 (50.0–52.1)
Race/ethnicity				
Black, non-Hispanic	471	53.9 (50.2–57.6)	8442	41.2 (37.0–45.4)
Hispanic	34	3.9 (2.5–5.3)	4410	22.4 (18.9–25.8)
White, non-Hispanic	297	33.4 (30.0–36.9)	5857	29.4 (26.8–32.1)
Other/multiracial	78	8.7 (6.7–10.8)	1,355	7.0 (6.2–7.8)
Gender and sex partner				
Any men who have sex with men (MSM)	481	55.2 (51.5–58.9)	9828	49.9 (48.2–51.6)
Men who have sex with women (MSW) only	170	19.6 (16.7–22.6)	4438	23.0 (22.0–24.0)
Any women who have sex with men (WSM)	190	21.0 (17.9–24.1)	4996	23.0 (21.8–24.1)
Other	39	4.2 (2.8–5.6)	798	4.1 (3.8–4.5)
Educational attainment				
High school education or higher	737	83.4 (80.5–86.3)	16,449	82.7 (81.8–83.5)
Less than high school education	143	16.6 (13.7–19.5)	3539	17.3 (16.5–18.2)
Health literacy*				
High confidence completing health forms	670	75.7 (72.5–78.9)	15,082	75.5 (74.7–76.3)
Low confidence completing health forms	209	24.3 (21.1–27.5)	4857	24.5 (23.7–25.3)
Household living at or below poverty level				
Yes	380	45.6 (41.8–49.4)	8146	42.9 (41.2–44.7)
No	467	54.4 (50.6–58.2)	10,398	57.1 (55.3–58.8)
Food insecurity				
Yes	202	23.4 (20.2–26.6)	4085	20.6 (19.8–21.4)
No	677	76.6 (73.4–79.8)	15,902	79.4 (78.6–80.2)
Gap in insurance**				
Yes	163	19.9 (16.8–22.9)	2082	11.4 (10.5–12.4)
No	709	80.1 (77.1–83.2)	17,687	88.6 (87.6–89.5)
ER visit				
Yes	445	51.5 (47.8–55.2)	7907	39.4 (38.2–40.6)
No	434	48.5 (44.8–52.2)	12,021	60.6 (59.4–61.8)
Homelessness				
Yes	101	12.0 (9.5–14.6)	1,832	9.0 (8.4–9.5)
No	779	88.0 (85.4–90.5)	18,169	91.0 (90.5–91.6)
Needed transportation assistance				
Yes	297	34.4 (30.8–38.0)	6,618	31.8 (30.9–32.7)
No	582	65.6 (62.0–69.2)	13,283	68.2 (67.3–69.1)
Incarceration				
Yes	54	6.1 (4.3–7.9)	928	4.9 (4.4–5.3)
No	826	93.9 (92.1–95.7)	19,060	95.1 (94.7–95.6)
Lifetime history of sexual/physical violence				
Yes	322	36.4 (32.8–39.9)	6522	32.7 (31.5–34.0)
No	549	63.6 (60.1–67.2)	13,227	67.3 (66.0–68.5)
Number of SDOH reported				

Table 1 (continued)

	Michigan		National	
	Sample size, N	Weighted Column percent (95% CI)	Sample size, N	Weighted Column Percent (95% CI)
0–1 indicators	282	33.6 (30.1–37.2)	7013	39.4 (38.1–40.8)
2 indicators	155	17.5 (14.8–20.3)	3602	20.0 (19.3–20.8)
3 indicators	134	17.0 (14.0–19.9)	2864	15.8 (15.1–16.5)
≥4 indicators	259	31.9 (28.3–35.5)	4598	24.7 (23.8–25.6)
Outcomes				
Any missed appointments				
Missed appointment	207	23.4 (20.3–26.6)	4745	24.1 (23.3–24.9)
No missed appointments	661	76.6 (73.4–79.7)	15,091	75.9 (75.1–76.7)
Excellent adherence (past 30 days)				
Adherent	431	51.8 (48.0–55.5)	11,325	59.9 (58.9–60.9)
Non-adherent	391	48.2 (44.5–52.0)	7595	40.1 (39.1–41.1)
Sustained viral suppression [†]				
Yes	603	63.0 (59.3–66.8)	13,498	62.8 (61.4–64.3)
No	277	37.0 (33.2–40.7)	6566	37.2 (35.7–38.6)
Symptoms of generalized anxiety disorder (GAD) [‡]				
Yes	190	22.1 (19.0–25.2)	3291	17.1 (16.2–18.0)
No	688	77.9 (74.8–81.0)	16,540	82.9 (82.0–83.8)
Symptoms of major or other depression [§]				
Yes	221	25.7 (22.4–29.0)	3806	19.7 (18.8–20.5)
No	653	74.3 (71.0–77.6)	15,961	80.3 (79.5–81.2)

Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant

*Health literacy is defined as how confident one is filling in medical forms, dichotomized as “low” (“somewhat”, “a little bit”, “not at all”) and “high” (“extremely”, “quite a bit”)

**Gap in insurance is defined as not having health insurance at any point in time within the past 12 months

[†]Sustained viral suppression is defined as all viral loads undetectable [<200 copies/mL] over the past 12 months

[‡]Symptoms were consistent with a GAD-7 score cutoff of 10 or higher for “yes” based on the previous two weeks prior to interview

[§]Symptoms were consistent with answering “more than half the days” or “nearly every day” to 2+ depression questions for “yes” based on the previous two weeks prior to interview

1.64 times as high as those aged 50+ (95% CI 1.06–2.55) and the prevalence among Black, non-Hispanic participants was 1.72 times as high as that among White, non-Hispanic participants (95% CI 1.17–2.52). PLWH who experienced any of the selected SDOH indicators had a higher prevalence of missed appointments compared with those who did not experience that respective SDOH indicator (Table 2).

The prevalence of excellent ART adherence among PLWH with 4+ SDOH indicators was 38% lower than that among those with 0–1 indicators (95% CI 0.50–0.78). Compared to PLWH aged 50+ years, PLWH aged 18–29 years were 40% less likely to have excellent ART adherence (adjusted prevalence ratio [aPR] 0.60, 95% CI 0.43–0.84) and PLWH aged 30–39 years (aPR 0.73, 95% CI 0.57–0.92) were 27% less likely to be ART dose adherent. A greater percentage of White PLWH had excellent adherence (63.9%, reference group) than persons identifying as Black, non-Hispanic (aPR 0.83, 95% CI 0.71–0.98) or multiracial/

other (aPR 0.66, 95% CI 0.47–0.92). The other gender/sex partner group had significantly different prevalence of ART adherence than the men who had sex with women (MSW) reference group. Education and health literacy were the only individual components that were not associated with ART adherence (Table 3).

Compared to having 0–1 SDOH indicators, having 4 or more SDOH indicators was significantly associated with a lower prevalence of sustained viral suppression (aPR 0.77, 95% CI 0.65–0.90). The prevalence of sustained viral suppression among PLWH aged 18–29 years was 0.76 times the prevalence of sustained viral suppression in those aged 50+ years (95% CI 0.61–0.95). The prevalence of sustained viral suppression among Black, non-Hispanic PLWH was 16% lower than that among White, non-Hispanic PLWH (95% CI 0.74–0.96). No specific gender/sex partner group showed significant differences in the prevalence of viral suppression. The following SDOH indicators were all

Table 2 Associations between SDOH indicators and having ≥ 1 missed HIV care appointment during the past 12 months among PLWH in Michigan—Medical Monitoring Project, 2015–2019

Missed healthcare appointments	Yes		Unadjusted PR (95% CI)	Adjusted [†] PR (95% CI)
	n	weighted % (95% CI)		
OSHI score and adjusted factors				
Number of SDOH reported				
0–1 indicators	32	11.6 (7.4–15.9)	Ref	Ref
2 indicators	18	13.8 (6.9–20.8)	1.19 (0.64–2.20)	1.02 (0.58–1.81)
3 indicators	37	27.7 (19.2–36.1)	2.38 (1.48–3.82)	1.96 (1.23–3.13)
≥ 4 indicators	108	39.4 (32.8–46.1)	3.39 (2.27–5.05)	2.57 (1.70–3.88)
Adjustment factors				
Age				
18–29 years	40	35.7 (25.6–45.8)	2.19 (1.51–3.20)	1.64 (1.06–2.55)
30–39 years	47	27.3 (20.0–34.6)	1.68 (1.16–2.42)	1.43 (0.99–2.06)
40–49 years	56	27.8 (20.8–34.8)	1.71 (1.20–2.43)	1.63 (1.16–2.29)
≥ 50 years	64	16.3 (12.2–20.3)	Ref	Ref
Race/ethnicity				
Black, non-Hispanic	145	30.0 (25.4–34.7)	2.53 (1.72–3.72)	1.72 (1.17–2.52)
Hispanic*	-	-	-	-
White, non-Hispanic	33	11.9 (7.7–16.1)	Ref	Ref
Other/multiracial	21	29.8 (18.2–41.5)	2.51 (1.49–4.25)	1.69 (1.01–2.83)
Gender and sex partner				
Any men who have sex with men (MSM)	92	19.0 (15.2–22.7)	0.70 (0.49–1.01)	0.79 (0.54–1.14)
Men who have sex with women (MSW) only	40	27.0 (18.8–35.2)	Ref	Ref
Any women who have sex with men (WSM)	60	29.8 (22.5–37.1)	1.10 (0.75–1.63)	0.99 (0.67–1.47)
Other	15	34.4 (19.0–49.8)*	1.27 (0.74–2.19)	1.12 (0.62–2.01)
Individual SDOH components				
Educational attainment				
High school education or higher	149	20.4 (17.2–23.6)	Ref	
Less than high school education	58	38.9 (29.6–48.2)	1.91 (1.43–2.54)	
Health literacy				
High confidence completing health forms	142	21.5 (18.0–24.9)	Ref	
Low confidence completing health forms	65	29.9 (23.1–36.7)	1.39 (1.05–1.84)	
Household living at or below poverty level				
Yes	125	32.5 (27.1–37.8)	2.05 (1.54–2.71)	
No	74	15.9 (12.2–19.5)	Ref	
Food insecurity				
Yes	82	39.7 (32.2–47.2)	2.12 (1.64–2.75)	
No	125	18.7 (15.4–22.0)	Ref	
Gap in insurance				
Yes	58	32.3 (24.7–39.9)	1.50 (1.13–2.00)	
No	148	21.5 (18.0–24.9)	Ref	
ER visit in past year				
Yes	134	29.9 (25.1–34.7)	1.78 (1.34–2.35)	
No	73	16.8 (12.9–20.7)	Ref	
Homelessness				
Yes	46	42.4 (31.6–53.2)	2.03 (1.51–2.74)	
No	161	20.9 (17.6–24.1)	Ref	
Needed transportation assistance				
Yes	101	32.9 (26.9–38.8)	1.78 (1.37–2.32)	

Table 2 (continued)

	Yes		Unadjusted PR (95% CI)	Adjusted [†] PR (95% CI)
	n	weighted % (95% CI)		
Missed healthcare appointments				
No	105	18.4 (14.9–22.0)	Ref	
Incarceration				
Yes	23	39.4 (24.9–54.0)	1.76 (1.18–2.61)	
No	184	22.4 (19.2–25.6)	Ref	
Lifetime history of sexual/physical violence				
Yes	102	29.3 (24.1–34.6)	1.49 (1.14–1.95)	
No	101	19.7 (15.8–23.6)	Ref	

Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant

[†]Models adjusted a priori for age, race/ethnicity, gender/sex partner

Estimates with an absolute CI width between 5 and 30 and a relative CI width > 130% and estimates of 0% or 100% are marked with an asterisk () and should be interpreted with caution. Excluded are estimates with a coefficient of variation ≥ 0.30

significantly associated with lower prevalence of sustained viral suppression (Table 4): being in a household living at or below the federal poverty level (aPR: 0.77, 95% CI 0.68–0.88), having food insecurity (aPR: 0.73, 95% CI 0.61–0.86), a health insurance gap (aPR: 0.78, 95% CI 0.65–0.93), ≥ 1 ER visit in the past 12 months (aPR: 0.69, 95% CI 0.61–0.78), any report of homelessness (aPR: 0.73, 95% CI 0.57–0.93), need for transportation assistance (aPR: 0.72, 95% CI 0.63–0.84), and a recent history of incarceration (aPR: 0.45, 95% CI 0.29–0.70).

Stigma and Mental Health

Stigma scores for PLWH who reported 4 or more SDOH indicators were higher than those who reported fewer than 4 (Fig. 1). PLWH who experienced the following 7 SDOH indicators had significantly higher stigma scores compared to those who did not experience those respective SDOH indicators: (1) having less than a high school diploma (median score yes high school diploma: 40.9, 95% CI 38.7–43.1, versus no high school diploma: 52.0, 95% CI 44.9–59.0), (2) low confidence filling out health forms (median score high confidence: 40.3, 95% CI 37.9–42.7, versus low confidence: 50.6, 95% CI 41.9–51.5), (3) experiencing food insecurity (median score yes: 56.4, 95% CI 41.9–51.5, versus no: 39.0, 95% CI 37.5–42.5), (4) ≥ 1 ER visit during the past 12 months (median score yes: 45.7, 95% CI 42.5–48.9, versus no: 38.0, 95% CI 42.5–48.9), (5) experiencing homelessness (median score yes: 54.0, 95% CI 45.7–62.4, versus no: 40.9, 95% CI 38.8–43.0), (6) recent history of being incarcerated (median score yes: 56.1, 95% CI 46.5–65.6, versus no: 41.5, 95% CI 39.3–43.6), and (7) lifetime history of sexual/physical violence (median score yes: 49.2, 95% CI 44.4–54.0, versus

no: 39.1, 95% CI 36.4–41.7). Those aged 18–29 years had higher stigma scores than those aged 50+ (48.2, 95% CI 41.6–54.8, versus 37.9, 95% CI 34.4–41.3) and women who have sex with men (WSM) had higher stigma scores than MSM and MSW (52.4, 95% CI 44.5–60.3, versus 40.9, 95% CI 38.4–43.5, and 38.4, 95% CI 33.4–43.3) (Fig. 2). HIV stigma did not differ by race or ethnicity.

Those with 3 reported SDOH indicators had a prevalence of symptoms of moderate or severe GAD during the previous 2 weeks that was 1.91 times that of those with 0–1 reported SDOH (95% CI 1.09–3.35) and prevalence was 3.55 times as high among those with ≥ 4 SDOH indicators compared to those with 0–1 (95% CI 2.25–5.61) (Table 5). Hispanic PLWH had a lower prevalence of anxiety symptoms than White PLWH (PR 0.33, 95% CI 0.11–0.96). All individual SDOH components were significantly associated with symptoms of moderate or severe GAD symptoms, with PLWH experiencing food insecurity having the highest prevalence at 2.61 times that of those not experiencing food insecurity (95% CI 1.99–3.40) (Table 5).

The prevalence of experiencing symptoms of major or other depression was 2.08 times as high for those with 3 indicators (95% CI 1.25–3.44), than for those with 0–1 indicators. The prevalence of experiencing symptoms of major or other depression was 4.03 times as high among those with 4+ indicators (95% CI 2.68–6.05), than among those with 0–1 indicators. The prevalence of depressive symptoms did not differ according to age, race/ethnicity, or gender/sexual orientation. Each of the 10 SDOH components, except for the gap in insurance, was associated with a higher prevalence of symptoms of depression. PLWH experiencing food insecurity had the highest prevalence at 2.48 times that of those not experiencing food insecurity (95% CI 1.95–3.16) (Table 6).

Table 3 Associations between SDOH indicators and having perfect ART dose adherence during the past 30 days among PLWH in Michigan—Medical Monitoring Project, 2015–2019

Excellent ART adherence (past 30 days)‡	Excellent ART adherence		Unadjusted PR (95% CI)	Adjusted† PR (95% CI)
	n	weighted % (95% CI)		
OSHI score and adjusted factors				
Number of SDOH reported				
0–1 indicators	180	64.0 (57.7–70.2)	Ref	Ref
2 indicators	86	52.8 (44.1–61.5)	0.83 (0.68–1.00)	0.86 (0.71–1.04)
3 indicators	64	55.8 (46.0–65.6)	0.87 (0.71–1.07)	0.92 (0.76–1.13)
≥4 indicators	78	34.0 (27.2–40.7)	0.53 (0.43–0.66)	0.62 (0.50–0.78)
Age				
18–29 years	27	27.3 (18.0–36.7)	0.44 (0.31–0.63)	0.60 (0.43–0.84)
30–39 years	58	42.5 (33.6–51.4)	0.69 (0.55–0.87)	0.73 (0.57–0.92)
40–49 years	102	51.3 (43.6–59.1)	0.83 (0.70–0.99)	0.86 (0.72–1.03)
≥50 years	244	61.6 (56.2–66.9)	Ref	Ref
Race/ethnicity				
Black, non-Hispanic	194	45.8 (40.6–51.0)	0.72 (0.62–0.83)	0.83 (0.71–0.98)
Hispanic	20	55.5 (36.3–74.6)*	0.87 (0.61–1.24)	0.93 (0.65–1.33)
White, non-Hispanic	193	63.9 (57.8–70.0)	Ref	Ref
Other/multiracial	24	35.0 (23.0–47.1)	0.55 (0.38–0.78)	0.66 (0.47–0.92)
Gender and sex partner				
Any men who have sex with men (MSM)	253	54.7 (49.8–59.6)	1.07 (0.88–1.30)	1.03 (0.85–1.26)
Men who have sex with women (MSW) only	88	51.1 (42.4–59.9)	Ref	Ref
Any women who have sex with men (WSM)	78	48.7 (40.1–57.4)	0.95 (0.75–1.22)	1.02 (0.81–1.29)
Other	12	29.2 (14.3–44.1)	0.57 (0.33–0.98)	0.84 (0.53–1.33)
Individual SDOH components				
Educational attainment				
High school education or higher	373	52.6 (48.5–56.6)	Ref	
Less than high school education	58	47.2 (37.2–57.2)	0.90 (0.72–1.12)	
Health literacy				
High confidence completing health forms	339	53.4 (49.1–57.7)	Ref	
Low confidence completing health forms	91	46.4 (38.6–54.1)	0.87 (0.72–1.05)	
Household living at or below poverty level				
Yes	156	45.6 (39.8–51.5)	0.81 (0.69–0.95)	
No	258	56.3 (51.3–61.4)	Ref	
Food insecurity				
Yes	58	32.0 (24.9–39.1)	0.56 (0.44–0.71)	
No	373	56.9 (52.6–61.1)	Ref	
Gap in insurance				
Yes	51	36.8 (27.9–45.7)	0.67 (0.52–0.86)	
No	378	55.2 (51.1–59.3)	Ref	
ER visit in past year				
Yes	175	42.6 (37.3–47.9)	0.70 (0.61–0.82)	
No	255	60.5 (55.3–65.7)	Ref	
Homelessness				
Yes	23	23.5 (14.5–32.4)	0.42 (0.29–0.63)	
No	408	55.3 (51.3–59.3)	Ref	
Needed transportation assistance				
Yes	118	44.2 (37.7–50.7)	0.80 (0.67–0.94)	
No	313	55.4 (50.9–60.0)	Ref	

Table 3 (continued)

Excellent ART adherence (past 30 days)‡

	Excellent ART adherence		Unadjusted PR (95% CI)	Adjusted† PR (95% CI)
	n	weighted % (95% CI)		
Incarceration				
Yes	16	35.7 (20.5–50.9)*	0.68 (0.44–1.04)	
No	415	52.7 (48.8–56.6)	Ref	
Lifetime history of sexual/physical violence				
Yes	129	43.3 (37.2–49.4)	0.76 (0.65–0.90)	
No	300	56.7 (52.0–61.5)	Ref	

Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant

†Models adjusted a priori for age, race/ethnicity, gender/sex partner

‡ Excellent ART adherence is defined as having taken all prescribed ART doses within the past 30 days

Estimates with an absolute CI width between 5 and 30 and a relative CI width > 130% and estimates of 0% or 100% are marked with an asterisk () and should be interpreted with caution

Discussion

The distribution of demographic characteristics and SDOH differs among PLWH in Michigan compared to the entire United States. PLWH in Michigan were more likely to report being Black, experience gaps in insurance, have ≥ 1 ER visit, and report ≥ 4 SDOH indicators. Adjusting for age, race/ethnicity, and gender/sexual orientation, we also observed that participants with the highest number of SDOH indicators tended to have point estimates suggestive of the worst HIV clinical outcomes (≥ 1 missed appointments in the past 12 months, ART dose adherence in the past 30 days, and viral suppression), though confidence intervals overlapped. This relationship was also present between the number of SDOH and mental health outcomes (symptoms of depression according to PHQ-9 and anxiety according to GAD-7) during the past 2 weeks. Mental health outcomes for both depression and anxiety symptoms were significantly associated with each individual SDOH indicator apart from anxiety symptoms for experiencing a gap in health insurance. Additionally, increased median stigma scores were significantly altered for each of the following SDOH indicators: (1) having less than a high school diploma, (2) low confidence filling out health forms, (3) experiencing food insecurity, (4) ≥ 1 ER visit during the past 12 months, (5) experiencing homelessness, (6) recent history of being incarcerated, and (7) lifetime history of sexual/physical violence.

These analyses also indicate several health inequities and areas of deficit within the safety net designed for PLWH. Nearly 1 in 5 PLWH in Michigan have had a gap in insurance within the previous 12 months, almost half had experienced poverty, nearly 1 in 8 had experienced homelessness, and close to 1 in 4 had experienced food insecurity. More than 1 in 3 PLWH in Michigan had experienced sexual or

physical violence, and PLWH in Michigan have higher levels of depression and GAD symptoms than PLWH nationally.

The National HIV/AIDS Strategy (NHAS) and the Ending the HIV Epidemic initiative (EHE) are programs which prioritize addressing health inequities and decreasing the spread of new HIV infection in populations at increased risk. The findings outlined here provide context for specific areas of improvement for meeting NHAS and EHE goals, including reducing gaps in medical coverage for PLWH, increasing access to food and shelter, and improving access to mental health services. Expanding the scope of programs targeting areas of need is necessary for meeting these goals.

The SDOH components outlined in the OSHI both alone and in combination with one another have significant impacts not only on HIV-related health outcomes, but on experiences of stigma and mental health. Social determinants of health have been posited to strongly influence how people seek and interact with care systems throughout their lives [24]. PLWH in Michigan are more likely to experience multiple SDOH challenges than a national sample. Key findings of high underinsured rate (nearly 1 in 5 PLWH had gaps in coverage) and high emergency room visits (over half of PLWH had at least one in past year) in Michigan point to ways in which SDOH impact health care utilization. Both the ability to pay for care and availability of preventative health visits impact the management of HIV as a chronic infection: being at or below the federal poverty level and having a gap in health insurance were significantly associated with missing HIV healthcare appointments, not having excellent ART dose adherence, and not having sustained viral suppression. The impact of economic disadvantage and stress on PLWH can result in worse adherence to treatment [25, 26]. National HIV/AIDS Strategy prioritizes addressing SDOH to improve

Table 4 Associations between SDOH indicators and having sustained viral suppression during the past 12 months among PLWH in Michigan—Medical Monitoring Project, 2015–2019

Sustained viral suppression†	Yes		Unadjusted PR (95% CI)	Adjusted‡ PR (95% CI)
	n	Weighted % (95% CI)		
OSHI score and adjusted factors				
Number of SDOH reported				
0–1 indicators	224	75.5 (69.4–81.5)	Ref	Ref
2 indicators	118	74.1 (66.1–82.0)	0.98 (0.86–1.12)	1.03 (0.90–1.18)
3 indicators	85	55.8 (45.9–65.7)	0.74 (0.61–0.90)	0.81 (0.67–0.97)
≥4 indicators	148	51.3 (44.2–58.3)	0.68 (0.58–0.80)	0.77 (0.65–0.90)
Age				
18–29 years	63	48.7 (38.2–59.2)	0.71 (0.56–0.89)	0.76 (0.61–0.95)
30–39 years	101	58.5 (49.7–67.4)	0.85 (0.72–1.01)	0.91 (0.78–1.07)
40–49 years	144	63.4 (55.5–71.4)	0.92 (0.80–1.07)	0.93 (0.81–1.08)
≥50 years	295	68.7 (63.3–74.1)	Ref	Ref
Race/ethnicity				
Black, non-Hispanic	294	54.9 (49.6–60.2)	0.72 (0.64–0.81)	0.84 (0.74–0.96)
Hispanic*	–	–	–	–
White, Non-Hispanic	236	76.4 (70.7–82.1)	Ref	Ref
Other/multiracial	45	55.8 (43.7–68.0)	0.73 (0.58–0.92)	0.89 (0.73–1.09)
Gender and sex partner				
Any men who have sex with men (MSM)	350	69.1 (64.3–73.9)	1.16 (0.98–1.37)	1.11 (0.94–1.32)
Men who have sex with women (MSW) only	114	59.6 (50.7–68.4)	Ref	Ref
Any women who have sex with men (WSM)	112	50.0 (41.5–58.4)	0.84 (0.67–1.05)	0.90 (0.73–1.10)
Other	27	64.7 (47.2–82.1)*	1.09 (0.80–1.48)	1.25 (1.00–1.57)
Individual SDOH components				
Educational attainment				
High school education or higher	517	64.9 (60.9–69.0)	Ref	
Less than high school education	86	53.5 (43.7–63.3)	0.82 (0.68–1.00)	
Health literacy				
High confidence completing health forms	473	65.2 (60.8–69.5)	Ref	
Low confidence completing health forms	129	56.3 (48.5–64.1)	0.86 (0.74–1.01)	
Household living at or below poverty level				
Yes	233	54.4 (48.6–60.3)	0.77 (0.68–0.88)	
No	349	70.7 (65.8–75.6)	Ref	
Food insecurity				
Yes	112	48.9 (41.1–56.7)	0.73 (0.61–0.86)	
No	490	67.3 (63.1–71.6)	Ref	
Gap in insurance				
Yes	88	51.8 (43.1–60.5)	0.78 (0.65–0.93)	
No	513	66.8 (62.6–71.0)	Ref	
ER visit in past year				
Yes	262	51.7 (46.3–57.0)	0.69 (0.61–0.78)	
No	340	75.0 (70.2–79.9)	Ref	
Homelessness				
Yes	54	47.6 (36.5–58.6)	0.73 (0.57–0.93)	
No	549	65.2 (61.2–69.2)	Ref	
Needed transportation assistance				
Yes	172	50.5 (44.0–57.0)	0.72 (0.63–0.84)	
No	431	69.7 (65.2–74.2)	Ref	

Table 4 (continued)

	Yes		Unadjusted PR (95% CI)	Adjusted‡ PR (95% CI)
	n	Weighted % (95% CI)		
Incarceration				
Yes	18	29.5 (16.8–42.2)	0.45 (0.29–0.70)	
No	585	65.2 (61.3–69.1)	Ref	
Lifetime history of sexual/physical violence				
Yes	225	65.0 (58.7–71.3)	1.05 (0.92–1.18)	
No	374	62.1 (57.4–66.9)	Ref	

Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant

†Sustained viral suppression defined as all viral loads undetectable [<200 copies/mL] over the past 12 months

‡Models adjusted a priori for age, race/ethnicity, gender/sex partner

Estimates with an absolute CI width between 5 and 30 and a relative CI width $>130\%$ and estimates of 0% or 100% are marked with an asterisk () and should be interpreted with caution. Excluded are estimates with a coefficient of variation ≥ 0.30

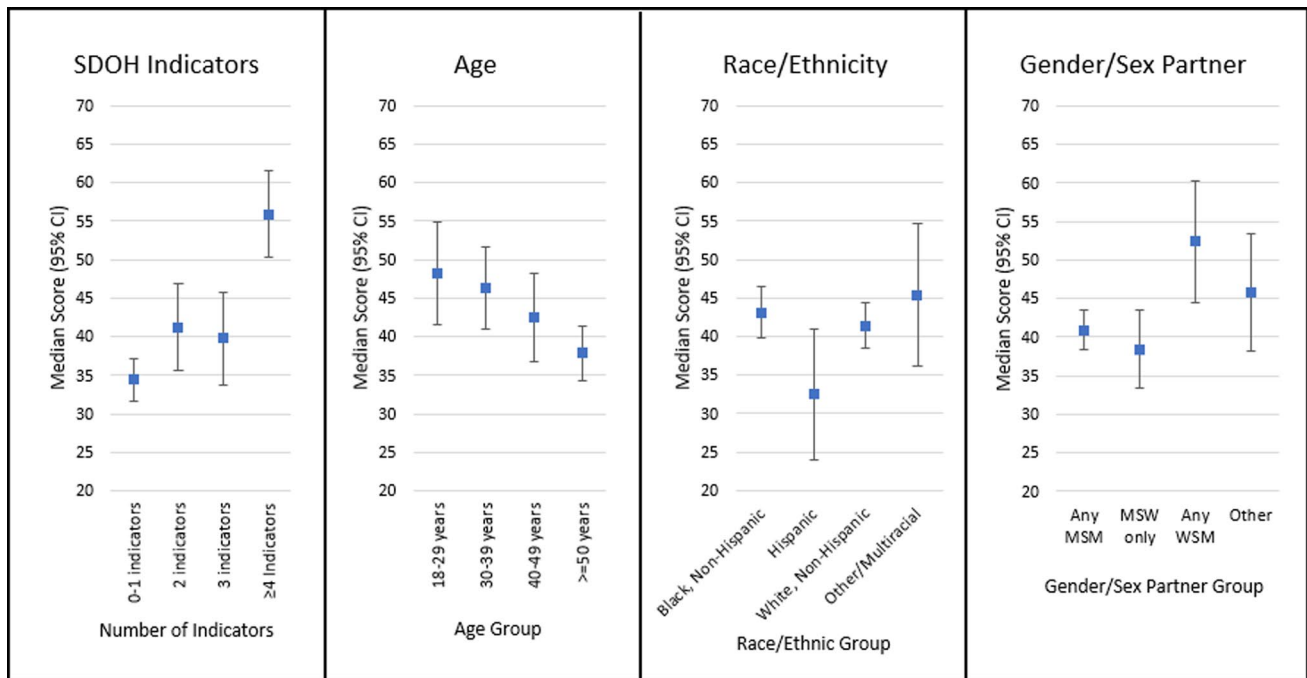


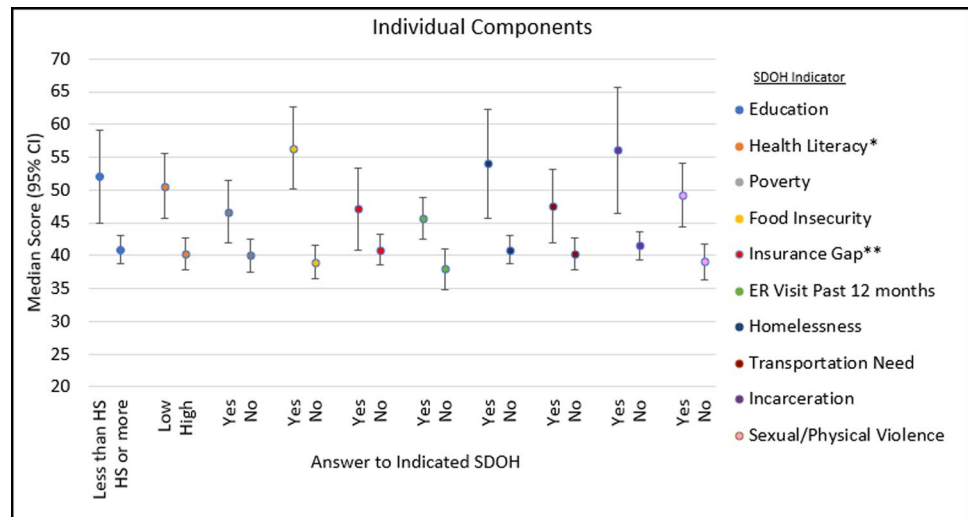
Fig. 1 Median stigma score with 95% confidence intervals by demographic characteristics and SDOH—Medical Monitoring Project, 2015–2019. *Health literacy is defined as how confident one is filling in medical forms, dichotomized as “low” (“somewhat”, “a little bit”,

“not at all”) and “high” (“extremely”, “quite a bit”). **Gap in insurance is defined as not having health insurance at any point in time within the past 12 months

HIV outcomes, but also quality of life of PLWH. Understanding what those factors look like and how they relate to outcomes in Michigan will be crucial to tailoring interventions to meet the needs of PLWH, addressing gaps in services, improving viral suppression and quality of life of PLWH in Michigan, and developing new strategies in increasing the effectiveness of HIV programs [27].

All individual SDOH components were significantly associated with missed healthcare appointments, all but two were significantly associated with excellent ART adherence, and all but three were significantly associated with sustained viral suppression. In addition, younger PLWH (18–29) were more likely to experience adverse HIV-related health outcomes in relation to missing

Fig. 2 Individual Components Stigma Score. Median stigma score with 95% confidence intervals for individual SDOH components. Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant



healthcare appointments, less likely to have excellent ART adherence, and less likely to be virally suppressed than those aged 50+ years. Similar disparate trends were observed among Black PLWH compared with their White counterparts.

Overall, stigma, anxiety, and depression scores were not significantly associated with race/ethnicity, age, or gender/sex partner relationships for PLWH in Michigan. Other studies have found that minorities tend to experience more instances of stigma and can be more prone to adverse mental health outcomes owing to factors such as the built environment and discrimination [28–30]. The results of this analysis may reflect other factors not included in the analysis, such as subgroup support systems and increased outreach efforts for minority populations.

This analysis had several limitations. Response rates were suboptimal, but results were adjusted for nonresponse and post-stratified to known population totals by age, race/ethnicity, and sex at birth from NHSS. Due to its cross-sectional

design, this analysis cannot establish causality or assess differences in patterns over time. Most characteristics included in this analysis were based on self-report and may have been subject to bias based on recall and social desirability, which may lead to overestimation and underestimation of estimates but is unlikely to change direction of associations. Additionally, differences between Michigan's estimates and national estimates were not assessed statistically and should not be interpreted as such.

The results of this analysis point to a need for interventions that address factors beyond HIV testing and clinical care, especially regarding linkage to health insurance, non-HIV related preventative health care, and mental health care. PLWH experiencing multiple SDOH factors may benefit from increased intervention socially and economically to improve physical health, mental health, and overall quality of life. Wraparound services available through Ryan White programs could meet some of these needs.

Table 5 Associations between SDOH indicators and having symptoms of moderate or severe GAD during the past 2 weeks among PLWH in Michigan—Medical Monitoring Project, 2015–2019

	Had symptoms of GAD in past 2 weeks		Unadjusted PR (95% CI)	Adjusted‡ PR (95% CI)
	n	weighted % (95% CI)		
Generalized anxiety disorder (GAD)†				
OSHI score and adjusted factors				
Number of SDOH reported				
0–1 indicators	26	9.9 (5.9–14.0)	Ref	Ref
2 indicators	20	13.8 (8.0–19.6)	1.39 (0.77–2.50)	1.29 (0.71–2.32)
3 indicators	27	18.9 (11.7–26.1)	1.90 (1.08–3.33)	1.91 (1.09–3.35)
≥ 4 Indicators	100	36.3 (29.7–42.9)	3.66 (2.34–5.72)	3.55 (2.25–5.61)
Age				
18–29 years	30	29.5 (19.4–39.7)	1.70 (1.11–2.59)	1.34 (0.86–2.10)
30–39 years	45	27.9 (20.3–35.6)	1.61 (1.11–2.32)	1.23 (0.81–1.85)
40–49 years	46	22.4 (15.9–28.9)	1.29 (0.88–1.88)	1.35 (0.91–2.01)
≥ 50 years	69	17.4 (13.1–21.6)	Ref	Ref
Race/ethnicity				
Black, non-Hispanic	104	23.3 (18.8–27.9)	1.20 (0.87–1.65)	0.78 (0.55–1.10)
Hispanic*	–	–	–	–
White, non-Hispanic	55	19.4 (14.5–24.3)	Ref	Ref
Other/multiracial	28	31.2 (20.7–41.8)	1.61 (1.05–2.45)	1.10 (0.71–1.72)
Gender and sex partner				
Any men who have sex with men (MSM)	92	19.6 (15.6–23.5)	1.10 (0.72–1.69)	1.26 (0.82–1.95)
Men who have sex with women (MSW) only	28	17.8 (11.0–24.5)	Ref	Ref
Any women who have sex with men (WSM)	55	28.3 (20.7–35.9)	1.59 (1.00–2.54)	1.37 (0.85–2.21)
Other	15	44.2 (26.8–61.5)*	2.49 (1.44–4.30)	1.90 (1.01–3.58)
Individual SDOH components				
Educational attainment				
High school education or higher	139	19.7 (16.4–23.0)	Ref	
Less than high school education	51	34.3 (25.3–43.4)	1.74 (1.28–2.38)	
Health literacy				
High confidence completing health forms	109	17.2 (13.8–20.6)	Ref	
Low confidence completing health forms	81	37.5 (30.2–44.8)	2.18 (1.65–2.87)	
Household living at or below poverty level				
Yes	114	28.6 (23.5–33.6)	1.82 (1.34–2.47)	
No	66	15.7 (11.8–19.6)	Ref	
Food insecurity				
Yes	80	41.9 (34.1–49.8)	2.61 (1.99–3.40)	
No	110	16.1 (13.0–19.2)	Ref	
Gap in insurance				
Yes	52	30.8 (22.9–38.8)	1.64 (1.20–2.24)	
No	134	18.8 (15.6–22.0)	Ref	
ER visit in past year				
Yes	119	28.6 (23.7–33.5)	1.88 (1.41–2.51)	
No	71	15.2 (11.7–18.8)	Ref	
Homelessness				
Yes	45	45.3 (34.1–56.4)	2.40 (1.78–3.22)	
No	145	18.9 (15.8–22.0)	Ref	
Needed transportation assistance				
Yes	94	31.5 (25.4–37.6)	1.83 (1.39–2.42)	

Table 5 (continued)Generalized anxiety disorder (GAD)[†]

	Had symptoms of GAD in past 2 weeks		Unadjusted PR (95% CI)	Adjusted [‡] PR (95% CI)
	n	weighted % (95% CI)		
No	96	17.2 (13.7–20.7)	Ref	
Incarceration				
Yes	26	48.9 (33.6–64.3)*	2.40 (1.70–3.41)	
No	164	20.3 (17.2–23.5)	Ref	
Lifetime history of sexual/physical violence				
Yes	93	29.5 (23.7–35.3)	1.67 (1.26–2.22)	
No	94	17.7 (14.1–21.2)	Ref	

Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant

[†]Symptoms were consistent with a GAD-7 score cutoff of 10 or higher for “yes”

[‡]Models adjusted a priori for age, race/ethnicity, gender/sex partner

Estimates with an absolute CI width between 5 and 30 and a relative CI width > 130% and estimates of 0% or 100% are marked with an asterisk () and should be interpreted with caution. Excluded are estimates with a coefficient of variation ≥ 0.30

Table 6 Associations between SDOH indicators and symptoms of major or other depression during the past 2 weeks among PLWH in Michigan—Medical Monitoring Project, 2015–2019

Prevalence of depression symptoms†	Had symptoms of major or other depression in past 2 weeks		Unadjusted PR (95% CI)	Adjusted‡ PR (95% CI)
	n	weighted % (95% CI)		
OSHI score and adjusted factors				
Number of SDOH reported				
0–1 indicators	32	11.0 (7.0–14.9)	Ref	Ref
2 indicators	24	16.5 (9.9–23.2)	1.50 (0.88–2.58)	1.41 (0.83–2.42)
3 indicators	33	22.2 (14.6–29.7)	2.02 (1.23–3.31)	2.08 (1.25–3.44)
≥ 4 Indicators	113	43.7 (36.7–50.7)	3.98 (2.68–5.90)	4.03 (2.68–6.05)
Age				
18–29 years	30	27.6 (18.0–37.2)	1.20 (0.80–1.80)	1.14 (0.77–1.67)
30–39 years	47	28.2 (20.7–35.8)	1.22 (0.87–1.72)	0.94 (0.64–1.37)
40–49 years	56	27.5 (20.5–34.6)	1.19 (0.86–1.66)	1.16 (0.84–1.60)
≥ 50 years	88	23.1 (18.2–28.0)	Ref	Ref
Race/ethnicity				
Black, non-Hispanic	117	26.8 (21.9–31.6)	1.11 (0.84–1.48)	0.76 (0.56–1.01)
Hispanic*	–	–	–	–
White, non-Hispanic	73	24.1 (18.8–29.3)	Ref	Ref
Other/multiracial	26	31.5 (20.4–42.6)	1.31 (0.86–1.98)	0.79 (0.52–1.21)
Gender and sex partner				
Any men who have sex with men (MSM)	106	21.6 (17.6–25.6)	0.83 (0.58–1.21)	0.97 (0.67–1.40)
Men who have sex with women (MSW) only	37	25.9 (17.6–34.2)	Ref	Ref
Any women who have sex with men (WSM)	65	35.2 (27.0–43.5)	1.36 (0.92–2.02)	1.26 (0.84–1.90)
Other	13	31.9 (16.8–47.1)*	1.23 (0.70–2.19)	1.08 (0.60–1.94)
Individual SDOH components				
Educational attainment				
High school education or higher	162	22.3 (18.9–25.7)	Ref	
Less than high school education	59	42.8 (33.1–52.6)	1.92 (1.46–2.52)	
Health literacy				
High confidence completing health forms	131	20.7 (17.1–24.4)	Ref	
Low confidence completing health forms	90	41.3 (33.8–48.8)	1.99 (1.55–2.57)	
Household living at or below poverty level				
Yes	131	35.4 (29.7–41.0)	2.08 (1.58–2.74)	
No	79	17.0 (13.2–20.8)	Ref	
Food insecurity				
Yes	89	47.5 (39.6–55.4)	2.48 (1.95–3.16)	
No	132	19.2 (15.8–22.5)	Ref	
Gap in insurance				
Yes	52	29.9 (22.1–37.7)	1.27 (0.94–1.72)	
No	164	23.5 (19.9–27.1)	Ref	
ER visit in past year				
Yes	145	34.2 (29.0–39.3)	2.04 (1.55–2.69)	
No	76	16.7 (12.9–20.6)	Ref	
Homelessness				
Yes	46	46.5 (35.3–57.8)	2.03 (1.53–2.70)	
No	175	22.9 (19.5–26.3)	Ref	
Needed transportation assistance				
Yes	104	35.8 (29.4–42.1)	1.74 (1.35–2.25)	

Table 6 (continued)

	Had symptoms of major or other depression in past 2 weeks		Unadjusted PR (95% CI)	Adjusted‡ PR (95% CI)
	n	weighted % (95% CI)		
No	117	20.5 (16.8–24.2)	Ref	
Incarceration				
Yes	22	43.0 (27.6–58.3)*	1.75 (1.19–2.56)	
No	199	24.6 (21.2–28.0)	Ref	
Lifetime history of sexual/physical violence				
Yes	110	35.2 (29.2–41.2)	1.75 (1.35–2.27)	
No	108	20.1 (16.3–23.9)	Ref	

†Symptoms were consistent with answering “more than half the days” or “nearly every day” to 2+ depression questions for “yes”

‡Models adjusted a priori for age, race/ethnicity, gender/sex partner

Estimates with an absolute CI width between 5 and 30 and a relative CI width > 130% and estimates of 0% or 100% are marked with an asterisk () and should be interpreted with caution. Excluded are estimates with a coefficient of variation ≥ 0.30

Poverty level, food insecurity, gap in insurance, ER visit, homelessness, need for transportation assistance, and incarceration were assessed over the 12 months prior to interview. History of sexual or physical violence was assessed over the lifetime of the participant

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Declarations

Conflict of interest The research leading to these results received funding from CDC via Grant Agreement Number NU62PS924594. We have no further competing interests to declare.

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