



Neighborhood Alcohol Environment: Differential Effects on Hazardous Drinking and Mental Health by Sex in Persons Living with HIV (PLWH)

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Published online: 10 August 2019
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Abstract

Despite greater mental health co-morbidities and heavier alcohol use among PLWH, few studies have examined the role of the neighborhood alcohol environment on either alcohol consumption or mental health. Utilizing cross-sectional data from a cohort study in a southern U.S. metropolitan area, we examine the association between neighborhood alcohol environments on hazardous drinking and mental health among 358 in-care PLWH (84% African American, 31% female). Multilevel models were utilized to quantify associations between neighborhood alcohol exposure on hazardous drinking and effect modification by sex. Neighborhood alcohol density was associated with hazardous drinking among men but not women. Women living in alcohol dense neighborhoods were nearly two-fold likely to report depression compared to those in less dense neighborhoods, with no association between neighborhood alcohol density and depression among men. Neighborhood alcohol environments may be an important contextual factor to consider in reducing heavy alcohol consumption and improving mental health among PLWH.

Keywords Neighborhoods · HIV · Alcohol · Sex · Mental health

Resumen

Aunque el uso de alcohol y los trastornos mentales son muy comunes en las personas que viven con VIH, muy pocos estudios han investigado el contexto social, específicamente las características del expendio de alcohol, en relación con su consumo y la salud mental de la población. Utilizando datos transversales de un estudio de cohorte de personas viviendo con VIH en un área metropolitana del Sur de Los Estados Unidos, nosotros examinamos la asociación entre las características del expendio de alcohol al nivel vecinal y el consumo de alcohol y la salud mental en 358 personas que viven con VIH (84% afroamericanos, 31% mujeres). Utilizamos modelos jerárquicos para examinar y cuantificar asociaciones entre el expendio de alcohol al nivel vecinal y el alto consumo de alcohol y un posible efecto de modificación por sexo. Encontramos que la densidad de establecimientos que expendían alcohol en el vecindario se asocia con un alto consumo de alcohol en los hombres, pero no así en las mujeres. Mujeres que viven en vecindarios caracterizados por una alta densidad de expendio de alcohol son dos veces más propensas a reportar depresión que aquellas que no viven en vecindarios con densidad alta. No hubo una asociación entre la densidad de expendio de alcohol a nivel vecinal y depresión en los hombres. Las características del expendio de alcohol en un vecindario puede ser un factor importante para reducir el alto consumo de alcohol y mejorar la salud mental en las personas que viven con VIH.

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Introduction

While a disproportionate burden of HIV is heavily concentrated in socially disenfranchised communities [1–3], a deeper understanding of how, under what circumstances, and for whom, social drivers play a role in HIV outcomes is needed [4]. Despite limited research examining the social determinants of HIV, we know that HIV care outcomes and clinical comorbidities cluster geographically [5]. Social determinants including factors such as poverty, unstable housing, and limited social support may impede optimal care and impact comorbidities in PLWH [1–3]. In general, higher levels of both psychosocial and physiological stress among PLWH have been associated with poorer immune status, increased viral load over time, faster disease progression, and higher rates of mortality [6–8]. Such stressors are also likely to interfere with achieving successful care and with the development or exacerbation of clinical comorbidities such as cardiometabolic conditions, substance use and mental health. Extra-individual contexts such as household chaos [9], violence [10], and poverty [11] have all been linked to both adherence and substance use in PLWH.

The neighborhood environment may one source of additional stress in the lives of PLWH. Many areas experiencing high rates of HIV in the U.S. are also characterized by inequities in investment across local urban municipalities, with high rates of violence and an often greater availability of alcohol outlets [12]. In addition to serving as a reminder to drink and supplying alcohol, outlets pose a situational risk in the neighborhood environment. Outlets are often sites where people who engage in high-risk behaviors gather, not just for drinking but sometimes to use and exchange other drugs [13]. Alcohol outlets are also associated with more social disorder [14, 15], which may be linked to various poor health outcomes. Alcohol outlet density has been linked to several health-related outcomes, including with alcohol consumption [14, 16] and poorer mental health [17]. Alcohol outlets are also likely to play a significant role in health outcomes at the neighborhood level, irrespective of individual consumption patterns [15].

Exposure to chronic and lifetime social stressors, including neighborhood-based stressors, is a pervasive experience of persons living with HIV (PLWH) [18–21], and these experiences of adversity are linked to elevated rates of poorer mental health and alcohol use in this population [22, 23]. Roughly half of PLWH in care screen positive for at least one psychiatric disorder [24], with the prevalence of depressive disorder ranging from 16 to 36% compared to 4.9% in the general HIV-negative population, up to 26% for alcohol abuse compared to 6.2% [24, 25], and a post-traumatic stress disorder (PTSD) prevalence of 10–75% compared to 8% in the general population [26]. Psychiatric

co-morbidities are important patient-related barriers to adequate adherence [27–30] and known influencers of substance use [31]. Alcohol use is prevalent in 50–66% of PLWH [32–35]. Nearly 27% of PLWH consume potentially hazardous quantities of alcohol [34, 35] and an estimated 12–14% of PLWH may meet the criteria for an alcohol use disorder diagnosis [33].

Examination of sex-specific differences in the relation between social conditions and alcohol use and mental health are paramount, as women bear the brunt of the co-occurring syndemic (HIV-trauma) worldwide, with trauma exposure at least two fold higher in HIV infected women [36, 37]. Neighborhood exposures may also have a differential influence on health, mental health and health behaviors by sex, due to a hypothesized increased susceptibility and/or exposure of women to neighborhood effects [38]. For example, Derosé et al. [39] have recently reported that women living in high-poverty neighborhoods in Los Angeles, CA have lower physical activity levels than men, and this is partly due to safety concerns related to accessing outdoor parks. Associations between neighborhood alcohol environment on drinking may also vary by sex [40].

The objectives of this study were, therefore, to: [1] examine the association between the neighborhood alcohol outlet density on heavy alcohol consumption and mental health among a cohort of in-care PLWH, and [2] to examine sex differences in these relationships. We hypothesized that PLWH living in areas of high alcohol outlet density would exhibit more hazardous alcohol consumption patterns and worse mental health compared to those living in areas with fewer alcohol outlets and that these associations would differ by sex.

Methods

Study Population

In-care PLWH were invited to participate in a translational longitudinal study, the *New Orleans Alcohol Use in HIV [NOAH]* Study. PLWH were recruited from an HIV Out-patient clinic and a local federally qualified health center (FQHC) from October 2015 to October 2017. The overall goal of the parent study is to identify associations between early life and adult stress on biological and clinical outcomes of PLWH over 2.5 years. We provide a brief description of study recruitment and data collection here, greater detail are provided in an additional publication [41].

Study eligibility included non-pregnant PLWH age 18 and older who were without acute illness or intoxication at the baseline study visit. There were no further exclusion criteria. Consenting individuals attended a baseline visit at which point data on residential address, alcohol use, physical

and mental health measures, and other health-related factors were obtained. Three hundred and sixty-five individuals completed a baseline visit, and those data were used in the present analysis.

Individual-Level Measures

Participants self-reported demographic information on sex (male, female), age (<40, 40–49, 50–59, 60+), and educational attainment (less than high school, high school diploma or GED, at least some college). Alcohol use was measured with several validated surveys, including the Alcohol Use Disorders Test (AUDIT) questionnaire, a 10-item tool developed by the World Health Organization [42.] The AUDIT has been widely used in both primary care and epidemiologic research, and its reliability and validity have been established in a variety of populations and settings [43–46]. Item responses are coded numerically and summed for an overall score ranging from a possible 0–40. Scores of 8 or higher reflect harmful or hazardous drinking [42]. Anxiety and Depression were measured using the Hospital Anxiety and Depression Scale (HADS), a validated and reliable screening tool consisting of 14-items (including 7-item subscales for anxiety and depression) [47–49]. Scored responses are categorized into normal or borderline/abnormal based on an established threshold for identifying symptoms of depression or anxiety [49].

Neighborhood-Level Measures

Participant residential address at the time of baseline study visit was geocoded using ArcGIS software (ESRI Inc., Redlands, CA) to identify Census tract Federal Information Processing System (FIPS) identification number, used to define residential neighborhoods. Over 98% of addresses were matched to the 2015 Census TIGER/Line Shapefile for Louisiana Census tract boundaries ($n=358$). These participants resided in 162 census tracts. Those that could not be geocoded ($n=7$) included three PO boxes, one out of state address, and three missing data on house number or zip code.

Off-premise alcohol sales outlets (specifically, liquor stores and convenience stores) were identified in the 2015 North American Industry Classification System data. Neighborhood alcohol off-premise outlet density was estimated as the number of off-premise alcohol outlets per 1000 residents in every Census tract in the New Orleans Metropolitan Area. These data were linked to participant Census tract of residence by FIPS number. Participant neighborhoods with a high density of alcohol outlets were defined as those greater than or equal to the 75th percentile of the sample distribution. The number of off-premise outlets within 500-, 1000- and 2000-m radii of each participant's residence was also

calculated and compared to tract-level density for consistency. The 2015 American Community Survey 5-year estimate of Census tract poverty rates (percentage of families within each tract living below the federal poverty level) was linked to participant residential FIPS number to measure neighborhood poverty (continuous).

Statistical Analysis

Descriptive statistics were used to characterize the sample's sociodemographic characteristics, alcohol use, mental health, and neighborhood environment. We fit a series of log-Poisson models with generalized estimating equations and a compound symmetry working correlation structure in order to estimate the relative risk of hazardous drinking, depression, and anxiety associated with living in a neighborhood with high alcohol outlet density [50]. Subsequently, we estimated the relative risk of depression and anxiety associated with hazardous drinking. Adjusted models included sex, age, education, and neighborhood poverty. Finally, given documented sex differences in mental health and alcohol consumption we fit the same series of models, stratified by participant sex (self-reported sex assigned at birth).

Results

Characteristics of the Study Population

Participants were predominantly male ($n=247$, 69%), over age 50 ($n=195$, 54%), and had a high school education or less ($n=257$, 72%) (Table 1). Prevalence of depressive symptoms was 27%, while 42% of participants screened positive for anxiety. Participants resided in neighborhoods where, on average, more than one in four families lived below the federal poverty level (mean = 27.0%). Neighborhood alcohol outlet density ranged from 0 to 6.9 outlets per 1000 residents. High alcohol density neighborhoods were those with more than 1.8 off-premise alcohol sales outlets per 1000 residents, based on the 75th percentile of the distribution of off-premise outlet rate.

Neighborhood Alcohol Outlet Density in Association with Hazardous Alcohol Use, and Mental Health Outcomes

Compared to participants in low alcohol density neighborhoods, those in high alcohol density neighborhoods were 69% more likely to report harmful or hazardous drinking, independent of their gender, age, education, and the poverty level of their neighborhood (adjusted RR = 1.69, 95% CI 1.24, 2.30; Table 2). Likewise, living in a high alcohol density neighborhood was associated with increased likelihood

Table 1 Characteristics of the study population (n = 358)

	Study population		Men		Women	
	N	%	N	%	N	%
Hazardous drinking (AUDIT score \geq 8)						
No	214	59.8	137	55.5	77	69.4
Yes	144	40.2	110	44.5	34	30.6
Off-premise alcohol outlet density (per 1000 census tract residents)						
Low (<75th percentile, < 1.8 per 1000 residents)	254	72.8	172	71.7	82	75.2
High (\geq 75th percentile, \geq 1.8 per 1000 residents)	95	27.2	68	28.3	27	24.8
Sex						
Female	111	31.0				
Male	247	69.0				
Age						
< 40	78	21.8	55	22.3	23	20.7
40 to < 50	85	23.7	53	21.5	32	28.8
50 to < 60	150	41.9	107	43.3	43	38.7
\geq 60	45	12.6	32	13.0	13	11.7
Education						
Less than high school	145	40.5	90	36.4	55	49.6
High school graduate/GED	112	31.3	79	32.0	33	29.7
At least some college	101	28.2	78	31.6	23	20.7
Depressive symptom levels						
Normal	263	73.5	180	72.9	83	74.8
Borderline or abnormal	95	26.5	67	27.1	28	25.2
Anxiety symptom levels						
Normal	209	58.4	150	60.7	59	53.2
Borderline or abnormal	149	41.6	97	39.3	52	46.9
	Mean (SD)		Mean (SD)		Mean (SD)	
Census tract household poverty rate (%)	27.0 (17.1)		26.7 (18.0)		27.2 (16.8)	

of depressive symptoms (adjusted RR = 1.41, 95% CI 0.99, 2.00), but not anxiety (adjusted RR = 1.15, 95% CI 0.96, 1.37; Table 3).

Hazardous Alcohol Use in Association with Mental Health Outcomes

Individuals reporting hazardous drinking levels were nearly 1.7 times as likely to report depression compared to lighter or non-drinkers (adjusted RR = 1.68, 95% CI 1.17, 2.42) and marginally more likely to report anxiety (adjusted RR = 1.27, 95% CI 0.98, 1.64; Table 4).

Sex Differences in the Associations Between Neighborhood Alcohol Outlet Density, Alcohol Use, and Mental Health Outcomes

Sex-stratified models revealed nuanced differences in associations with neighborhood environment, alcohol use, and mental health between men and women. High neighborhood

alcohol density was associated with increased risk for hazardous drinking among men (adjusted RR for high vs. low neighborhood alcohol density = 1.57, 95% CI 1.09, 2.28) but not among women (adjusted RR = 1.08, 95% CI 0.58, 2.02; Table 2). However, women in alcohol dense neighborhoods were nearly two-fold likely to report depression compared to those in less dense neighborhoods (adjusted RR = 1.99, 95% CI 1.18, 3.38). However, there was no association between neighborhood alcohol density and depression among men (adjusted RR = 1.17, 95% CI 0.70, 2.00; Table 3). Finally, hazardous drinking was associated with increased anxiety among women (adjusted RR = 1.83, 95% CI 1.25, 2.68), but was not associated with either depression (adjusted RR = 1.41, 95% CI 0.94, 2.14) or anxiety (adjusted RR = 1.00, 95% CI 0.73, 1.36; Table 4) among men in this sample.

Table 2 Adjusted relative risks (RR) and 95% confidence intervals (95% CI) for associations between neighborhood alcohol outlet density and hazardous drinking (AUDIT score ≥ 8)

	Whole sample		Men		Women	
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)
Off-premise alcohol outlet density						
Low	Reference		Reference		Reference	
High	1.69	(1.24, 2.30) ^a	1.57	(1.09, 2.28) ^b	1.08	(0.58, 2.02)
Sex						
Male	Reference					
Female	0.73	(0.52, 1.03)				
Age						
<40	1.34	(0.85, 2.10)	1.29	(0.80, 2.08)	1.40	(0.36, 5.48)
40 to <50	1.37	(0.87, 2.15)	1.33	(0.83, 2.13)	1.52	(0.38, 6.10)
50 to <60	1.22	(0.77, 1.93)	0.97	(0.60, 1.58)	2.26	(0.65, 7.94)
≥ 60	Reference		Reference		Reference	
Education						
Less than high school	1.40	(1.07, 1.82) ^b	1.70	(1.23, 2.36) ^a	0.82	(0.48, 1.41)
High school graduate/GED	1.00	(0.70, 1.41)	1.41	(0.94, 2.09)	0.21	(0.06, 0.76)
At least some college	Reference		Reference		Reference	
Neighborhood poverty (per 10% increase)	0.94	(0.85, 1.03)	0.95	(0.86, 1.06)	1.02	(0.87, 1.21)

^a $p < 0.01$ ^b $p < 0.05$

Discussion

To address the current challenges facing effective efforts to improve care and well being of PLWH, it is paramount that we focus on not only multiple social determinants, but also on their social experiences and life environments [21, 51]. This study examined the potential role that the neighborhood alcohol environment may play in heavy alcohol consumption and mental health, both of which can impact the continuum of care among PLWH [52, 53]. We observed a strong positive relationship between the neighborhood alcohol environment and heavy alcohol consumption, while the relationship seen with mental health outcomes was not as strong. This may be due to the differential association seen by sex, whereby the neighbourhood alcohol environment played a larger role in heavy drinking among men and in mental health outcomes among women.

Findings corroborate previous studies that have demonstrated the role of the neighborhood alcohol environment, an indicator of social disorder, on number of negative health outcomes including greater alcohol consumption, sexual risk behavior, sexually transmitted infections (STI), and HIV [54–56]. While there have been calls to examine the relationships between structural context and the neighborhood environment, in particular, in shaping the patterns of care for PLWH [21, 51, 57, 58,] the number of studies that have focused on specific conditions in the neighborhood environment that may be amenable to change are limited. These include a focus on socioeconomic status and poverty,

segregation, and the residential food environment [18, 19, 58, 59]. No studies to date, however, have examined the role of the alcohol environment on factors that may promote successful care among PLWH.

One explanation for our findings is that living in neighborhoods characterized by high levels of off-premise alcohol outlets creates psychological distress. Many outlets have been strongly linked to crime and assaultive violence as well as other forms of social disorder [60, 61], and in addition have been associated with numerous health and social outcomes, including neighborhood domestic violence [62, 63]. Such psychological distress may contribute to health behaviors and outcomes known to negatively impact HIV care outcomes, including depression, substance abuse, and non-adherence to HIV treatment. We did observe, however, that the association differed by sex, with the neighborhood alcohol environment playing a larger role in alcohol consumption among men and in mental health among women.

The observed sex differences make sense, given the hypothesized increased susceptibility and/or exposure of women to neighborhood effects [38], and the differential coping mechanisms between men and women that are often observed, likely due to socialization mechanisms [64, 65]. In response to stressors, numerous epidemiologic studies have shown that women are more likely to internalize stress and to experience more depression and anxiety; while men are more likely to exhibit personality disorders and increased alcohol and drug use [65]. Examination of sex-specific differences are paramount as women bear the brunt of the co-occurring

Table 3 Adjusted relative risks (RR) and 95% confidence intervals (95% CI) for associations between neighborhood alcohol outlet density and depression and anxiety

	Depression				Anxiety					
	Men		Women		Men		Women			
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)		
Off-premise alcohol outlet density										
Low	Ref		Ref		Ref		Ref			
High	1.41	(0.99, 2.00)	1.17	(0.70, 2.00)	1.99	(1.18, 3.38) ^a	1.02	(0.74, 1.39)	1.25	(0.88, 1.77)
Sex										
Male	Ref				Ref					
Female	0.82	(0.56, 1.21)			1.12	(0.86, 1.46)				
Age										
< 40	3.52	(1.29, 9.56) ^a	5.29	(1.10, 25.38) ^a	1.39	(0.35, 5.61)	1.52	(0.90, 2.57)	1.72	(0.81, 3.65)
40 to < 50	3.44	(1.23, 9.68) ^a	6.00	(1.33, 27.03) ^a	1.27	(0.32, 5.07)	1.70	(1.04, 2.80)	1.93	(0.93, 4.02)
50 to < 60	2.94	(1.10, 7.87) ^a	4.30	(0.99, 2.65)	1.19	(0.32, 4.47)	0.94	(0.55, 1.61)	0.98	(0.44, 2.18)
≥ 60	Ref		Ref		Ref		Ref		Ref	
Education										
Less than high school	1.30	(0.88, 1.93)	1.63	(1.01, 2.63)	0.75	(0.32, 1.73)	1.37	(0.94, 2.00)	0.67	(0.47, 0.95)
High school graduate/GED	1.10	(0.66, 1.83)	1.62	(0.99, 2.65)	0.28	(0.05, 1.42)	1.24	(0.83, 1.85)	0.40	(0.23, 0.71)
At least some college	Ref		Ref		Ref		Ref		Ref	
Neighborhood poverty (per 10% increase)	0.96	(0.88, 1.05)	1.00	(0.87, 1.14)	0.90	(0.79, 1.03)	1.05	(0.96, 1.15)	1.04	(0.95, 1.13)

^ap < 0.05^bp < 0.01

Table 4 Adjusted relative risks (RR) and 95% confidence intervals (95% CI) for associations between hazardous drinking and depression and anxiety

	Depression				Anxiety					
	Men		Women		Men		Women			
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)		
Hazardous drinking (AUDIT score ≥ 8)										
No	Ref		Ref		Ref		Ref			
Yes	1.68	(1.17, 2.42) ^a	1.41	(0.94, 2.14)	1.27	(0.78, 3.02)	1.00	(0.73, 1.36)	1.83	(1.25, 2.68)
Sex										
Male	Ref		Ref		Ref		Ref		Ref	
Female	0.88	(0.59, 1.30)			1.17	(0.90, 1.50)				
Age										
< 40	3.46	(1.18, 10.12) ^b	5.20	(1.03, 26.30) ^b	1.61	(0.41, 6.13)	1.52	(0.89, 2.60)	1.57	(0.73, 3.37)
40 to <50	3.48	(1.19, 10.17) ^b	5.94	(1.27, 27.85) ^b	1.72	(0.37, 6.09)	1.70	(1.04, 2.82) ^b	1.84	(0.90, 3.77)
50 to <60	2.96	(1.09, 8.18) ^b	4.39	(0.99, 19.58)	0.99	(0.31, 4.86)	0.94	(0.64, 1.53)	0.86	(0.40, 1.88)
≥ 60	Ref		Ref		Ref		Ref		Ref	
Education										
Less than high school	1.22	(0.88, 1.93)	1.51	(0.91, 2.49)	1.07	(0.38, 1.53)	1.38	(0.95, 1.99)	0.71	(0.48, 1.06)
High school graduate/GED	1.11	(0.66, 1.83)	1.58	(0.96, 2.59)	0.90	(0.09, 1.34)	1.24	(0.83, 1.85)	0.51	(0.28, 0.91)
At least some college	Ref		Ref		Ref		Ref		Ref	
Neighborhood poverty (per 10% increase)	0.97	(0.87, 1.10)	1.01	(0.88, 1.17)	1.02	(0.67, 0.92)	1.05	(0.95, 1.15)	1.03	(0.93, 1.13)

^ap < 0.01

^bp < 0.05

HIV-trauma syndemic worldwide, with trauma exposure at least two-fold higher in HIV-infected women than in HIV negative women [36, 37]. However, chronic stressors and psychological trauma exposure are highly prevalent in both men and women living with HIV and have been linked to a variety of adverse physical and mental health outcomes.

This unique sample of in-care PLWH, in a southern city that still experiences one of the highest rates of HIV infection in the U.S. and with an alcohol environment unlike many in the nation, provides a unique examination of the role that such an environment may play in health factors that may play an important role in the continuum of care. Despite strengths, this study is not without its limitations, including a limited geographic representation; cross-sectional nature; and reliance on self-reported outcome data. Our neighborhood definitions are also based on administrative boundaries and may not truly represent a respondent's neighborhood; however, we utilized a variety of neighborhood exposure metrics for comparison.

In summary, thoughtful consideration of how neighborhood conditions such as the alcohol environment may be associated with mental health and substance use among PLWH is imperative for furthering intervention development to improve the continuum of care in this population. The sample utilized in this analysis is engaged in care and was recruited from outpatient settings. Findings suggest that being engaged in care may not be protective to manage the psychological stress that is experienced in neighborhoods with high alcohol exposure and likely other forms of disinvestment and stressors. This suggests that interventions that consider the daily challenges of living in stressful and often impoverished communities are needed to help patients better manage their HIV infection.

This study provides an examination of one potential neighborhood social determinant, and one amenable to both individual and structural-level interventions and policy changes. Additional contexts in the community that are amenable to structural interventions—such as the neighborhood alcohol environment—have not been examined in relation to mental health or substance use among PLWH. These contexts, however, may influence substance use behavior, as well as overall stress and violence exposure, all of which may play a role in HIV care behavior and retention in care. Given the higher burden of HIV among racial and ethnic minorities in the U.S. and the differential community contexts across race in the U.S. [66], a deeper exploration of the neighborhood or other social and spatial contexts in the lives of PLWH is warranted for the development of new and potentially more impactful environmental prevention strategies to improve the continuum of care.

Acknowledgements We thank the research subjects for their willingness to participate. We acknowledge the hard work and time devoted

by study staff, and referring clinicians. They are key to the success of the study. The authors recognize the contributions of study personnel Mary Meyaski-Schluter, RN, and Virginia Garrison, RN. The study was supported by grants from the National Institutes of Health (NIH, P60AA009803). This study was approved by the Tulane University and Louisiana State University Health Sciences Center Institutional Review Boards. The data were collected in compliance with ethical standards regarding treatment of human participants. All authors have contributed significantly to the manuscript, approved the submission of this version, and consent to having their names on the manuscript. No form of payment was given to anyone to produce the manuscript.

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