



Tobacco use characteristics, treatment preferences, and motivation to quit among adults accessing a day shelter in Oklahoma City

Laili Kharazi Boozary^{a,b,*}, Summer G. Frank-Pearce^{b,d}, Adam C. Alexander^{b,c},
Munjireen S. Sifat^b, Jasmin Kurien^b, Joseph J.C. Waring^e, Sarah J. Ehlke^b,
Michael S. Businelle^{b,c}, Jasjit S. Ahluwalia^f, Darla E. Kendzor^{b,c}

^a Department of Psychology, Cellular and Behavioral Neurobiology, University of Oklahoma, Norman OK 73019

^b TSET Health Promotion Research Center, Stephenson Cancer Center, University of Oklahoma Health Sciences Center, Oklahoma City, OK, United States

^c Department of Family and Preventive Medicine, University of Oklahoma Health Sciences Center, Oklahoma City, OK, United States

^d Department of Biostatistics and Epidemiology, Hudson College of Public Health, University of Oklahoma Health Sciences Center, Oklahoma City, OK, United States

^e Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

^f School of Public Health, Behavioral and Social Sciences, Brown University, Providence, RI, United States

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ABSTRACT

Background: Smoking rates are exceptionally high among adults experiencing homelessness (AEH). Research is needed to inform treatment approaches in this population.

Methods: Participants (n=404) were adults who accessed an urban day shelter and reported current smoking. Participants completed surveys regarding their sociodemographic characteristics, tobacco and substance use, mental health, motivation to quit smoking (MTQS), and smoking cessation treatment preferences. Participant characteristics were described and compared by MTQS.

Results: Participants who reported current smoking (N=404) were primarily male (74.8%); White (41.4%), Black (27.8%), or American Indian/Alaska Native (14.1%) race; and 10.7% Hispanic. Participants reported a mean age of 45.6 (SD=11.2) years, and they smoked an average of 12.6 (SD=9.4) cigarettes per day. Most participants reported moderate or high MTQS (57%) and were interested in receiving free cessation treatment (51%). Participants most frequently selected the following options as among the top 3 treatments that offered the best chance of quitting: Nicotine replacement therapy (25%), money/gift cards for quitting (17%), prescription medications (17%), and switching to e-cigarettes (16%). Craving (55%), stress/mood (40%), habit (39%), and being around other smokers (36%) were frequently identified as the most challenging aspects of quitting. Low MTQS was associated with White race, lack of religious participation, lack of health insurance, lower income, greater cigarettes smoked per day, and higher expired carbon monoxide. Higher MTQS was associated with sleeping unsheltered, cell phone ownership, higher health literacy, more years of smoking, and interest in free treatment.

Discussion: Multi-level, multi-component interventions are needed to address tobacco disparities among AEH.

1. Introduction

Adults experiencing homelessness (AEH) face age-adjusted mortality rates that are more than three times that of U.S. adults overall (Baggett et al., 2013; Barrow et al., 1999; Hibbs et al., 1994; Morrison, 2009). The leading causes of death among AEH aged 45–64 years are heart disease and cancer, both of which are linked with smoking (Baggett et al., 2013). Although smoking rates have declined to 12.5% among U.S. adults (Cornelius et al., 2022), 70–80% of AEH continue to smoke (Baggett and Rigotti, 2010; Soar et al., 2020; Taylor et al., 2016). Nevertheless, AEH who smoke often report moderate to high

readiness to quit (Connor et al., 2002; Maddox and Segan, 2017; Porter et al., 2017). Effective approaches to cessation are needed to address tobacco-related health disparities in this vulnerable population.

While standard tobacco cessation approaches may be helpful for many (Fiore et al., 2008), population-specific approaches are needed for AEH. AEH have unique barriers to smoking cessation that include social, environmental, and psychological factors (Okuyemi et al., 2006a; Soar et al., 2020); tailored approaches should be developed based on the specific illness, substance use, and low health literacy which are common among AEH, and may influence motivation to quit smoking (MTQS), treatment engagement, and the likelihood of cessation

* Corresponding author at: TSET Health Promotion Research Center 655 Research Parkway, Suite 400 Oklahoma City, OK 73104, United States.

E-mail address: laili.boozary@ou.edu (L.K. Boozary).

(Nguyen et al., 2015). For example, smoking prevalence rates among people experiencing mental illness or substance use disorder (SUD) are 2-3 times higher than in the general population (Prochaska et al., 2017), and co-occurring mental illness and substance use further increase the likelihood of smoking (Petty and Aubry, 2018). Moreover, lower health literacy, common among AEH (Odoh et al., 2019), has been linked with greater nicotine dependence (Stewart et al., 2013) and relapse following a cessation attempt (Stewart et al., 2014).

Traditional evidence-based strategies for smoking cessation include counseling and pharmacological treatment (Fiore et al., 2008). Although offering these strategies remains important, non-traditional strategies should also be explored to address persistently high rates of smoking among AEH. CM is an effective approach for promoting smoking cessation among socioeconomically disadvantaged adults (Davis et al., 2016; Fraser et al., 2017; Kendzor et al., 2015; Lasser et al., 2017), and this approach has shown initial promise among AEH who smoke (Businelle, 2014; Rash et al., 2018). Switching from combustible cigarettes to ECs may be a practical harm reduction strategy (Levy et al., 2017), given research demonstrating that EC use is associated with fewer harmful exposures than combustible cigarettes (Hajek et al., 2014; Nutt et al., 2014; Wagener et al., 2017). Preliminary research to evaluate the efficacy of using ECs to aid smoking cessation in other vulnerable populations has shown promise (Gentry et al., 2019; Rubenstein et al., 2021). However, the extent to which AEH are interested in or could benefit from CM and ECs for smoking cessation is unclear. In sum, little is known about how to most effectively assist AEH with smoking cessation. The purpose of the current study was to describe sociodemographic and tobacco use characteristics, treatment preferences, and correlates of MTQS among AEH. Findings will inform tobacco cessation intervention approaches for this group.

2. Methods

2.1. Participants and procedure

Parent study respondents were 554 adults (≥ 18 years old) who accessed Homeless Alliance Day Shelter services in Oklahoma City, OK between May 2019 and February 2020 (see Alexander et al., 2022, Ehlke et al. 2022). Respondents completed surveys on a tablet device at the shelter and were assisted by study staff as needed (e.g., due to low literacy level). Participants provided a breath sample, and were compensated with a \$10 gift card.

Participants were included in the current analyses if they reported current smoking (i.e., smoked ≥ 100 cigarettes in their lifetime and smoked within the past 30 days). Participants were excluded if they did not provide information about smoking status ($n=14$) or MTQS ($n=2$). Analyses included 404 currently smoking day-shelter guests (73.3% of parent sample).

2.2. Measures

2.2.1. Sociodemographic characteristics

Participants indicated their sex (male/female), marital/partner status (married or living with significant other vs. single [single/divorced/widowed/separated]), race/ethnicity (Non-Hispanic White vs. Hispanic or Non-White, income ($< \$5,000$ /year vs. $\geq \$5,000$), education (completed high school [≥ 12 years (GED/High School Diploma)] vs. less than high school education [≤ 11 years]), insurance status (insured [Medicare/Medicaid/SoonerCare/Military Insurance/Insurance from a job/private insurance] vs. uninsured), employment status (unemployed vs. employed [Regular full-time work/Regular part-time work]), location slept last night (unsheltered [Abandoned building/Outside or on the street/Car/Tent] vs. sheltered [Friend's or family member's house or apartment/Homeless shelter/Jail/Hospital/personal apartment or house/Hotel/Motel/Drug/alcohol treatment center]), veteran status (yes/no), and cell phone ownership (yes/no). Participants were asked

separately about their gender identity and sexual orientation and responses were collapsed into a single variable (heterosexual/cisgender vs. sexual/gender minority [SGM; Lesbian/gay/queer/Bisexual/Other/Do not know/Not sure/Transgender]).

2.2.2. Motivation to quit smoking

MTQS was assessed with the one-item Motivation to Stop Scale (MTSS). Participants selected one of six statements that best reflected their MTQS (Kotz et al., 2013). The MTSS statements characterize three aspects of an individual's motivation: belief that they should quit, desire to quit, and intent to quit. Participants were grouped into three categories based on their selection: 1) low MTQS (i.e. *I do not want to stop smoking or I think I should stop smoking but do not really want to*), 2) moderate MTQS (i.e. *I want to stop smoking but have not thought about when, I REALLY want to stop smoking but I do not know when I will, or I want to stop smoking and hope to soon*), and 3) high MTQS (i.e. *I REALLY want to stop smoking and intend to in the next 3 months or I REALLY want to stop smoking and intend to in the next month*).

2.2.3. Religiosity

Participants were asked "How often do you take part in religious services?" (Huber and Huber, 2012). They selected the frequency of their attendance from 6 response options. Responses were dichotomized to Never/Less than once a year/A few times a year vs. A few times a month/Once a week/More than once a week.

2.2.4. Health literacy

Health literacy, defined as having the basic reading skills needed to navigate a health care environment, was assessed with the question: "How confident are you filling out medical forms by yourself?" (Chew et al., 2004). Participants responded on 5-point Likert scale. Responses were dichotomized to higher health literacy (Quite a bit/Extremely) vs. lower health literacy (Not at all/A little bit/Somewhat; Chew et al., 2008; Wallace et al., 2006)

2.2.5. Food insecurity

The 9-item Household Food Insecurity Access Scale (HCMS) assessed three Domains of food insecurity: Anxiety and uncertainty (*Food Worry*), insufficient food quality (*Food Quality*), and insufficient food intake and its physical consequences (*Food Quantity*). Endorsement of ≥ 1 question within a domain indicated insecurity within that domain. Final analyzed variables were endorsement of insecurity within each domain (yes/no).

2.2.6. Tobacco use and treatment preferences

Expired carbon monoxide (CO) was measured via breath sample. Questions assessing tobacco history included years of smoking, average cigarettes smoked per day (CPD), non-daily smoking, number of past quit attempts, longest quit duration, and treatment preferences (see Table 2). Participants were additionally asked about alternate tobacco product (ATP) use: "Which of the following products have you used in the past 30 days? (Check all that apply)"; see Section 3.2 for response options. Participants also responded to the questions: "Which of the following options would give you the best chance for quitting smoking?" (see Table 2 for response options) and "Which of the following are the most difficult aspects of quitting smoking?" (see Table 2 for response options); participants were asked to select their top three choices. Participants' menthol preference was selected from the following options: *I smoke menthol 80% of the time, I smoke non-menthol 80% of the time, or I smoke menthol and non-menthol the same amount* (Cohn, 2022; Strasser et al., 2013).

2.2.7. Heaviness of smoking index (HSI)

Participants completed the 2-item HSI (Kozlowski et al., 1994) to assess smoking dependence. Scores of 0-1, 2-4, and 5-6 indicated low, moderate, and high dependence, respectively (Heatherton et al., 1989; NIDA, 2016). Scores were dichotomized to low vs. moderate-high dependence.

2.2.8. Mental health

Three diagnostic screeners were administered to assess current mental health: a modified Patient Health Questionnaire-9 – Depression (PHQ; Spitzer et al., 1999), the Primary Care Post-Traumatic Stress Disorder Screen (PC-PTSD; Prins et al., 2016), and the Generalized Anxiety Disorder Scale (GAD; Kroenke et al., 2003). The PHQ included 8 questions asked about the frequency of depression symptoms over the past two weeks (suicidal ideation item omitted). Symptoms endorsed were summed for a total score of 0-8. If participants endorsed questions 1 and/or 2 and had a sum score >4, then they were considered to have probable Major Depressive Disorder (MDD). The PC-PTSD included 4 questions, with total scores ranging from 0-4. Scores of ≥ 3 indicated a positive screen for PTSD. The GAD included 7 questions about the frequency of anxiety, with total scores ranging from 0-21. Scores of 0-4, 5-9, 10-14, and 15-21 indicated no, mild, moderate, and severe GAD, respectively. Total GAD scores were dichotomized as no/mild GAD vs. moderate/severe GAD. A summary variable was created to reflect whether participants had ≥ 1 mental illness (yes/no).

2.2.9. Substance use

Participants completed the Texas Christian University Drug Screen 5 (TCU) to assess for SUDs (Institute of Behavioral Research, 2020). Scores ranged from 0-11 indicating mild (2-3), moderate (4-5), and severe (≥ 6) SUD. These scores were dichotomized to no SUD vs. any SUD (mild, moderate, or severe SUD). Participants were asked how many standard drinks of alcohol they consumed on each day of the previous week. Heavy alcohol use was defined as >14 drinks/week for males and >7 drinks/week for females (Centers for Disease Control, 2021). Participants responded (yes/no) to the questions: “Have you used needles to inject drugs in past 6 months?” and “Have you used marijuana in the past 30 days?”

2.2.10. E-Cigarette use (EC)

Participants were asked about lifetime and past 30-day EC use (yes/no). Among those who endorsed past 30-day EC use, reasons for use were assessed (see Table 3 for response options).

2.3. Analytic plan

Analyses were generated using SAS software, Version 9.4 for Windows, Copyright © 2016 SAS Institute, Inc. (The SAS Institute, 2016). Means and frequencies were generated to describe participant characteristics and preferences. Participant characteristics were compared by MTQS (low, moderate, high) using analysis of variance (ANOVA) and chi-square tests. Following each ANOVA or chi-square test, Tukey's and Bonferroni adjustments were applied (respectively) to post-hoc comparisons (Mills et al., 2022; Rothman, 1990) in order to identify differences across high-to-low, moderate-to-low, and moderate-to-high motivation groups. A multivariate ordinal logistic regression (OLR) analysis with stepwise selection was conducted to evaluate all variables that were significantly associated with MTQS ($p < 0.05$) together in a single model.

3. Results

3.1. Participant characteristics

3.1.1. Sociodemographic and personal characteristics

Participants' mean age was 45.6 years ($SD=11.2$), and a minority of participants (25.2%) were female. Participants were primarily White (41.4%), Black (27.8%), or American Indian/Alaska Native race (14.1%), and 10.7% reported Hispanic ethnicity. Overall, 92.1% identified as currently homeless and 39.1% reported sleeping unsheltered the previous night. About half of the participants had low health literacy (45.5%). Most participants reported attending religious services *A few times a month* or more (60.4%). The majority of participants reported food insecurity on ≥ 1 domain of the HCMS (70.1%). See Table 1 for participant characteristics.

3.1.2. Mental health/substance use

Many participants screened positive for MDD (22.5%), PTSD (27.0%), and moderate/severe GAD (28.1%). Almost half of participants screened positive for ≥ 1 mental illness (46.0%). Overall, 39.6% of participants screened positive on the TCU for a SUD. Additionally, 51.5% reported past 30-day marijuana use, 23.0% reported heavy drinking, and 12.5% endorsed using needles to inject drugs in the past 6 months.

3.1.3. Motivation to quit smoking

Most reported moderate (42.1%) or high (14.9%) MTQS, while 43.1% reported low (see Fig. 1).

3.1.4. Differences in sociodemographic characteristics by MTQS

Chi-square analyses indicated that Non-Hispanic White race (vs. all others; $p=0.045$) and Black race (vs. all others; $p=0.03$) were significantly related to MTQS (see Tables 1 and 2). Post-hoc chi-square analyses indicated that Non-Hispanic White individuals were more likely to report low than moderate MTQS ($\chi^2(1)=4.23$, $p=0.04$) or high MTQS ($\chi^2(1)=4.03$, $p=0.04$). Conversely, Blacks were less likely to report low than moderate MTQS ($\chi^2(1)=4.51$, $p=0.03$) or high MTQS ($\chi^2(1)=5.61$, $p=0.02$). Additionally, having slept unsheltered the previous night ($p=0.03$) and higher health literacy ($p=0.04$) were significantly related to MTQS. Those who slept unsheltered the previous night ($\chi^2(1)=6.79$, $p=0.009$) and those with higher health literacy ($\chi^2(1)=5.81$, $p=0.02$) were more likely to report high or moderate than low MTQS, respectively.

3.2. Tobacco use characteristics and cessation preferences

3.2.1. Smoking characteristics

Most participants had HSI scores that indicated moderate/high cigarette dependence (71.5%). The average expired CO was 12.91 parts per million (ppm; $SD=10.37$), and participants reported smoking an average of 12.56 ($SD=9.38$) CPD for 23.09 ($SD=12.51$) years. Few participants (15.1%) reported non-daily smoking, 56.9% reported smoking ≤ 10 CPD, and 32.9% of participants reported smoking menthol cigarettes $\geq 80\%$ of the time. About half of participants endorsed past 30-day ATP use (52.7%, $n=213$): 41.3% ($n=167$) *Roll your own cigarettes*; 26.2% ($n=106$) *Cigars*; 16.1% ($n=65$) *Little Cigars* or *Cigarillos*; 11.9% ($n=48$) *Chewing tobacco*; 6.2% ($n=25$) *Hookah*; 5.9% ($n=24$) *Snus*; 5.2% ($n=21$) *Other tobacco products*; and 3.0% ($n=12$) *Dissolvable tobacco products*. The median number of past quit attempts was 3, and the median duration of the longest quit attempt (among those who reported ≥ 1 previous quit attempt) was 90 days. Expired CO ($p=0.03$) and CPD ($p<0.01$) were significantly related to MTQS. Specifically, both were lower in those with high MTQS (CO [high vs. moderate]: 9.75 vs. 13.85, $p<0.05$; CPD [high vs. low]: 9.63 vs. 13.92, $p<0.05$).

3.2.2. Cessation preferences

Most participants were interested in free cessation treatment (51.3%) and using ECs for smoking cessation (55.4%). However, 52.0% reported never using cessation aids in any past quit attempts, and a minority (10.2%) reported ever using the Oklahoma Tobacco Helpline. The treatment approaches most commonly believed to offer the best chance of successful cessation were *Cold turkey* (25.2%), *Nicotine Replacement Therapy* (NRT; 24.8%), and *Other/none of the above* (23.3%). In addition, 17.3% endorsed *money/gift cards for quitting*, 16.6% endorsed *Prescription medications*, and 16.1% endorsed *switching to ECs*. Selecting *Other/None of the above* or *Money/Gift cards for quitting* were significantly related to MTQS. For *Other/None of the above*, significant differences were found between low vs. moderate or high MTQS ($\chi^2(1)=14.90$, $p=0.0001$; $\chi^2(1)=9.24$, $p=0.002$). Participants with low MTQS were more likely to select *Other/None of the Above* than participants with moderate or high MTQS. As the level of MTQS increased, participants were more likely to endorse *Money/Gift cards for quitting* as offering the best chance for successful cessation (low vs. moderate: $\chi^2(1)=5.77$, $p=0.02$;

Table 1
Participant characteristics overall and by motivation to quit smoking (N = 404).

Variable	n	Overall n = 404**	Motivation to Quit				p		
			n	Low n = 174**	n	Moderate n = 170**		n	High n = 60**
Sociodemographic/Personal Characteristics									
Age, years, (M ± SD)	404	45.60±11.18	174	45.3±10.3	170	46.1±12.0	60	45.0±11.2	0.72
Sex, % Female (n)	404	25.2 (102)	174	24.1 (42)	170	25.3 (43)	60	28.3 (17)	0.81
Ethnicity, % Hispanic/Latinx (n)	403	10.7 (43)	174	8.0 (14)	169	12.4 (21)	60	13.3 (8)	0.32
Non-Hispanic White, % (n) ***	403	41.4 (167)	174	48.3 (84)	169	37.3 (63)	60	33.3 (20)	0.045 ^{HL,ML,‡}
Black/AA, % (n) ***	403	27.8 (112)	174	21.3 (37)	169	31.4 (53)	60	36.7 (22)	0.03 ^{HL,ML,‡}
American Indian/Alaska Native, % (n) ***	403	14.1 (57)	174	13.2 (23)	169	15.4 (26)	60	13.3 (8)	0.83
Education, % <High school/GED (n)	404	68.1 (275)	174	68.4 (119)	170	68.2 (116)	60	66.7 (40)	0.97
Employment, % Unemployed/Disabled (n)	378	88.9 (336)	163	89.0 (145)	155	87.1 (135)	60	93.3 (56)	0.43
Insurance status, % Uninsured (n)	404	65.8 (266)	174	71.8 (125)	170	63.5 (108)	60	55.0 (33)	0.04 ^{HL}
Income, % <\$5,000/year (n)	340	70.00 (238)	146	80.1 (117)	142	66.2 (94)	52	51.9 (27)	0.0003 ^{HL,ML}
Marital Status, % married or living with someone (n)	403	15.9 (64)	174	16.1 (28)	169	16.6 (28)	60	13.3 (8)	0.84
Sexual/Gender Minority, % SGM (n)	402	14.9 (60)	174	15.5 (27)	168	13.1 (22)	60	18.3 (11)	0.59
Location slept previous night, % Unsheltered (n)	404	39.1 (158)	174	32.8 (57)	170	41.2 (70)	60	51.7 (31)	0.03 ^{HL}
Veteran, % yes (n)	402	7.2 (29)	174	6.3 (11)	168	7.1 (12)	60	10.0 (6)	0.61*
Active cell phone, % yes (n)	404	43.3 (175)	174	36.2 (63)	170	49.4 (84)	60	46.7 (28)	0.04 ^{ML}
Frequency of Religious Attendance, % ≥A few times a month (n)	394	60.4 (238)	169	57.4 (97)	167	58.7 (98)	58	74.1 (43)	0.07 ^{HL}
Health Literacy, % good literacy (n)	391	54.5 (213)	168	48.2 (81)	166	56.6 (94)	57	66.7 (38)	0.04 ^{HL}
Mental Health									
PHQ Depression, % positive (n)	391	22.5 (88)	168	22.0 (37)	166	19.3 (32)	57	33.3 (19)	0.09
PT-PTSD, % positive (n)	404	27.0 (109)	174	27.0 (47)	170	28.2 (48)	60	23.3 (14)	0.76
GAD-7, % mod/severe (n)	391	28.1 (110)	168	28.0 (47)	166	24.7 (41)	57	38.6 (22)	0.13
Substance Use									
SUD, % mild/moderate/severe (n)	391	39.6 (155)	168	38.7 (65)	166	40.4 (67)	57	40.4 (23)	0.95
Marijuana use, past 30 days, % (n)	404	51.5 (208)	174	50.0 (87)	170	54.7 (93)	60	46.7 (28)	0.49
Past 7-day Heavy Alcohol Use, % (n)	391	23.0 (90)	168	22.6 (38)	166	24.7 (41)	57	19.3 (11)	0.70
Used Needles to inject drugs, past 6 months, % (n)	392	12.5 (49)	169	16.6 (28)	166	10.8 (18)	57	5.3 (3)	0.06
E-cigarette Use									
Would you be interested in using an e-cigarette to help you quit smoking, % yes (n)	381	55.4 (211)	162	50.6 (82)	162	61.7 (100)	57	50.9 (29)	0.10
Ever tried E-cigarettes, % yes (n)	404	31.7 (128)	174	31.0 (54)	170	32.9 (56)	60	30.0 (18)	0.89
Past 30-day E-cigarette use, % yes (n)	404	14.6 (59)	174	14.4 (25)	170	15.3 (26)	60	13.3 (8)	0.93

‡ = did not remain significant after Bonferroni or Tukey's correction

* = Used Fisher's Exact Test p-value

** = Maximum sample size for the column. Analytic sample may be smaller due to missing data. See analytic sample in "n" columns.

*** = Total race/ethnicity breakdown: 10.67% Hispanic, 41.44% Non-Hispanic White, 26.05% Non-Hispanic Black, 12.66% Non-Hispanic American Indian or Alaskan Native, 9.18% Non-Hispanic Other (including Asian, Native Hawaiian or Pacific Islander, Multi-race, or Other). Racial dichotomies in Table 1 reflect Non-Hispanic White, Hispanic/non-Hispanic Black, and Hispanic/non-Hispanic American Indian or Alaskan Native. HL = High Motivation significantly different from low motivation. ML = Moderate Motivation significantly different from low motivation. MH = Moderate Motivation significantly different from high motivation. SGM = Sexual and/or Gender Minority. HSI = Heaviness of Smoking Index. MDD = Major Depressive Disorder. PC-PTSD = Primary Care – Post-Traumatic Stress Disorder. GAD = Generalized Anxiety Disorder. TCU = Texas Christian University Drug Screen

Table 2
Tobacco use characteristics and treatment preferences/challenges by motivation to quit smoking (N = 404).

Variable	n	Overall n = 404**	Motivation				p		
			n	Low n = 174**	n	Moderate n = 170**		n	High n = 60**
Tobacco Use Characteristics									
Carbon Monoxide, ppm (M ± SD)	404	12.91±10.37	174	13.10±9.7	170	13.85±11.0	60	9.75±10.2	0.03 ^{MH}
Years of smoking (M ± SD)	401	23.09±12.51	172	24.66±12.2	169	21.80±13.2	60	22.23±11.1	0.09
Non-Daily Smoking, %(n)	404	15.1 (61)	174	10.9 (19)	170	16.5 (28)	60	23.3 (14)	0.06
Cigarettes smoked per day (M ± SD)	400	12.56±9.38	171	13.92±9.7	170	12.2±9.07	59	9.63±8.5	0.008 ^{HL}
HSI, % moderate/high dependence (n)	404	71.5 (289)	174	77.6 (135)	170	67.1 (114)	60	66.7 (40)	0.06
Menthol use, % ≥80% of the time (n)	404	32.9 (133)	174	34.5 (60)	170	30.6 (52)	60	35.0 (21)	0.69
Interested in receiving FREE smoking cessation treatment, % (n)	310	51.3 (159)	136	35.3 (48)	126	59.5 (75)	48	75.0 (36)	<.0001 ^{HL,ML}
Which of the following options would give you the best chance for quitting smoking? (Please choose your top three)***									
Cold turkey (i.e., no treatment), % (n)	404	25.2 (102)	174	24.7 (43)	170	22.9 (39)	60	33.3 (20)	0.27
NRT (e.g., nicotine patches, gum, or lozenges), % (n)	404	24.8 (100)	174	19.5 (34)	170	25.3 (43)	60	38.3 (23)	0.01 ^{HL}
Other/None of the above, % (n)	404	23.3 (94)	174	33.9 (59)	170	15.9 (27)	60	13.3 (8)	<.0001 ^{HL,ML}
Money or gift cards for quitting, % (n)	404	17.3 (70)	174	9.8 (17)	170	18.8 (32)	60	35.0 (21)	<.0001 ^{HL,ML,MH}
Prescription medications, % (n)	404	16.6 (67)	174	13.8 (24)	170	18.8 (32)	60	18.3 (11)	0.42
Switching to e-cigarettes, % (n)	404	16.1 (65)	174	11.5 (20)	170	20.0 (34)	60	18.3 (11)	0.09
Group counseling, % (n)	404	7.7 (31)	174	6.3 (11)	170	8.2 (14)	60	10.0 (6)	0.57*
Individual counseling, % (n)	404	6.9 (28)	174	4.6 (8)	170	5.9 (10)	60	16.7 (10)	0.01* ^{HL,MH}
Telephone counseling, % (n)	404	5.0 (20)	174	4.6 (8)	170	4.7 (8)	60	6.7 (4)	0.74*
Smartphone App, % (n)	404	2.7 (11)	174	1.7 (3)	170	4.1 (7)	60	1.7 (1)	0.38*
Which of the following are the most difficult aspects of quitting smoking? (Please select the top 3 most difficult)***									
Craving cigarettes, % (n)	404	55.0 (222)	174	55.7 (97)	170	53.5 (91)	60	56.7 (34)	0.88
Stress/mood, % (n)	404	39.6 (160)	174	35.6 (62)	170	40.0 (68)	60	50.0 (30)	0.14
Habit, % (n)	404	38.9 (157)	174	42.5 (74)	170	37.6 (64)	60	31.7 (19)	0.30
Being around other smokers, % (n)	404	36.4 (147)	174	34.5 (60)	170	36.5 (62)	60	41.7 (25)	0.61
Coping with life stress, % (n)	404	24.3 (98)	174	21.8 (38)	170	29.4 (50)	60	16.7 (10)	0.09
Avoiding friends who smoke, % (n)	404	9.4 (38)	174	8.0 (14)	170	7.6 (13)	60	18.3 (11)	0.04 ^{HL,MH,†}
Fear of weight gain, % (n)	404	7.9 (32)	174	5.7 (10)	170	9.4 (16)	60	10.0 (6)	0.34*

† = did not remain significant after Bonferroni or Tukey's correction.

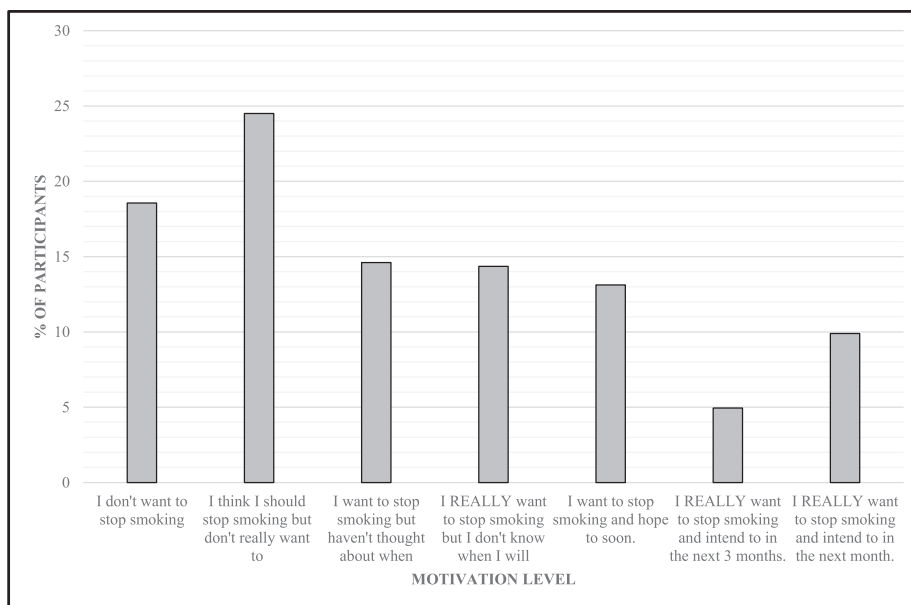
* = Used Fisher's Exact Test p-value

** = Maximum sample size for the column. Analytic sample may be smaller due to missing data. See analytic sample in "n" columns.

*** = Note that many participants did not select three answer choices; see section 2.2 for exact details.

NRT = Nicotine Replacement Therapy. HL = High Motivation significantly different from Low Motivation. ML = Moderate Motivation significantly different from Low Motivation.

MH = Moderate Motivation significantly different from High Motivation



Low Motivation = I don't want to stop smoking and I think I should stop smoking but don't really want to.
 Moderate Motivation = I want to stop smoking but haven't thought about when, I REALLY want to stop smoking but I don't know when I will, and I want to stop smoking and hope to soon.
 High Motivation = I REALLY want to stop smoking and intend to in the next 3 months and I REALLY want to stop smoking and intend to in the next month.

Fig. 1. Motivation to quit smoking among study participants (n = 404). Low Motivation = I do not want to stop smoking and I think I should stop smoking but do not really want to. Moderate Motivation = I want to stop smoking but have not thought about when, I REALLY want to stop smoking but I do not know when I will, and I want to stop smoking and hope to soon. High Motivation = I REALLY want to stop smoking and intend to in the next 3 months and I REALLY want to stop smoking and intend to in the next month.

moderate vs. high: $\chi^2(1)=6.54, p=0.01$; low vs. high: $\chi^2(1)=20.88, p<0.0001$). Participants with low MTQS were more likely to endorse NRT ($\chi^2(1)=8.55, p<0.01$).

The most frequently endorsed items indicating the top 3 most difficult aspects of quitting were: *craving cigarettes* (55.0%), *stress/mood swings* (39.6%), *habit* (38.9%), *being around other smokers* (36.4%), and *coping with life stress* (24.3%). Note that 47.8% of participants chose <3 response options, and 1.0% chose 4 options. The only significant difference by MTQS was that those who endorsed *Avoiding friends who smoke* were more likely to report moderate than low MTQS ($\chi^2(1)=5.42, p=0.02$).

3.2.3. EC use characteristics

Nearly one-third of participants endorsed EC ever-use (31.7%, n = 128), while fewer endorsed EC use during the previous 30 days (14.6%, n=59). See Table 3. Among past 30-day EC users, 66.1% (n=39) en-

dorsed ever use of ECs daily for a month or more; and the top reasons for using ECs included *I can use it in places where cigarettes are not allowed* (39.0%), *To help me quit smoking cigarettes* (37.3%), and *To help me cut down on smoking cigarettes* (37.3%). Due to small sample size, relationships with MTQS were not examined.

3.2.4. Multivariate model of MTQS

A multivariate OLR model evaluated the following significant correlates of MTQS: white race, black race, insurance status, income, CPD, CO, location slept previous night, cell phone status, frequency of religious attendance, health literacy, interest in free smoking cessation treatment, endorsing NRT, *Other/None of the above*, *Individual counseling*, and *Money/gift cards* (as providing the best chance of cessation), and endorsing *Avoiding friends who smoke* (as most difficult aspects of quitting). The following variables were associated with higher MTQS: Income \geq \$5,000/year (OR: 2.45; CI: 1.44, 4.16; $p<0.001$), interest in free smoking cessation treatment (OR: 3.39; CI: 2.03, 5.65; $p<0.0001$), and endorsing *Individual Counseling* (OR: 2.68; CI: 1.14, 6.29; $p=0.02$) and *Money/Gift Cards* (OR: 3.62; CI: 1.92, 6.83; $p<0.0001$) as providing best chance at quitting.

4. Discussion

Nearly three-quarters of day shelter guests reported current smoking, which is greater than five times the smoking rate in the general population (Cornelius et al., 2022). While most participants reported some MTQS, only a minority reported intention to quit within the next 1-3 months. Among evidence-based treatments, participants most frequently selected NRT, abstinence-contingent incentives, prescription medications, and EC switching as offering the best chances of quitting smoking. Participants were most likely to report craving, stress/mood, habit, and being around other smokers as the most difficult aspects of quitting. Characteristics associated with greater MTQS included lower CO, smoking fewer CPD, Black race, sleeping unsheltered, owning a

Table 3
Reasons for E-cigarette use among past-30 day users (n = 59).

Variable	% (n)
Ever used EC daily for a month or more	66.1 (39)
Reasons for E-cigarette use (check all that apply), % yes	
I can use it in places where cigarettes are not allowed	39.0 (23)
To help me quit smoking cigarettes	37.3 (22)
To help me cut down on smoking cigarettes	37.3 (22)
It is cheaper than smoking cigarettes	35.6 (21)
It tastes better or is more pleasurable to use than cigarettes	33.9 (20)
Because I enjoy it	32.2 (19)
It is less harmful to my health than cigarettes	18.6 (11)
Curiosity/just wanted to try	18.6 (11)
To avoid returning to smoking	15.3 (9)
I use this product for reasons that are not listed	11.9 (7)
None of the above reasons	8.5 (5)
Weight loss	5.1 (3)

cell phone, having health insurance, earning more income, attending religious services, having higher health literacy, and interest in free smoking cessation treatment. In a multivariate model, annual income >\$5000, and interest in free tobacco cessation treatment, individual counseling, and money/gift cards for cessation, remained significantly predictive of higher MTQS. Although not associated with MTQS, rates of mental illness diagnosis and SUD were exceptionally high, likely presenting challenges to cessation. Findings offer several potential pathways for smoking cessation intervention.

4.1. Characteristics of AEH smokers

Notably, PTSD, MDD, GAD, and SUD rates were 4-7 times higher in our study than in the general population (NIMH, 2017; SAMHSA, 2020); these conditions are associated with higher rates of smoking (Apollonio et al., 2016; Kalman et al., 2005) and lower rates of cessation (Hitsman et al., 2013; Kearns et al., 2018; Morissette et al., 2007; Piper et al., 2011). Among domiciled individuals, prescription pharmacotherapies (i.e. bupropion and varenicline; Peckham et al., 2017) and combination interventions (i.e. behavioral + pharmacotherapy; Lightfoot et al., 2020) are effective smoking cessation treatments for individuals with severe mental illness. Initiating smoking cessation treatment during SUD treatment may positively impact substance-related outcomes (McKelvey et al., 2017; Prochaska et al., 2004). Plausibly, these approaches may also be relevant for AEH who are willing to participate in more intensive interventions.

Regarding treatment preferences, participants were most likely to select NRT (25%), *Money or gift cards for quitting* (17%), *Prescription medications* (17%), and *Switching to e-cigarettes* (16%) as the evidence-based treatments that offered the best chance of quitting. It is noteworthy that one-quarter of participants selected *Cold turkey* and *Other/none of the above*. These findings suggest a need for education about the strong link between using evidence-based smoking cessation treatments and successful cessation. In addition, further exploration of less commonly available treatment approaches, including switching to e-cigarettes and incentivizing smoking cessation is warranted.

More than half of participants endorsed interest in using ECs to help them quit smoking. Among past 30-day EC users, the top 5 reasons for use related to the facilitation of smoking cessation or preferable characteristics of ECs relative to combustible cigarettes. Notably, interest in ECs for smoking cessation was high across levels of MTQS, suggesting that this approach might be acceptable for individuals with lower MTQS. The findings of one feasibility study indicated that almost half of AEH reduced expired CO by 50% at 24-week follow-up with EC treatment alone – twice the rate of usual care (Dawkins et al., 2020).

4.2. Characteristics associated with MTQS

While the majority of participants reported some MTQS, only 15% of participants reported intention to quit in the next 1-3 months. These findings suggest the need for motivational approaches. Okuyemi et al. has evaluated motivational interviewing in combination with the nicotine patch among AEH with modest effects (Okuyemi et al., 2013, 2006b). Interventions that emphasize the financial savings associated with quitting smoking (Puljevic et al., 2021), as well as incentive-based interventions (e.g., see Baggett et al., 2018; Businelle et al., 2014; Rash et al., 2018) and EC switching (Cox et al., 2022) may also appeal to those who are less ready to quit in the near-term. Future research should explore the specific reasons why individuals who express MTSQ may not be ready to quit in the near future.

Notably, Black day-shelter guests reported higher MTQS than other racial groups, while Whites reported lower MTQS. This finding aligns with previous research indicating that Black adults are more likely to report intention to quit (Soulakova et al., 2017), but are less likely to successfully quit smoking than Whites (Webb Hooper et al., 2015). Supplemental analyses indicated that Black participants were more likely

to have moderate/high smoking dependence than participants of other races ($p=0.03$). Thus, Black day-shelter guests may benefit from additional support strategies that directly target nicotine/smoking dependence, such as NRTs and EC switching.

Income and health insurance status, both indicators of SES, were associated with MTQS, likely reflecting the SES gradient in health (Adler et al., 1994) even within this extremely low-SES population. Surprisingly, participants who reported that they had slept unsheltered the previous night reported higher MTQS, a link which had not been previously identified. Plausibly, the burden of obtaining cigarettes may be greater for unsheltered individuals, or alternatively, the distance from shelter-based social networks where smoking is prevalent may foster greater MTQS. In addition, lower health literacy was common and associated with lower MTQS. Thus, health literacy must be considered when developing interventions for AEH. Interventions might include assessments of participants' recall and comprehension of information (Schillinger et al., 2003), incorporate a low reading level in intervention materials (Egbert & Nanna, 2009), and limit written materials in place of visual/verbal communication.

Notably, many participants expressed interest in incentives-based treatment. Interestingly, participants who selected *Money or gift cards for quitting* as offering the best chance of quitting were more likely to report higher MTQS. Initial incentives-based intervention research with AEH has shown promising results (Baggett et al., 2018; Businelle et al., 2014; Rash et al., 2018). Offering abstinence-contingent incentives may be particularly appealing to AEH who have little or no income and unmet basic needs.

Plausibly, religiosity may be used to facilitate smoking cessation among AEH. Many participants reported that they believed God or something divine, and regularly attended religious services. Those who reported never attending religious services had lower MTQS than those who reported some attendance. Church-based smoking cessation interventions have been successful in other vulnerable populations (e.g., see Schoenberg et al. 2016). Offering cessation treatment that incorporates religious beliefs or is delivered in partnership with churches might be appealing to AEH.

4.3. Strengths and limitations

Strengths of the study include the focus on tobacco use, tobacco treatment preferences, and MTQS in a large and extremely vulnerable population of adults accessing day shelter services. Notably, the demographic distribution of the study sample was comparable to the demographics of homeless adults in Oklahoma City (Homeless Alliance, 2020). Limitations include the cross-sectional study design and the focus on participants from a single shelter and geographic location. In addition, the study evaluated relationships between a large number of variables with MTSQ, which increased the likelihood of Type I error (although minimizing Type II error; for a discussion see Feise 2002).

5. Conclusion

AEH are highly vulnerable to tobacco-related disease and experience unique challenges to cessation. Nevertheless, most participants reported some MTQS and were interested in smoking cessation treatment. Offering traditional cessation interventions alongside non-standard approaches may offer new pathways to address tobacco-related disparities among AEH. Effective interventions must be developed in the context of mental health problems and SUDs. Smoking cessation programs may be incorporated in established case management (Segan et al., 2015) or other intervention programs (i.e. mental health or SUD treatment; Burling et al., 2001; Okuyemi et al., 2006a). Smoking restrictions at shelters (Businelle et al., 2015) and policies that address homelessness and low SES are likely to have a downstream impact on tobacco-related disease (Dow et al., 2010; Kerman et al., 2018).

Ethical approval

The study procedures were approved by the Institutional Review Board of the Oklahoma University Health Sciences Center with waived consent for an anonymous survey.

Declaration of Competing Interest

DEK received tobacco cessation medication (varenicline) from Pfizer as part of a study unrelated to current research. All other authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

CRedit authorship contribution statement

Laili Kharazi Boozary: Investigation, Writing – original draft, Formal analysis, Writing – review & editing. **Summer G. Frank-Pearce:** Formal analysis, Writing – original draft, Writing – review & editing. **Adam C. Alexander:** Writing – original draft, Writing – review & editing. **Munjireen S. Sifat:** Writing – original draft, Writing – review & editing. **Jasmin Kurien:** Writing – original draft, Writing – review & editing. **Joseph J.C. Waring:** Writing – original draft, Writing – review & editing. **Sarah J. Ehlke:** Writing – original draft, Writing – review & editing. **Michael S. Businelle:** Writing – original draft, Writing – review & editing. **Jasjit S. Ahluwalia:** Writing – original draft, Writing – review & editing. **Darla E. Kendzor:** Investigation, Visualization, Writing – original draft, Writing – review & editing.

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