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Development and Validation of a Multidimensional Measure of Stress Among African American Light Smokers

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Abstract

The complete Multidimensional Measure of Stress (MMOS) measure may be made available to interested persons by contacting the corresponding author.

Context—Smoking rates are higher among inner-city and lower-income African Americans, perhaps due to psychosocial barriers to cessation efforts, including stress.

Objective—To describe the development of the MMOS and examine the psychometric properties of the MMOS among African American light smokers.

Design—Secondary analysis of data generated from a 2×2 randomized clinical trial, designed to examine the efficacy of nicotine replacement and cessation counseling among 755 African American light smokers.

Results—Fourteen items were included in the final MMOS ($\alpha = .83$). An exploratory factor analysis identified 3 factors: interpersonal ($\alpha = .80$), safety ($\alpha = .70$), and financial ($\alpha = .75$). The MMOS was significantly correlated with the Perceived Stress scale ($r = 0.49$, $p < .001$) and was associated with several demographic, psychosocial, and tobacco-related variables.

Conclusions—The MMOS appears to be a valid measure of stress among African American light smokers enrolled in a cessation trial.

Keywords

African Americans; tobacco; stress

Tobacco use remains the leading cause of preventable morbidity and mortality in the United States. According to the Centers for Disease Control and Prevention,¹ approximately 46 million US adults are current smokers, including 21% of African Americans and 22% whites. Smoking rates are higher among African Americans who have less than a high school education² and considerably higher among urban/lower-income African Americans when compared to the general population.³ Further, at least 50% of the 5.2 million African American smokers are light smokers (< 10 cigarettes per day).⁴⁻⁵ There are significant health risks for light smokers, including cancer, chronic obstructive pulmonary disease, and cardiovascular disease.⁶ African Americans experience a disproportionate share of tobacco-related disease and mortality. Increased cessation efforts are needed to address smoking among African Americans, and such efforts could be informed by improved measurement of factors influencing light smoking behavior.

The relationship between psychological stress and smoking has been well documented.⁷ For inner-city and lower-income African Americans, higher life stress^{8,9} has been identified as a risk factor hindering smoking cessation.¹⁰ Stress is also associated with smoking persistence and relapse.¹¹ To evaluate the link between stress and smoking, scientists have relied on existing stress measures, such as the Perceived Stress scale (PSS).¹²⁻¹⁵ The PSS is utilized extensively in tobacco-related research to measure a global level of stress related to the degree to which individuals find their lives uncontrollable, unpredictable, and overloaded.^{16,17} The PSS has proven reliability in measuring individuals' self-assessment of their ability to handle life generally.^{16,18,19} The PSS, however, may have some limitations when applied to African Americans. A limitation of this commonly used measure is its lower reported internal validity when used among ethnically diverse, urban samples.²⁰ Moreover, the PSS was not developed specifically to address smoking related stress. Based on the diversity of potential stressors for lower-income and inner-city African Americans light smokers, identifying specific events perceived to be stressful may be an important consideration. Stressful events commonly cited as problematic for lower-income and inner-city African Americans include exposure to chronic crime, housing concerns, discrimination, neighborhood violence, and chronic poverty.

Several additional measures^{21,22} provide evaluation of stressful life events, including the Life Events Checklist²³ and the City Stress Inventory.²⁴ These measures are also limited in evaluating context-specific stress across settings and/or experiences, and were not developed specific to smoking and stress. A multidimensional measure developed for light smokers that covers a comprehensive range of stressful events encountered by lower-income populations can provide a potentially more efficient means of measuring chronic life stress across a spectrum of contexts to which urban African Americans may be exposed.

The current investigation describes the development and psychometric validation of the Multidimensional Measure of Stress (MMOS) that integrates several well-validated and reliable situation-specific stress measures to evaluate smoking behavior and outcomes

among a convenience sample of African American light smokers enrolled in a smoking cessation randomized clinical trial.

Methods

The present analyses are based on data collected in a 2×2 factorial designed randomized clinical trial, Kick It at Swope-II (KIS-II). The data examined the efficacy of nicotine replacement (gum vs placebo) and counseling (motivational interviewing vs health education) for smoking cessation among 755 African American light smokers (ie, those smoking <10 cigarettes per day). Recruitment methods, study methodology, and outcomes of the trial are briefly reviewed below and are detailed elsewhere.²⁵⁻²⁷ The trial procedures were approved and monitored by the University of Kansas Medical Center's Human Subjects Committee.

In brief, 1931 smokers in a midwestern city who self-identified as either African American or black were screened. Of those screened, 1012 were eligible for the study and were invited to participate. Enrollment continued until 755 participants were randomized. Study staff and participants were blind to whether participants received active gum or placebo. However, assignment to motivational counseling or health education was not blinded. Participants were required to be African American, aged 18 years or older, smoke less than 10 cigarettes per day for more than 6 months, smoke cigarettes on more than 25 of the last 30 days, interested in quitting within 14 days from screening, and have a home address along with a functioning telephone number. Participants were ineligible if they had used pharmacotherapy for smoking cessation in the past 30 days, used other forms of tobacco in the past 30 days or met standard exclusionary criteria for nicotine gum (eg, cardiac disease, pregnancy, stroke, pregnancy, or jaw problems).

Intervention

The 755 enrolled participants received an 8-week supply of either 2-mg nicotine or placebo gum at the randomization visit. Instructions given for gum use depended on the number of cigarettes smoked at baseline following expert consensus and manufacturer's recommendations. Participants were assigned randomly to receive 1 of 4 treatments: 8-week treatment with placebo gum plus 6 health education sessions, 8-week treatment with placebo gum plus 6 motivational interviewing counseling sessions, 8-week treatment with 2-mg nicotine gum plus health education session, or 8-week treatment with 2-mg nicotine gum plus 6 motivational interviewing counseling sessions. Over the course of the study, 4 health education or motivational interviewing sessions were delivered in person (ie, at randomization visit and at weeks 1, 8, and 16) and 2 were delivered by telephone (ie, at weeks 3 and 6). In addition to gum and counseling, participants in all 4 arms received a culturally tailored smoking cessation guide developed specifically for African American light smokers. Participants in all four arms were followed for 6 months. The trial's primary outcome was cotinine-verified 7-day abstinence at 26 weeks after randomization. The MMOS was administered to participants at baseline, prior to randomization into treatment condition. Participants were asked to read each statement and report how often they

experienced each potential stressful event during the prior 30 day period on a Likert scale of 0 to 5, from never, rarely, sometimes, often, or very often.

Development of the Multidimensional Measure of Stress

Content validity—Items used in the development of the MMOS were chosen by a team of stress experts to tap primary dimensions of stress among lower-income/ inner-city African Americans. These experts selected key questions thought to tap each of the 11 stress domains (ie, financial stress, filial stress, interpersonal mistreatment, family turmoil, family separation, housing concerns, public assistance, neighborhood disorder, and exposure to violence). Items were selected from validated measures or developed by the team to tap each of the 11 stress domains. Given the exploratory nature of this research and our intent to assess multiple tangible life events that may be associated with stress among urban African Americans, we attempted to balance the number of items selected (ie, subject burden, length of the measure) with sufficient coverage of each domain.

In order for the items to have generalizability to those with limited reading skills, generation of items containing 3 or more syllable words was avoided. Further, content validity was accomplished through regular consultation and review of the measure at all phases of development with experts in the field of stress.

Item selection—Neighborhood disorder and exposure to violence was assessed using 4 items selected from the City Stress Inventory (CSI). The CSI was developed to assess stress associated with living in impoverished urban neighborhoods.²³ Items included: “drug dealers were working near my home,” “strangers drunk near my home,” “family member attacked,” and family member stabbed or shot.” Family turmoil and separation was measured using select items from the Family Turmoil and Separation scale, developed to assess stress associated with exposure to something that disrupts the family unit.²² Items included: “a close family member had a serious medical problem” and “different people moved in and out of my home.” Interpersonal mistreatment was assessed using several items from the Interpersonal Mistreatment scale. This validated instrument evaluates diverse forms of interpersonal mistreatment.²¹ Items included “people acted as if they think you are not smart” and “you received poorer service than other people at restaurants or stores.” Financial and family stress were evaluated using items were selected from stress measures identified in studies by Norris;²⁴ Norris and Uhl;²⁸ and Thompson, Norris, and Ruback.²⁹ Items included: “you did not have enough money to afford the kind of clothing or food you or your family should have” and “you had trouble making your monthly payments or paying your bills.” Items designed to assess housing and public assistance-related stress were created by our team of experts. Examples of these items included: “you felt your home was in need of repairs,” “you felt unsafe where you live,” and “you felt dissatisfied with government sponsored agencies.”

Concurrent validity—A well-validated stress measure, the 4-item PSS,^{30,31} was used to examine concurrent validity. Items included: “have you felt that you were unable to control the important things in your life?,” “have you felt confident about your ability to handle

your personal problems,” “have you felt that things were going your way,” “have you felt difficulties were piling up so high that you could not overcome?”

To further examine concurrent validity, measures of demographic, the correlation between scores on the MMOS and select demographic, tobacco-related, and psychosocial variables were examined. Select measures included the Fagerström Test for Nicotine Dependence (FTND),³² the 10-item Center for Epidemiological Studies Depression scale (CES-D),³³ PSS,¹⁶ the Smoking Self-Efficacy Questionnaire (SEQ-12),³⁴ and a single-item for motivation and confidence for quitting on a 10-point continuum ranging from “not at all motivated/confident” to “extremely motivated/confident.”^{35,36} Nicotine withdrawal was assessed using the modified scale developed by Hughes and Hatsukami.³⁷⁻³⁹ Serum cotinine analysis (measured in ng/mL), used to verify self-reported smoking abstinence, was performed by the Clinical Pharmacology Laboratory at the University of California, San Francisco. These measures and others used in the larger trial are described in greater detail elsewhere.²⁵⁻²⁷

Predictive Validity—In order to examine the predictive validity of the MMOS, we examined the association of scores on the MMOS and smoking cessation outcomes at week 26. The primary outcome variable was cotinine-verified 7-day point-prevalence smoking cessation at month 6, defined as having smoked no cigarettes—not even a puff—in the previous 7 days. Self-reported abstinence at month 6 was verified with salivary cotinine cut-off of less than 20 ng/mL. Secondary outcomes included number of quit attempts. All outcome data were calculated using an intent-to-treat model (ie, those lost to follow-up (n = 118) were imputed as smokers).

Data Analysis

Surveys were double-data-entered into an Access database (Microsoft Corp, Redmond, Washington) and exported into SAS version 9.1 for analysis.⁴⁰ Categorical variables were summarized by frequencies and percentages, and continuous variables were summarized by means and standard deviations. The 2-sample Wilcoxon rank-sum test and χ^2 test were used to compare demographics between those subjects who completed the measure and those who did not. There were no demographic differences among the 4 treatment groups at baseline. In all analyses, statistical tests yielding *p* values at or below .05 were considered as evidence of findings not attributable to chance.

Internal validity—To characterize the factor structure of the MMOS, common factor analysis was conducted on the 14 items. An orthogonal (varimax) rotation was used to allow the individual constructs to remain independent. Cronbach's α was calculated for the total score and each subscale score.

Concurrent validity—Correlation analyses were used to examine the association between the MMOS and the PSS. The associations of total MMOS total score and each factor with select baseline demographic, tobacco-related, psychosocial, and health-related characteristics were also examined. We compared demographics and other baseline

measures with the MMOS total score and for each of subscales score using the 2-sample Wilcoxon rank-sum test and Spearman correlations.

Predictive validity—Wilcoxon rank-sum test and the Spearman correlations were used to determine the predictive validity of the MMOS total and subscale scores; and each factor score with week-26 cigarettes smoked per day, 24-hour quit attempts, and cotinine-verified abstinence.

Item reduction—Initially, items assessing time frame other than “last 30 days” and items utilizing a yes/no scoring scale were removed. Based on the results of the above analyses, we then investigated items that could be potentially removed from the larger pool of original items. The following criteria were used: (1) floor and ceiling effects (<5% or >95% endorsed), (2) item total score correlation (investigated items with low item-total score correlation (absolute value of $r < 0.20$), and (3) factor analysis results (items that did not load on any factor (loading <.30) or items that loaded on multiple factors were investigated for removal).

Following removal of items, scores were recalculated by summing the number of scores of all endorsed items.

Results

Participant Characteristics

Of the 755 enrolled in the study, 748 completed the 31-item version of the MMOS. Table 1 presents baseline demographic characteristics of the study participants. The majority of study participants were female (66.7%); middle-aged (mean age, 45.0; SD = 10.7); single, separated, or divorced (62%); and had at least a high school education (84%). Participants smoked approximately 8 cigarettes per day (SD = 3.2), have been smoking for the past 23.9 years (SD = 12.0), scored an average of 2.9 (SD = 1.8) on the FTND (ie, indicating a low level of nicotine dependence), and averaged 3.3 (SD = 6.6) quit attempts in the past year. Forty-six percent of the sample reported elevated levels suggestive of clinical depression (CES-D score >4).

Items Positively endorsed

Table 2 describes the proportion of participants reporting that each potentially stressful situation occurred during the past 30-day period. For these analyses, all items reported to have occurred rarely, sometimes, often, or very often were collapsed. Item response rates ranged from 30% to 73%.

Item Reduction

Of the original 31 items, 10 were dropped because they were not asked whether they occurred during the current timeframe (ie, the previous 30 days). Additionally, 6 items were dropped due to not being scored on a Likert scale of 0 to 4. Finally, 1 item was dropped due to an item loading score less than 0.30 (ie, item from filial stress dimension “Responsible for

the care and well-being of family or friend”). Therefore, of the original 31 items, 14 items remained in the final MMOS measure.

Each of the remaining 14 items had a 5-point likert response scale (0-4), indicating how often the item was felt or experienced during the past year (ie, never, rarely, sometimes, often, very often). The MMOS total score was calculated by summing the individual questions. This total score could take on values from 0 to 56. One item was reverse scored (ie, “have money to afford clothes and food”).

Internal Validity

Fourteen items were included in the final MMOS (Table 3). The analysis identified 3 factors with eigenvalues greater than 1. Factor 1 (eigenvalue = 2.42), comprising 5 items, was interpreted as interpersonal and accounted for 17.3% of the total variance. These items had loadings from 0.41 to 0.79 in absolute value. Factor 2 (eigenvalue = 1.95), consisting of 4 items, was interpreted as safety and accounted for 14.0% of the total variance. These items had loadings from 0.31 to 0.83 in absolute value. Factor 3 (eigenvalue = 1.68), consisting of 5 items, was interpreted as financial and accounted for 12.0% of the total variance. These items had loadings from 0.50 to 0.72 in absolute value. Reliability was assessed by calculating Cronbach's α , which was 0.83 for the total 14 items. Factor 1 was 0.80, factor 2 was 0.70, and factor 3 was 0.75.

Concurrent Validity

Concurrent validity was established between the MMOS and the PSS. The total score correlation between the 4-item PSS and MMOS was 0.49 ($p < .001$). Correlation with subscales were also calculated—interpersonal, 0.40 ($p < .001$); safety, 0.19 ($p < .001$); and financial, 0.51 ($p < .001$).

Association of Multidimensional Measure of Stress total and Factor Scores With Select demographic Characteristics

The MMOS total score ranged from 0 to 56. The mean total score was 15.9 (SD = 10.1; median, 14.0; range, 0-48). Table 4 presents MMOS total score and factor scores by select demographics. Variables significantly associated with elevated MMOS scores included: younger age, nicotine dependence as determined by the FTND, lower internal and external self-efficacy to refrain from smoking, nicotine withdrawal, depression, being single or divorced, being unemployed, having lower income, and having less education (< high school education).

Predictive Validity

Wilcoxon rank-sum test and the Spearman correlations conducted to examine whether MMOS total and subscale scores were associated with verified cessation abstinence or 24-hour quit attempts at week 26 and failed to find a significant association for any of the 3 factors (Table 4).

Discussion

The primary purpose of this study was to describe the development of the MMOS and examine its psychometric properties among African American light smokers and to explore associations among context-specific life stress, demographic, tobacco-related, psychosocial, and smoking cessation outcomes.

Internal Validity

Results indicate that the overall MMOS has adequate internal consistency reliability. The factor analysis helped to determine the unique dimensions of specific stressful events measured by the MMOS—interpersonal, safety, and financial—which were also correlated. Each of these specific stressful events appears to evaluate the general construct of stress evidenced by the similar scores for each dimension. The differences in the scoring suggest that the stress being measured is distinct. Interpersonal stress involves conflicts or tensions in social relationships. The dimension of safety primarily describes stressful events related to living in challenged urban environments. Financial stress is those specific events related to experiencing financial hardship. Overall, the MMOS appears to have acceptable reliability within this population of African Americans.

Concurrent Validity

Cohen and colleagues¹⁶ purport that it is important to not only assess stress globally but to pair this assessment with measurement of specific stressful events. Overall, the MMOS demonstrates significant correlation with the PSS. Higher perceived stress is also significantly associated with each subscale—interpersonal, safety, and financial stress. Since the PSS is a well-validated measure of stress, significant concurrent validity suggests that the MMOS is evaluating stress (Figure)—albeit related to specific stressful events in this instance.

The MMOS was also significantly correlated with select psychosocial characteristics and smoking behaviors. Higher dependence (ie, FTND), withdrawal, and depression at baseline are significantly associated with all dimensions of the MMOS within this sample of African American light smokers. These findings contribute to the limited research^{11,41-43} that has investigated the connection between these particular variables and stress among light smokers in African American populations. In the current study there were also significant correlations between MMOS and being unemployed, having lower income, and less than a high school education. Research has shown that individually and together that these factors present a source(s) of stress among low-income smokers.⁴⁴

Predictive Validity

This study contributes to research assessing stress as predicting smoking cessation outcomes among African American light smokers. In the current study, MMOS was not significantly associated with week 26 24-hour quit attempts nor did it predict cotinine-verified 7-day point-prevalence abstinence at 6 months. Studies have found that PSS did not predict cessation among a similar demographic.²⁸ As was the purpose for identifying context-specific measure of stress, research supports that during context-driven stressful events,

smokers tend to smoke more.^{45,46} More research is necessary to determine the predictive validity of the MMOS among light smokers. Additionally, the relationship among cigarettes smoked per day, quit attempt, cessation outcomes, and the lower stress reported by African American light smokers should be explored in future studies.

Limitations

Limitations of the study include it being a secondary data analysis of a study where the primary focus was not stress. We utilized the opportunity of this randomized clinical trial to develop a multidimensional measure of stress. These current findings may not generalize to other African Americans or to other groups of smokers and nonsmokers. It is recommended that future studies assess the validity of the MMOS among other groups before the MMOS can be considered a valid measure of stress among low-income, urban samples across ethnicity. Additionally, there were limitations related to item selection. Research has demonstrated that African Americans have unique stressors due to factors such as acculturation⁴⁷ and unfair treatment due to racial/ethnic discrimination.⁴⁸ While these factors influence African Americans' health and health behavior in the United States, they were not assessed in the larger clinical trial. As a result, these unique stressors could not be considered in the development MMOS.

In spite of these limitations, current findings provide preliminary evidence of the validity of the MMOS among African American light smokers. Findings suggest that it is important to investigate the association of specific stressful events in addition to global perceptions of stress among low-income, inner-city, African American light smokers. At this time, however, it is premature to assert that, among these smokers, the MMOS is a better assessment than the PSS. Further comparative research is warranted; and with no multidimensional measure of stress in existence, the MMOS presents a promising option. Furthermore, development of a measure of stress among low-income African American smokers recruited at an inner-city clinic may assist health care providers to provide better quality of care among this population group.

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Figure. Correlation Between Perceived Stress Score and Multidimensional Measure of Stress

Table 1
Baseline Demographic and Tobacco-Related Variables for Total Sample

Characteristic	N = 748
Age, y; mean (SD)	45.0 (10.7)
Female, No. (%)	499 (66.7%)
Married or living with a partner, No. (%)	283 (37.9%)
Monthly family income <\$1800, No. (%)	428 (58.7%)
At least a high school graduate, No. (%)	625 (83.7%)
No. of cigarettes smoked per day, mean (SD)	7.5 (3.2)
Nicotine dependence (Fagerström score), mean (SD)	2.9 (1.8)
Quit attempts in the last year, mean (SD)	3.3 (6.6)
Body mass index, kg/m ² , mean (SD)	30.7 (8.1)
Center for Epidemiological Studies Depression scale, mean (SD)	3.5 (2.6)
Possible clinical depression, No. (%)	343 (45.9%)
Motivation to quit, mean (SD)	9.0 (1.7)

Table 2
Percentage of Affirmative Responses to Each Item (% Endorsement) and Total Score
Correlations

Factors	Question	% Endorsement ^a	Correlation With Total
Personal	Family or friends critical of you	56.0	0.43
Personal	You were treated with less respect than other people.	57.0	0.56
Personal	People acted as if I wasn't smart.	55.4	0.59
Personal	People acted better than me.	65.2	0.55
Personal	Received poor service at restaurants/stores	50.1	0.36
Safety	Felt unsafe where you live	30.0	0.44
Safety	Concerned with pest problems	30.0	0.32
Safety	Saw people dealing drugs near my house	48.1	0.38
Safety	Strangers drunk or high near my home	52.8	0.41
Financial	Have money to afford clothes and food	73.3	0.51
Financial	Have trouble with monthly payments	70.5	0.50
Financial	Difficulty with medical bills/ins	44.4	0.39
Financial	Receive poor service from government agencies	47.9	0.49
Financial	Dissatisfaction with government agencies	50.1	0.48

^aFor this table, an item was counted as an affirmative response if the participant reported that it occurred rarely, sometimes, often, or very often.

Table 3
Factor Loadings of the Multidimensional Measure of Stress^a

	Factor 1	Factor 2	Factor 3
Item	Interpersonal	Safety	Financial
Family or friends critical of you	0.49		
You were treated with less respect than other people.	0.75		
People acted as if I wasn't smart.	0.79		
People acted better than me.	0.70		
Received poor service at restaurants/stores	0.41		
Felt unsafe where you live		0.33	
Concerned with pest problems		0.31	
Saw people dealing drugs near my house		0.80	
Strangers drunk or high near my home		0.83	
Have money to afford clothes and food			0.63
Have trouble with monthly payments			0.72
Difficulty with medical bills/ins			0.55
Receive poor service from government agencies			0.47
Dissatisfaction with government agencies			0.50
Eigenvalues	2.42	1.95	1.68

^a All items have factor loadings greater than or equal to 0.30.

Table 4
Significant Association of Multidimensional Measure of Stress Total and Factor Scores
With Select Demographic, Psychosocial, Tobacco-Related Characteristics; and Health
Behaviors

Baseline Variables	Correlation With Total	Mean Total Score	P Value	Significant Factors
Age	-0.09		.009	P
No. of 24-hour quit attempts	0.11		.003	P,S
FTND	0.16		<.001	P,S,F
Smoking self-efficacy, internal	-0.14		<.001	P,F
Smoking self-efficacy, external	-0.09		.018	F
MN Withdrawal scale	0.42		<.001	P,S,F
CES-D	0.53		<.001	P,S,F
Perceived Stress scale	0.49		<.001	P,S,F
Life Events Checklist	0.27		<.001	P,S,F
Marital status			<.001	S,F
Not married or living w/partner		16.9		
Married or living w/partner		14.2		
Education			<.001	P,S,F
<High school		18.5		
>1 High school		15.4		
Current employment status			<.001	P,S,F
0, Not employed		18.2		
1, Employed		13.3		
Monthly Income			<.001	P,S,F
<\$1800		18.4		
>\$1800		12.3		

Abbreviations: F, financial; P, interpersonal; S, safety.

^a Significant associations with Multidimensional Measure of Stress total scores are indicated in bold in the significance column.

^b Correlation with total: Reports the Spearman correlation between the total stress and the specific quantitative variable.

^c P value for total: For quantitative variables, it reports the P value of the Spearman correlation. For variables with two levels, it reports the P value of Wilcoxon rank-sum test.

^d Significant factors: Reports the individual factors from the factor analysis that are significantly related to the specific variables (used $p < .05$ as the level of significance). In some cases, an individual factor may have been significant, but the total score was not.