

Original investigation

# Perceived Interrelations of Pain and Cigarette Smoking in a Sample of Adult Smokers Living With HIV/AIDS

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## Abstract

**Introduction:** Persons living with HIV/AIDS (PLWH) have very high prevalences of both cigarette smoking and pain, yet little is known about the relationship between smoking and pain for PLWH. This study examined the factor structure, reliability, and validity of a measure of perceived interrelations of pain and smoking in a sample of PLWH.

**Methods:** Participants in this study were 108 current cigarette smoking PLWH (64.8% reporting current pain) in the Bronx, NY. Participants completed assessments of demographics, smoking behaviors, and pain. Interrelations of pain and smoking were measured using the 9-item Pain and Smoking Inventory (PSI). The dimensionality of the PSI was evaluated using Horn's Parallel Analysis and exploratory factor analysis. Internal consistency was evaluated using Cronbach's alpha, and validity analyses evaluated the relationship between the PSI and demographics, HIV clinical characteristics, smoking, and pain in the total sample.

**Results:** A single-factor structure was the best fit for the PSI. The internal consistency of the PSI total score was excellent in the total sample ( $\alpha = 0.94$ ) and among participants with pain ( $\alpha = 0.93$ ). The PSI total score was significantly higher for PLWH who smoke and had current pain versus no current pain. Among smokers with HIV and pain, higher PSI scores were associated with higher pain interference, pain severity, and certain neuropathic pain symptoms (ie, numbness and pain to touch).

**Conclusions:** Among a sample of PLWH, the PSI appeared to be a reliable and valid instrument as a one-factor measure to assess perceived interrelations among pain and cigarette smoking.

**Implications:** Even though PLWH have very high prevalences of both pain and cigarette smoking, little is known about the relationship between pain and smoking for PLWH. This study is the first to examine a measure of the perceived interrelations of pain and smoking in a sample of PLWH. The measure was reliable and valid, and higher scores, reflecting that higher perceived interrelations of pain and smoking, were associated with more intense pain and pain interference. Learning more about pain and smoking among PLWH will help to better target smoking interventions to this key subgroup of smokers.

## Introduction

Tobacco use is the leading preventable cause of mortality and morbidity in the United States with extensive serious individual and societal costs.<sup>1</sup> Whereas approximately 15% of the general US adult population smoke cigarettes,<sup>2</sup> persons living with HIV (PLWH) smoke at prevalences that are two to four times higher.<sup>3,4</sup> Smoking in PLWH is associated with a range of HIV-related and non-HIV-related illnesses including pulmonary disease, cardiovascular disease, and cancer; poorer health-related quality of life; and greater mortality.<sup>5-7</sup> One way to improve the health of PLWH would be to better understand factors related to smoking that could be targeted through medical or behavioral interventions to reduce smoking.

## HIV and Pain

Pain is a significant and costly health condition in the United States<sup>8</sup> and specifically for PLWH.<sup>9</sup> According to the International Association for the Study of Pain, pain is second only to fever as the most common symptom among ambulatory persons with HIV.<sup>10</sup> A systematic review of 28 studies of pain and HIV found that the majority of PLWH reported pain at each time point examined.<sup>11</sup> For example, just over half of PLWH (54%) reported experiencing moderate-to-severe pain in the past week while more than four-fifths of PLWH (83%) reported moderate-to-severe pain in the past 3 months. Studies published since this review continue to report high prevalences of current pain and chronic pain (ie, pain lasting at least 3 months) among PLWH.<sup>12,13</sup> Pain, especially untreated pain, among PLWH is associated with depression and anxiety, lower health-related quality of life, and lower adherence to antiretroviral medication regimens.<sup>11,13</sup>

## Smoking and Pain

Adults with pain report higher prevalences of smoking than adults without pain,<sup>14,15</sup> and, conversely, smokers are more likely to report pain, more intense pain, and pain interference than nonsmokers.<sup>16,17</sup> Smokers with pain, compared with smokers without pain, report greater nicotine dependence and greater daily smoking.<sup>14,18,19</sup> Smokers with pain also report greater pain intensity and interference with functioning,<sup>20</sup> and greater intensity of pain is associated with greater daily smoking, nicotine dependence, and years of daily smoking.<sup>21</sup> The presence of co-occurring pain may serve as a barrier that keeps smokers from engaging in or succeeding during a quit attempt (see Ditte et al., 2011<sup>15</sup> for a review). For example, increased pain ratings are associated with greater urges to smoke and decreased ability to resist smoking.<sup>22</sup> Although smoking cessation is associated with decreased pain,<sup>23</sup> and smokers with pain report motivation to quit smoking and make attempts to quit,<sup>19,24</sup> they also tend to report less confidence in their ability to stop smoking and greater beliefs that quitting smoking will be difficult.<sup>18,24</sup>

The Pain and Smoking Inventory (PSI)<sup>25</sup> was developed to measure perceived interrelations of pain and smoking, including pain as a motivator for smoking, the use of smoking to cope with pain, and pain as a barrier to smoking cessation. Among a sample of 75 current cigarette smoking adults (51% women, 91% White), persons with chronic pain scored higher on each domain of the PSI, and higher PSI scores were associated with greater pain intensity, pain interference, and pain-related emotional distress, as well as greater nicotine dependence, greater withdrawal during quit attempts, and greater expected difficulty quitting smoking.<sup>25</sup> The PSI demonstrated good internal consistency ( $\alpha = 0.95$ ), and factor analysis yielded a single-factor solution that accounted for 71% of the variance.<sup>25</sup>

These initial data suggest that the PSI is reliable and would be a useful instrument for learning more about smoking and pain interrelations in subgroups of smokers, especially those who experience high prevalences of pain such as PLWH.

## Smoking and Pain Among PLWH

As described above, PLWH smoke at high rates and experience a significant level of pain. There is also evidence that pain may be more severe among PLWH who smoke.<sup>26,27</sup> Although smoking in response to pain has been associated with greater pain- and smoking-related behaviors (eg, greater nicotine dependence) among community adult smokers, little is known about interrelations between pain and tobacco smoking among PLWH. Among a sample of 450 PLWH with peripheral neuropathy in the United States, Puerto Rico, Norway, Taiwan, and Columbia, nearly one-third (30.9%) reported using smoking to help manage pain,<sup>28</sup> while a study of 60 current smoking PLWH in New York found that nearly a quarter of PLWH reported that smoking helps “somewhat” or “a lot” with decreasing pain.<sup>29</sup> Two studies of PLWH samples in the United States reported a relationship between current smoking and lower self-reported pain,<sup>26,30</sup> while a third study reported an association between pain and lower nicotine dependence scores among current smokers in Vietnam.<sup>31</sup> Among a sample of 339 female PLWH in the United States, current smoking was associated with greater severity and frequency of pain.<sup>32</sup> To our knowledge, no previous work has examined perceived pain and tobacco smoking interrelations among PLWH, or examined how such interrelations may be associated with pain and smoking behavior among PLWH.

## The Current Study

PLWH demonstrate very high prevalences of both pain and cigarette smoking. However, little is known about the interrelations between these two factors and how these interrelations relate to clinical variables. The development of the PSI has provided an opportunity to assess the interrelations of pain and cigarette smoking among PLWH. The purpose of this study was to conduct the first examination of how PLWH tobacco smokers perceive their pain and smoking behaviors to be interrelated. The first aim of the study was to evaluate the factor structure of the PSI in a sample of current cigarette smoking PLWH. It was expected that the PSI would demonstrate a single-factor solution similar to past research.<sup>25</sup> The second aim was to examine the reliability of the PSI in a sample of current cigarette smoking PLWH. It was expected that the PSI would demonstrate good reliability, similar to results obtained using a community adult sample.<sup>25</sup> The third aim of the study was to examine relationships between smoking for pain-related reasons (ie, PSI scores) and several pain-related (eg, pain intensity, pain chronicity, and pain interference) and smoking-related (eg, smoking quantity) outcomes. It was expected that greater endorsement of perceived pain and smoking interrelations would be associated with greater pain intensity, chronicity, and functional interference, as well as greater cigarettes smoked per day, lower motivation to quit smoking, and lower confidence in quitting smoking.

## Methods

### Participants

Participants were recruited from the Montefiore Medical Center's Center for Positive Living, an urban outpatient HIV clinic in the Bronx, NY, located in a predominantly low-income area, between May 21, 2015 and September 21, 2015. Inclusion criteria were as

follows: (1) a self-reported diagnosis of HIV, (2) capacity to give informed consent, (3) age of 18 years or older, (4) English speaking, and (5) current cigarette smoking (ie, self-report of smoking at least one cigarette in the past day).

## Procedures

All aspects of the study were reviewed and approved by the Albert Einstein College of Medicine (IRB no. 2014–4204). The study was classified by the Institutional Review Board as exempt and was approved with oral consent procedures. For each time period that research staff collected data, one of the authors (JS) generated a list of patients with appointments during that time. The patients were assigned numbers and entered into a randomizing generator to ensure proper randomization. Using the randomized list, members of the research staff would approach each patient on the list in numerical order while balancing the number of women and men who completed the study. Individuals who verbally consented to participate in this study were enrolled. Participants completed a one-time survey that included measures of demographics, smoking behaviors, and pain. Participants were compensated for their time with a \$20 gift card.

## Measures

### Demographics

Participants reported age (years), gender (male, female, or transgender), sexual orientation (heterosexual, homosexual (gay or lesbian), bisexual, or other), education (1st–8th grade, 9th–11th grade, high school graduate, GED, some college, junior college degree, college degree, some postcollege work, or advanced degree), race, (Black/African American, White, American Indian/Alaskan Native, Asian, Native Hawaiian/Other Pacific Islander, or other), and ethnicity (Hispanic or non-Hispanic). For analyses, race/ethnicity was trichotomized into non-Hispanic Black, Hispanic, and non-Hispanic White/American Indian/Other. Sexual orientation was trichotomized into heterosexual, homosexual (gay, lesbian), and bisexual/other. Furthermore, education was coded as 1st–11th grade, high school graduate or General Education Diploma (GED), and some college or college graduate.

### HIV Status

Questions related to HIV status included the year of HIV diagnosis, whether the participant had received a diagnosis of acquired immunodeficiency syndrome (AIDS; ie, the most advanced stage of HIV disease which is marked by a CD4 cell count of <200 cells/mm and/or specific opportunistic illnesses and cancers<sup>33</sup>), and use of antiretroviral medication.

### Current Smoking Behavior

Participants were asked to report the frequency and quantity of their current cigarette smoking, current use of noncigarette tobacco products, and past quit attempts.

### Pain

Participants were asked to report the current intensity of their pain (0 = no pain to 10 = worst pain imaginable) and chronicity of their pain. Neuropathic pain was assessed using the 3-item Neuropathic Pain Questionnaire-short form that assesses amount of tingling pain (0 = no tingling pain to 10 = worst tingling pain imaginable), numbness sensation (0 = no numbness to 10 = worst numbness sensation imaginable), and increased pain due to touch (0 = no increase at all

to 10 = greatest increase imaginable).<sup>34</sup> Pain interference was assessed using the PROMIS Pain Interference scale, which includes 8 items (eg, “how much did pain interfere with your day to day activities”) measured on a 5-point Likert scale (1 = not at all to 5 = very much).

### Smoking for Pain-Related Reasons

Perceived pain and smoking interrelations were assessed using the 9-item PSI.<sup>25</sup> The PSI includes three subscales, focused on three different aspects of smoking and pain, that contain three items each and are measured on a 7-point Likert scale (0 = not true at all, 6 = extremely true): (1) Pain as a motivator for smoking (eg, “When my pain flares up, I want to have a cigarette.”), (2) Smoking for pain coping (eg, “Smoking helps me cope with my pain.”), and (3) Pain as a barrier to quitting (eg, “My pain prevents me from trying to quit smoking.”). In a sample of current smoking adults with pain, the PSI demonstrated excellent internal reliability (full scale  $\alpha = 0.95$ , Pain as a motivator for smoking  $\alpha = 0.84$ , Smoking for pain coping  $\alpha = 0.87$ , and Pain as a barrier to quitting  $\alpha = 0.95$ ).<sup>25</sup>

### Statistical Analysis

The distributions of all relevant study variables were examined. Bivariate relationships between demographics, clinical characteristics, and the presence of pain were examined using *t* tests (normally distributed continuous variables), chi-squares (three-level nominal variables), chi-square with continuity correction (binary variables), and Mann–Whitney *U*'s (continuous variables that violate the assumptions of normality).

Given the preliminary nature of the existing literature regarding the dimensionality of the PSI, factor structure was evaluated using Horn's Parallel Analysis and exploratory factor analysis using a promax rotation. Horn's Parallel Analysis constructs random distributions of possible eigenvalues to determine the appropriate eigenvalue cutoff for retention of factors using both lenient (mean eigenvalue) and stringent (95th percentile eigenvalue) cutoff criteria. Internal consistency was evaluated using Cronbach's alpha. Sensitivity analyses evaluated the dimensionality of the PSI in relevant subsamples, including participants who endorsed current pain ( $n = 70$ ), participants who endorsed clinically significant pain (pain severity  $\geq 4$ ;  $n = 64$ ), participants who endorsed chronic pain (pain duration  $\geq 6$  months;  $n = 41$ ), and participants who endorsed daily smoking ( $n = 79$ ).

Validity analyses evaluated the relationship between the PSI and demographics, HIV clinical characteristics, smoking clinical characteristics, and the presence of pain in the total sample. Validity analyses also evaluated the relationship between the PSI and pain characteristics among participants who endorsed current pain. All validity tests were evaluated using *t* tests for binary variables, ANOVA for three-level nominal variables, Pearson correlations for normally distributed continuous variables, and Spearman correlations for nonnormally distributed continuous variables. Sensitivity analyses evaluated these relationships among participants who endorsed clinically significant pain, chronic pain, and daily smoking. For inferential testing, all alphas were set at 0.05 or confidence intervals set at 95%. All analyses were conducted using SPSS v.22 and STATA v.15.

## Results

### Patient Characteristics

One hundred and eight PLWH completed the study, and 70 participants (64.8%) reported the current presence of pain. See [Table 1](#) for

**Table 1.** Demographics and Clinical Characteristics by Presence of Pain

	Total, N = 108	With pain, N = 70	Without pain, N = 33	p value
	M (SD) or N (%)	M (SD) or N (%)	M (SD) or N (%)	
<b>Demographics</b>				
Age	49.7 (8.6)	50.5 (8.2)	47.7 (9.7)	.133
Gender				
Male	53 (49.1%)	36 (51.4%)	16 (48.5%)	.946
Female	55 (50.9%)	34 (48.6%)	17 (51.5%)	
Sexual orientation <sup>a</sup>				
Heterosexual	74 (71.8%)	48 (70.6%)	23 (74.2%)	.268
Homosexual	19 (18.4%)	11 (16.2%)	7 (22.6%)	
Bisexual/Other	10 (9.7%)	9 (13.2%)	1 (3.2%)	
Race/Ethnicity <sup>b</sup>				
Black, non-Hispanic	45 (42.1%)	27 (39.1%)	15 (45.5%)	.832
Hispanic	52 (48.6%)	35 (50.6%)	15 (45.5%)	
White, American Indian, Other, non-Hispanic	10 (9.3%)	7 (10.1%)	3 (9.1%)	
Highest grade completed <sup>c</sup>				
1st–11th grade	38 (36.5%)	23 (33.8%)	12 (37.5%)	.888
High school graduate/GED	38 (36.5%)	25 (36.8%)	12 (37.5%)	
Some college or college graduate	28 (26.9%)	20 (29.4%)	8 (25.0%)	
<b>HIV clinical characteristics</b>				
Years since HIV diagnosis <sup>d</sup>	18.8 (7.1)	19.2 (7.7)	17.9 (6.3)	.420
AIDS diagnosis <sup>e</sup>				
Yes	42 (40.4%)	30 (44.8%)	11 (33.3%)	.380
No	62 (59.6%)	37 (55.2%)	22 (66.7%)	
Antiretroviral medication <sup>f</sup>				
Yes, currently	68 (77.3%)	46 (80.7%)	21 (77.8%)	.652
Yes, in the past	5 (5.7%)	4 (5.7%)	1 (3.7%)	
No	15 (17.0%)	7 (12.3%)	5 (18.5%)	
<b>Smoking clinical characteristics</b>				
Smoking days <sup>d</sup>				
Daily	79 (79.8%)	49 (76.6%)	25 (83.3%)	.633
Less than daily	20 (20.2%)	15 (23.4%)	5 (16.7%)	
Cigarettes per day <sup>g</sup>				
≥10	49 (47.6%)	32 (48.5%)	15 (45.5%)	.943
<10	54 (52.4%)	34 (51.5%)	18 (54.5%)	
Other tobacco product use				
Cigar, e-cigarette, or pipe	14 (13.0%)	11 (15.7%)	2 (6.1%)	.290
None	94 (87.0%)	59 (84.3%)	31 (93.9%)	
Quit attempts (Mdn, IQR)				
Number of attempts <sup>h</sup>	1.0 (0.0–4.0)	2.0 (0.0–5.0)	1.0 (0.0–3.3)	.101
Days of longest attempt <sup>i</sup>	0.0 (0.0–3.0)	0.0 (0.0–3.0)	0.0 (0.0–7.0)	.762

Five participants did not complete the pain severity question.

GED = General Education Diploma; IQR = interquartile range; M = mean; Mdn = median.

<sup>a</sup>Total N = 103, With pain N = 68, and Without pain N = 31.

<sup>b</sup>Total N = 107, With pain N = 69, and Without pain N = 33.

<sup>c</sup>Total N = 104, With pain N = 70, and Without pain N = 32.

<sup>d</sup>Total N = 99, With pain N = 64, and Without pain N = 30.

<sup>e</sup>Total N = 108, With pain N = 67, and Without pain N = 33.

<sup>f</sup>Total N = 88, With pain N = 57, and Without pain N = 27.

<sup>g</sup>Total N = 103, With pain N = 66, and Without pain N = 33.

<sup>h</sup>Total N = 95, With pain N = 62, and Without pain N = 29.

<sup>i</sup>Total N = 107, With pain N = 70, and Without pain N = 3.

the demographic, clinical, and smoking characteristics of the sample overall and by the presence of pain. The sample was predominantly Hispanic (48.6%) or Black (42.1%), heterosexual (71.8%) men (49.1%) and women (50.9%) with less than a high school (36.5%) or a high-school level of education (36.5%). Less than half of participants (40.4%) reported being diagnosed with AIDS, and over three-quarters of participants were currently taking antiretroviral

medications (77.3%). The majority of participants (79.8%) reported smoking daily; approximately half smoked 10 cigarettes per day or more (47.6%). The current report of pain was associated with no demographic, HIV, or smoking participant characteristics.

Among people who reported pain ( $n = 70$ ), the median pain severity was 7 on a 0–10 scale (IQR = 6.0–8.0), which falls in the severe range (see Table 2). The majority of people who reported pain

reported clinically significant (91.4%) and chronic (65.6%) pain. The majority of participants with current pain also reported some level of neuropathic symptoms, including tingling (92.9%), numbness (87.0%), and/or pain that increases with touch (82.6%).

**PSI Factor Structure**

Horn’s Parallel Analysis and traditional cutoffs (eigenvalue ≥ 1) revealed that a single-factor structure is the best fit for the PSI in this sample (Table 3). Thus, we evaluated both the single-factor structure supported by the current findings and the scale development literature,<sup>25</sup> as well as the three-factor structure based on the three suggested subscales.

The single-factor structure revealed strong factor loadings across all items, ranging from 0.72 (Item 1) to 0.88 (Items 3 and 7; Table 4). Using a promax rotation, correlations among the three factors were modest (Factor 1 and Factor 2,  $r = .64$ ; Factor 1 and Factor 3,

$r = .79$ ; Factor 2 and Factor 3,  $r = .64$ ); therefore, we interpreted the oblique rotation. Promax rotation of the three-factor structure resulted in considerable cross-loading of items across factors; for example, the factor loadings for Item 9 ranged from 0.68 to 0.74 across the three factors. Further, factors did not correspond in any consistent way with the subscales identified in the scale development literature. Therefore, we chose to move forward evaluating only the scale total score in subsequent analyses.

Sensitivity analyses revealed no differences in factor structure or loadings when evaluated only in participants who endorsed current pain, clinically significant pain, chronic pain, or daily cigarette smoking.

**PSI Reliability**

The internal consistency of the 9-item Total PSI was excellent in both the total sample ( $\alpha = 0.94$ ) and in participants with pain ( $\alpha = 0.93$ ) as well as participants who endorsed clinically significant pain ( $\alpha = 0.92$ ), participants who endorsed chronic pain ( $\alpha = 0.94$ ), and participants who endorsed daily smoking ( $\alpha = 0.94$ ).

**PSI Validity**

As expected, the PSI was not significantly associated with any demographic variable or HIV clinical characteristic ( $ps > .05$ ). The PSI was also not significantly associated with any smoking clinical characteristics ( $ps > .10$ ; see Table 5).

See Table 5 for the relationships between the PSI and pain variables. The PSI was significantly higher among smokers with HIV who endorsed current pain ( $M = 23.9$ ,  $SD = 16.1$ ) compared with smokers with HIV who did not endorse current pain ( $M = 5.1$ ,  $SD = 0.3$ ;  $t(94.5) = -7.44$ ,  $p < .001$ ). Among smokers with HIV and pain, higher PSI scores were associated with higher pain interferences ( $\rho = 0.49$ ;  $p < .001$ ), higher pain severity ( $\rho = 0.26$ ;  $p < .05$ ), and higher endorsement of certain neuropathic pain symptoms (numbness  $\rho = 0.28$ ;  $p < .05$ ; pain to touch  $\rho = 0.32$ ;  $p < .01$ ).

**Table 2. Pain Characteristics Among People With Pain**

Pain characteristics	Mdn (IQR) or N (%)
Pain severity (0–10)	7 (6.0–8.0)
Chronicity of pain <sup>a</sup>	
1–2 months	12 (19.7%)
3–6 months	9 (14.8%)
6–12 months	5 (8.2%)
>12 months	35 (57.4%)
Neuropathic pain questionnaire	
Tingling (0–10)	6.0 (4.0–8.0)
Numbness (0–10) <sup>b</sup>	5.0 (2.5–8.0)
Pain to touch (0–10) <sup>b</sup>	6.0 (3.0–8.0)
Pain interference (PROMIS-PI) <sup>c</sup>	66.2 (58.1–71.0)

IQR = interquartile range; Mdn = median.

<sup>a</sup>N = 61.

<sup>b</sup>N = 69.

<sup>c</sup>N = 67.

**Table 3. Eigenvalues of the Three Factors of the Pain and Smoking Inventory**

Factor	Factor name	Eigenvalue	Mean	95th percentile	% of variance
1	Pain as a motivator for smoking	6.18	1.49	1.63	68.71
2	Smoking for pain coping	0.76	1.30	1.40	8.49
3	Pain as a barrier to quitting	0.51	1.17	1.26	5.64

Mean and 95th percentile indicate the eigenvalue threshold needed to retain a factor using both a lenient (mean) and more stringent (95th percentile) criterion as determined by Horn’s Parallel Analysis.

**Table 4. Item Factor Loadings of the Pain and Smoking Inventory**

Items	Single-factor structure	Three-factor structure		
		Factor 1	Factor 2	Factor 3
1. Smoking helps me cope with my pain.	0.72	0.58	0.99	0.59
2. The number of cigarettes I smoke per day is often influenced by my pain.	0.84	0.77	0.67	0.74
3. When my pain flares up I want to have a cigarette.	0.88	0.77	0.65	0.99
4. My pain makes me less confident that I could stop smoking for good.	0.82	0.82	0.49	0.73
5. Smoking a cigarette helps me think about something other than my pain.	0.84	0.80	0.62	0.69
6. My pain would interfere with any attempt I make to quit smoking.	0.82	0.81	0.60	0.62
7. Feeling pain makes me want to smoke.	0.88	0.83	0.57	0.86
8. My pain prevents me from trying to quit smoking.	0.84	0.90	0.51	0.68
9. Smoking helps me cope with the stress and unhappiness that comes with pain.	0.80	0.70	0.74	0.68

Factor 1 = Pain as a motivator for smoking; Factor 2 = Smoking for pain coping; Factor 3 = Pain as a barrier to quitting.



**Table 5.** Relationships Between the Pain and Smoking Inventory and Cigarette Smoking and Pain Characteristics

	M (SD) or $\rho$	<i>p</i> value
Total sample ( <i>N</i> = 108)		
Smoking days		
Daily	19.4 (17.6)	.587
Less than daily	17.0 (17.2)	
Cigarettes per day		
<10	16.4 (16.4)	.231
≥10	20.5 (17.9)	
Quit attempts		
Number of attempts	$\rho = 0.10$	.326
Days of longest attempt	$\rho = 0.06$	.553
Pain presence		
Yes ( <i>N</i> = 70)	23.9 (16.1)	<.001
No ( <i>N</i> = 32)	5.0 (9.3)	
Among people with pain ( <i>N</i> = 70)		
Pain severity (0–10)	$\rho = 0.26$	.032
Chronicity of pain		
≥6 months ( <i>N</i> = 40)	23.9 (17.2)	.561
<6 months ( <i>N</i> = 21)	26.5 (14.7)	
Neuropathic pain		
Tingling (0–10)	$\rho = 0.19$	.125
Numbness (0–10) <sup>a</sup>	$\rho = 0.28$	.020
Pain to touch (0–10) <sup>a</sup>	$\rho = 0.32$	.007
Pain interference <sup>b</sup>	$\rho = 0.49$	<.001

M = mean; SD = standard deviation.

<sup>a</sup>*N* = 69.

<sup>b</sup>*N* = 67.

Sensitivity analyses revealed no meaningful differences in validity analysis results among people with pain, clinically significant pain, chronic pain, or daily smokers.

## Conclusions

Results from this study suggest that the PSI is a reliable and valid instrument to assess perceived interrelations among pain and smoking in adult cigarette smokers living with HIV. Notably, reliability and validity estimates were similar among participants who did and did not endorse current pain, suggesting that perceived interrelations among pain and smoking are relevant for PLWH who smoke cigarettes, even if they are not currently experiencing pain. Further, among PLWH who smoke and report current pain, greater interrelationships between pain and smoking were evidenced for those with higher pain interference, greater pain severity, and several neuropathic symptoms. There were no significant associations found between the PSI and smoking characteristics (eg, cigarettes per day and number of quit attempts).

This study is the second to identify a single-factor structure for the PSI, as our findings were consistent with those of Ditre and colleagues.<sup>25</sup> While a one-factor solution was found to be the best fit in the pilot validation study,<sup>25</sup> principle components analysis was also used to develop three subscales that differed in content and may have useful research and clinical implications: Pain as a motivator for smoking, Smoking for pain coping, and Pain as a barrier to quitting. This study was limited by a relatively small sample, and certain sensitivity analyses (most notably chronic pain) were underpowered to reliably evaluate factor structure. Thus, it is possible that different subscales could be more relevant for certain subgroups of

PLWH who smoke. However, sensitivity analyses were remarkably consistent, suggesting this is an unlikely explanation for the results. Further, when a three-factor structure was force extracted, items loadings did not approximate the subscales identified in the literature.<sup>25</sup> Therefore, we believe that, in this sample, PLWH who smoke may not have conceptually grouped items into subscales, but rather perceived each item to contribute independently to a single construct of perceptions regarding interrelations between pain and smoking. However, it would be important to examine this hypothesis in larger samples of PLWH. Future studies should also continue to empirically evaluate the factor structure of the PSI using techniques such as Horn's Parallel Analysis in a variety of medical populations, with a range of levels of pain and levels of smoking. Future studies should also directly assess invariance of the factor structure across different levels of pain (eg, chronic vs. acute) and smoking (eg, daily vs. non-daily). Finally, given our findings, the PSI may lend itself to a more parsimonious short form, perhaps consisting of three or fewer items with the highest level of loading in the factor analysis.

An evolving reciprocal model posits that pain and smoking interact through a positive feedback loop, resulting in greater pain and the maintenance of tobacco dependence.<sup>15,35,36</sup> Consistent with this perspective, cigarette smoking has been identified as a unique risk factor in the onset and progression of pain conditions such as rheumatoid arthritis and back pain,<sup>37,38</sup> and situational pain has been shown to motivate smoking urges and behavior.<sup>22</sup> Greater pain has also been associated with lower likelihood of smoking abstinence in a clinical trial of a cell phone-delivered smoking intervention administered to 474 PLWH in Texas,<sup>39</sup> and there is emerging evidence that smoking abstinence increases pain,<sup>40</sup> which in turn may precipitate relapse. Potential mechanisms for the general relationships between smoking and pain have been discussed, including chronic smoking-induced alterations to the opioid and serotonergic systems, and a variety of psychosocial factors (eg, stress, comorbid anxiety and depression, smoking-related outcome expectancies, and socioeconomic status).<sup>15,17,36</sup> Mechanisms, potential mediators, and potential moderators of the relationship between smoking and pain specific to PLWH would be important areas of future research.

In the general community, people who smoke hold a range of beliefs about the benefits of smoking (eg, reducing negative affect, coping with boredom, relieving cravings, and weight management<sup>41</sup>), and these beliefs impact smoking maintenance and quit behavior.<sup>41,42</sup> With regard to beliefs about smoking and pain, patients with chronic pain conditions have reliably endorsed smoking in response to pain.<sup>43,44</sup> Adults who endorse smoking to cope with pain report more severe pain and physical interference, and greater fear of pain relative to those who do not endorse smoking to cope with pain<sup>44,45</sup> and greater beliefs that smoking will reduce pain are associated with greater smoking urges following experimental pain induction.<sup>46</sup> Further, anxiety over pain is associated with stronger beliefs that smoking will relieve negative affect,<sup>47</sup> greater tobacco dependence,<sup>48</sup> and early smoking lapse during a quit attempt.<sup>49</sup> In addition, persons who smoke and have chronic pain, compared with persons who smoke and do not have chronic pain, expect greater withdrawal during quit attempts and endorse that quitting smoking will be more difficult.<sup>18</sup> Beliefs about smoking can be experimentally challenged with impacts seen on smoking behavior,<sup>50</sup> and challenging beliefs that smoking reduces pain can alleviate smoking urges.<sup>51</sup> In this study, stronger beliefs in the interrelationship of smoking and pain (eg, using cigarettes to cope with pain and not quitting smoking because of pain) were associated with greater pain intensity and interference. While this study did not find significant associations

of the PSI with the assessed smoking behaviors (eg, cigarettes per day), these beliefs may be more strongly related to other smoking behaviors such as those related to quitting (eg, nicotine dependence and smoking lapse<sup>48,49</sup>), and future research should examine the relationship of the PSI to smoking quit outcomes. At least one published study of behavioral tobacco treatment for PLWH smokers included a module on the pain-smoking-HIV relationship, although the specific effects of this module were not reported.<sup>52</sup> Future research can examine how targeting these beliefs may mediate changes in motivation to quit smoking and quit behaviors for PLWH.

This study had a number of limitations. First, the sample size was too small to empirically evaluate factor structure invariance across PLWH with and without pain, or in different subgroups of PLWH with pain (eg, chronic vs. episodic pain) or by smoking behavior (eg, daily smoking vs. nondaily smoking). Second, the sample from this study included PLWH from one medical center in the Bronx, NY who were primarily heterosexual and of non-Hispanic Black and Hispanic race/ethnicity. Future work in other PLWH would help to determine the generalizability of these results to other geographic locations, sexual orientations, and races/ethnicities. Third, all variables (eg, cigarette smoking) were measured through self-report without additional medical or biochemical confirmation (eg, medical records, physician report, and carbon monoxide measurement). Fourth, the PSI examines the relationship between cigarette smoking and pain and does not evaluate the relationship between pain and the use of noncigarette tobacco products (eg, smokeless tobacco and e-cigarettes) or for multiple tobacco product use.

Another limitation of this study was that there was the lack of information available about the use and misuse of pain medication in this sample. Given the high prevalence of pain among PLWH, it is not surprising that PLWH are prescribed more analgesic medications than persons in the general population.<sup>53</sup> However, research also indicates that opioid misuse behaviors (eg, taking more than prescribed, seeking multiple prescriptions, and medication diversion) are especially prevalent among PLWH, with rates of misuse as high as 62%.<sup>54</sup> Analgesic, and especially opiate, misuse may provide an ulterior motive to exaggerate pain symptoms and could affect analyses of the pain-smoking-HIV relationship. Examining the relationship of analgesic use and misuse among PLWH in relation to the interrelationship between pain and smoking would be an important area of future research.

In summary, among a sample of PLWH from New York, the PSI proved to be a reliable and valid instrument as a one-factor measure to assess perceived interrelations among pain and cigarette smoking. Persons with HIV have complex social, economic, psychiatric, and medical needs that may influence both smoking and pain. Understanding the relationships between pain and smoking for PLWH can help identify ways to assist PLWH to reduce their smoking and smoking-related health consequences.

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## Declaration of Interests

None declared.

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