Cancer Causes Control
DOI 10.1007/s10552-013-0262-5

ORIGINAL PAPER

Psychosocial stress and cigarette smoking persistence, cessation, and relapse over 9–10 years: a prospective study of middle-aged adults in the United States

Natalie Slopen · Emily Z. Kontos · Carol D. Ryff · John Z. Ayanian · Michelle A. Albert · David R. Williams

Received: 6 November 2012 / Accepted: 3 July 2013

Abstract
Purpose Year-to-year decreases in smoking in the US have been observed only sporadically in recent years, which suggest a need for intensified efforts to identify those at risk for persistent smoking. To address this need, we examined the association between a variety of psychosocial stressors and smoking persistence, cessation, and relapse over 9–10 years among adults in the United States ($n = 4{,}938$, ages 25–74).

Methods Using information provided at baseline and follow-up, participants were categorized as non-smokers, persistent smokers, ex-smokers, and relapsed smokers. Stressors related to relationships, finances, work–family conflict, perceived inequality, neighborhood, discrimination, and past-year family problems were assessed at baseline and follow-up.
Results High stress at both assessments was associated with greater odds of persistent smoking for stressors related to relationships, finances, work, perceived inequality, past-year family problems, and a summary score. Among respondents who were smokers at baseline, high stress at both time points for relationship stress, perceived inequality, and past-year family problems was associated with nearly double the odds of failure to quit.
Conclusions Interventions to address psychosocial stress may be important components within smoking cessation efforts.

Keywords Cigarette smoking · Smoking cessation · Smoking persistence · Psychosocial stress · Longitudinal · Midlife in the United States (MIDUS)

N. Slopen · E. Z. Kontos · D. R. Williams
Department of Social and Behavioral Sciences, Harvard School of Public Health, Boston, MA, USA

N. Slopen (✉)
Center on the Developing Child, Harvard University, 50 Church Street, 4th Floor, Cambridge, MA 02139, USA
e-mail: nslopen@hsph.harvard.edu

C. D. Ryff
Department of Psychology/Institute on Aging, University of Wisconsin-Madison, Madison, WI, USA

C. D. Ryff
Institute on Aging, University of Wisconsin, Madison, Madison, WI, USA

J. Z. Ayanian
Division of General Medicine and Primary Care, Department of Health Care Policy, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

M. A. Albert
Division of Cardiovascular Medicine, Howard University College of Medicine and Howard University Hospital, Washington, DC, USA

D. R. Williams
Department of African and African American Studies, Harvard University, Cambridge, MA, USA

Introduction

Tobacco control in the United States (US) is often touted as a major public health achievement with the percentage of adults who report they currently smoke down from 42 in 1965 to 19.3 % in 2010 [1]. Despite this significant decline, tobacco remains the leading preventable cause of morbidity and mortality in the United States [1], and year-to-year decreases in smoking prevalence have been observed only sporadically in recent years. Furthermore, smoking prevalence has remained higher among certain

Published online: 17 July 2013

segments of the US population, relative to other groups (i.e., racial/ethnic minorities, groups with lower socioeconomic status) [2]. Education is one of the strongest predictors of tobacco use with nearly 25 % of those with a high school degree or less reporting being a smoker compared to 9.9 % of those with a 4-year college degree [1]. The slowing decline in smoking prevalence between 2005 (20.9 %) and 2010 (19.3 %), compared to the decline between 2000 (23.2 %) and 2005, suggests the need for increased efforts to identify those at risk for persistent smoking and to maximize successful quit attempts among current smokers [1, 3, 4]. The aim of this study is to prospectively examine the relationship between psychosocial stressors and smoking persistence, cessation, and relapse over 9–10 years in a sample of middle-aged adults in the US.

Psychosocial stressors include acute negative life events or chronic strains [5] and have been implicated as risk factors for tobacco use [6–9]. Psychological stress may influence smoking behavior (e.g., initiation, maintenance, and relapse) through a number of mechanisms. Specifically, smoking may function as a coping behavior, whereby nicotine is used to self-medicate in response to stress [10]; it is also possible that exposure to stress may result in diminished self-regulation to control the urge to smoke [11]. Previous observational studies illustrate that acute stressful events [12] and greater exposure to chronic stressors (e.g., related to work [13], finances [14], or relationships [7]) are associated with higher smoking prevalence compared to persons who did not experience these stressors. Very few studies have used population-based data to prospectively examine the role of psychosocial stressors on smoking behavior over time. For example, Ayyagari and Sindelar [13] used data from the Health and Retirement Study to analyze prospectively the association between job stress and smoking behavior between 1992 and 2004 among adults aged 50–64 at baseline. They found that job stress was positively associated with continued smoking among recent smokers. In an analysis of former smokers in the Americans' Changing Lives study, McKee et al. [12] showed that different types of psychosocial stressors may vary in their influence on smoking behavior and that some types of stress may actually encourage smoking cessation; over a 3-year observation period, interpersonal loss events were associated with sustained abstinence from smoking, while adverse financial events and change of residence were associated with increased probability of relapse [12]. Research on the relative impact of different types of stressors on smoking status is important, as this work can be used to inform the design of prevention and cessation intervention programs.

One limitation of prior population-based prospective research is that very few studies have assessed a comprehensive set of psychosocial stressors, spanning multiple domains of day-to-day life. Sociological research suggests that it is important to estimate stress exposure comprehensively [5, 15]. As shown by Turner and colleagues [15], when stress exposure is measured more comprehensively than in typical studies, differences in stress exposure account for substantially more variability in mental health outcomes than would be suggested by less comprehensive assessments of stress. Thus, we may be able to improve our understanding of the relationship between stress and smoking by considering a broad variety of stressor domains, and whether high exposure on multiple stressors is a stronger predictor relative to single domains of stress. A second limitation of prior research is that it is challenging to characterize the temporal sequence between stress and smoking. Some researchers have utilized laboratory-based experimental studies to gain insight into the temporal association between psychosocial stress and smoking behavior. For example, in controlled experimental settings, stress induction among current smokers is related to heightened self-reported desire to smoke [16, 17] and increase in smoking intensity and inability to resist smoking [18]. However, experimental studies typically do not generalize to broader populations of smokers [19] or provide information about psychosocial stress in relation to persistent smoking over prolonged periods of time. Third, prior studies have not consistently evaluated the potential influence of negative affect (i.e., negative emotion, dissatisfaction, or distress) for associations between stressors and smoking; yet, emotional experience and report of stress exposure are intertwined in a manner that may be substantively important. Smoking may help individuals to reduce negative affect when confronted with stressors [19], consistent with self-medication [20], and stress-coping [21] models of substance abuse; or smoking may induce negative affect (i.e., consistent with the stress induction model of smoking) [22], which could lead to heightened exposure to—or biased reporting of—stressors.

In the present study, we examined multiple domains of psychosocial stress and smoking abstinence, persistence, relapse, and cessation from baseline to a 9–10 year follow-up in a national sample of adults in the United States. On the basis of prior research, we hypothesized that high levels of psychosocial stress at baseline and follow-up would be associated with (1) reports of smoking at both baseline and follow-up (i.e., persistent smoking) and (2) failure to quit smoking among individuals who reported an attempt to quit smoking between baseline and follow-up. In sensitivity analyses, we examined our initial results adjusted for negative affect, because negative affect may influence both experience and/or report of psychosocial stressors and smoking behavior or it could be on the causal pathway between psychosocial stressors and smoking.

Methods

Sample

Data for this study were drawn from the Midlife in the US (MIDUS) study. MIDUS is a nationally representative cohort of non-institutionalized adults (25–74 years) initiated in 1995/1996 (MIDUS I) to examine the influence of behavioral, psychological, and social factors on mental and physical health in midlife. Details of the study have been previously described [23]. Households in the continental United States were sampled using random digit dialing (RDD), and a randomly selected English-speaking adult was randomly selected within each participating household. The study also recruited siblings of some RDD respondents, a national twin sample, and city-specific oversamples. Participants completed telephone surveys and self-administered questionnaires ($n = 7{,}108$). Follow-up was performed 9–10 years later (MIDUS II in 2004/2005). The present analysis uses data from 4,938 individuals who participated in both the initial and follow-up surveys ($n = 2{,}245$ RDD respondents, 728 siblings, 1,477 twins, and 488 from city-specific oversamples). We excluded 25 individuals from 4,963 individuals with data at both time points, because these 25 individuals (i.e., 0.5 % of the sample) became regular smokers *for the first time* between baseline and follow-up (i.e., they did not have history of smoking in 1995/1996). This group was too small to analyze as a separate outcome and thus was excluded. Respondents who participated in both MIDUS I and MIDUS II were more likely to be White, female, married, more highly educated, and in better health, compared to those individuals who died or were lost to follow-up [24]. Additional details about sampling, enrollment, and longitudinal retention are documented elsewhere [24]. Participants provided informed consent, and the study was approved by the Institutional Review Board at the University of Wisconsin and Harvard School of Public Health.

Measures

Smoking status

At baseline and follow-up, participants were asked the following question: "Do you smoke cigarettes regularly now?" Participants who responded "yes" were categorized as current smokers. Based on combined responses at both time points, we sorted participants into one of four categories to describe their smoking status at the two time points of the study: (1) non-smokers (at baseline and follow-up); (2) persistent smokers (i.e., regular smoker at baseline and follow-up); (3) ex-smokers (i.e., current smoker at baseline, non-smoker at follow-up); and (4) relapsed smokers (i.e., ex-smoker at baseline, smoker at follow-up). Individuals who reported regular smoking at baseline were also asked if they had "tried to quit smoking" during the time since the last interview (yes/no). Using this information (in combination with smoking status in 2004/2005), we categorized baseline smokers who attempted to quit smoking between baseline and follow-up as "successful" or "unsuccessful".

Psychosocial stressors

Eight domains of stressors reflected the experiences and challenges that participants may face in daily life, including: relationship stress, financial stress, work stress, work-family spillover, perceived inequality, neighborhood stress, discrimination, and recent problems in the family. Identical measures for each domain were administered at baseline and follow-up. Nearly all stress domains were comprised of multiple scales, as described below (see "Appendix").

Relationship stress consisted of four measures: family strain (four items; Cronbach's $\alpha = 0.80$); friend strain (four items; $\alpha = 0.79$); marital risk (five items; $\alpha = 0.69$); and spouse/partner strain (six items; $\alpha = 0.81$) [25]. *Financial stress* was assessed using a two-item measure that captures financial difficulties ($\alpha = 0.79$). *Work stress* consisted of measures of skill discretion (three items; $\alpha = 0.68$), decision authority (six items; $\alpha = 0.85$), demands (four items; $\alpha = 0.74$), coworker non-support (two items; $\alpha = 0.74$), and supervisor non-support (two items; $\alpha = 0.87$), risk of injury on the job (one item), and job insecurity (one item) [26]. *Work-family spillover* measured negative work-to-family spillover (four items; $\alpha = 0.84$) and negative family-to-work spillover (four items; $\alpha = 0.81$) [27]. *Perceived inequality* assessed the extent to which individuals are dissatisfied with their relative position or experiences in three life domains: work opportunities (six items; $\alpha = 0.78$), living environments (six items; $\alpha = 0.80$), and ability to provide for their children (six items; $\alpha = 0.69$) [28]. *Neighborhood stress* was measured using a four-item scale that assessed safety and trust in the neighborhood ($\alpha = 0.68$) [29]. *Discrimination* included an inventory of major discrimination events (11 items) and the everyday discrimination scale (nine items; $\alpha = 0.97$) [30]. *Past-year family problems* included three inventories that measured financial, health, legal, and relationship problems in the respondents' immediate family: parents, children, and spouse (ten items each).

If a given stress measure was not applicable, the participant was assigned the lowest value (i.e., least stress) on the scale and a covariate to reflect non-eligible status was included in multivariate analyses. For example, respondents who were not working received the lowest possible value (i.e., zero) on the work stress measures, rather than

have a missing value. In multivariate analyses using this variable, a dummy variable indicating whether or not the individual was employed was also included. Using this technique, work stress reflects the effect estimate for work stress among those who are working [31]. An identical procedure was used for marital stress measures for single respondents and child-related measures for respondents without any children (see Table 3 for details).

We created stress trajectory variables that described stress experiences at both waves of the study in four steps. First, all measures for a given domain were standardized into *z*-score distributions and summed together. Second, the resulting value was standardized into a *z*-score. Third, this *z*-score was transformed into a dichotomous variable with values above the top quartile identified as "high" for that domain. We chose to dichotomize these values to facilitate the creation of categorical trajectory variables to describe stress exposure over time. Finally, to characterize stress exposure over time, we created 4-category variables for each stress domain to describe stress trajectories between baseline and follow-up: (1) high at baseline and follow-up, (2) low at baseline and follow-up, (3) high at baseline and low at follow-up, and (4) low at baseline and high at follow-up. In addition to creating stress trajectory variables for each of the eight stress domains, we created cumulative stress scores (for baseline and follow-up) by summing together the *z*-scores for the eight stressor domains, standardizing these values into a *z*-score, and repeating the subsequent steps described above.

Of note, the MIDUS assessments include additional stressors, such as early life adversity as well as a standard assessment of stressful life events measured at MIDUS II [32]. Those were not included because each was based on only a measure at a single time point and therefore could not be used to operationalize cross-time trajectories.

Socio-demographic characteristics

Demographic covariates from the baseline survey included gender, age, household income, education, race/ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, and other), and parental status. We also created variables to reflect employment and partner status (marital or similar) at both time points. Negative affect (at baseline) was assessed using a standard six-item measure ($\alpha = 0.87$) [33].

Statistical analysis

Chi-square tests were used to compare demographic characteristics and stress at both time points by smoking status. We then calculated a series of multinomial logistic regression models to examine associations between (1) psychosocial stressors and the smoking abstinence, persistence, cessation, and relapse in the full sample ($n = 4{,}938$), and (2) among individuals who attempted to quit smoking between baseline and follow-up ($n = 766$). Multinomial models were used because this type of model can estimate outcomes with more than two outcome categories, and non-smokers were the reference group in all analyses. All models that estimated the associations between the psychosocial stress domains and smoking status were adjusted for age, gender, race/ethnicity, income, and education, and for clustering among siblings or twins. We tested the robustness of our results by replicating our analyses with additional adjustment for negative affect. Finally, we tested for effect modification by age, gender, income, and education. Multiple imputation of missing observations was performed using IVEware software [34, 35] since missing data may not be random. We created 10 imputed datasets and analyzed these datasets using SUDAAN statistical software.

Results

Bivariate analyses

Socio-demographics and smoking trajectories

Table 1 shows demographic characteristics according to smoking status. Among our 4,938 participants, 13.0 % were regular smokers at baseline and follow-up (referred to as "persistent smokers"), while 6.8 % quit between baseline and follow-up (referred to as "ex-smokers"), and 2.1 % were ex-smokers at baseline and smokers at follow-up (referred to as "relapsed smokers"). Over three quarters of the sample (78.2 %) were not smokers at baseline or follow-up (referred to as "non-smokers"). Smoking status over the course of the study was significantly related to age, income, education, marital status, and employment status, and parental status (Chi square *p*-values $<.05$). Persistent smokers were more likely to be younger, have less education, and have lower annual incomes. Participants who were married at baseline and follow-up were disproportionately more likely to be non-smokers at both time points, while individuals who were single at both time points were most likely to be new smokers at follow-up. Changes in smoking status were not associated with gender or race/ethnicity. Among the 766 smokers at baseline who reported an attempt to quit smoking during the study period, 334 respondents (44 %) were ex-smokers at follow-up, while 432 respondents (56 %) failed in their attempt to quit smoking.

Table 1 Demographic characteristics of full sample by smoking pattern between baseline and follow-up

	Full sample[a] % (*n*)	Stratified by smoking status				
		Persistent smoker (M1 and M2) %	Ex-smoker (smoker M1, non-smoker M2) %	Relapsed smoker (ex-smoker M1, smoker M2) %	Non-smoker (non-smoker at M1 and M2) %	χ^2 *p* value
Sample size (*n*)	100 (4,938)	12.96 (640)	6.77 (334)	2.09 (103)	78.19 (3,860)	
Gender						
Female	53.37 (2,636)	13.62	6.34	2.20	77.83	0.27
Male	46.63 (2,302)	12.20	7.25	1.95	78.59	
Age (years)[b]						
<35	19.74 (975)	14.87	8.00	3.38	73.74	<.0001
35–44	26.83 (1,325)	16.00	6.04	2.41	75.54	
45–54	25.35 (1,251)	14.22	7.72	1.60	76.46	
≥55	28.07 (1,385)	7.57	5.73	1.30	85.40	
Annual income($)[b]						
<25,000	17.09 (771)	16.33	8.91	2.51	72.24	<.0001
25,000–44,999	20.01 (925)	13.62	7.81	2.34	76.23	
45,000–69,999	21.62 (992)	14.49	6.82	2.13	76.57	
≥70,000	41.28 (1,837)	10.44	5.34	1.77	82.45	
Education[b]						
≤High school	34.98 (1,725)	19.46	8.92	2.49	69.14	<.0001
Some college	30.31 (1,493)	14.43	7.16	2.54	75.87	
Bachelors degree	34.70 (1,711)	5.14	4.26	1.28	89.32	
Race/ethnicity						
White	85.39 (4,177)	12.65	6.62	1.94	78.79	0.43
Black	4.02 (175)	11.55	7.52	1.25	79.69	
Hispanic	6.48 (149)	16.05	6.50	3.26	74.19	
Other	4.11 (88)	16.13	9.24	3.69	70.94	
Marital status[c]						
Married T1 and T2	66.85 (3,300)	11.09	5.91	1.73	81.28	<.001
Single T1 and T2	7.74 (382)	17.28	6.28	3.93	72.51	
Married T1, single T2	7.65 (378)	14.81	8.99	2.38	73.81	
Single T1, married T2	17.76 (877)	17.33	9.24	2.51	70.92	
Employment status[c]						
Working T1 and T2	62.25 (3,073)	13.31	6.86	1.85	77.98	0.01
Working T1, not T2	16.34 (807)	13.75	8.30	2.85	75.09	
Not working T1, working T2	5.02 (246)	14.21	6.86	3.63	75.29	
Not working T1, working T2	16.39 (794)	10.48	4.83	1.73	82.96	
Has 1 + child[b]						
Yes	81.95 (4,045)	13.49	6.50	2.05	77.96	0.05
No	18.05 (891)	10.55	7.97	2.24	79.24	

Column percents are presented for the full sample; row percents are presented for stratified sample

[a] N's refer to data prior to imputation; percents were calculated using 10 imputed data sets. [b]Measured at baseline. [c]T1 = baseline (MIDUS 1); T2 = follow-up (MIDUS 2)

Psychosocial stress and smoking persistence, cessation, and relapse

Table 2 presents the distribution of stress trajectories by smoking status over the study period. In bivariate analyses, smoking behavior was associated with financial stress, perceived inequality, and past-year family problems, as well as the cumulative stress score (Chi-square *p*-values <.05). Each of these stressors shared the same general pattern, whereby persistent smokers were disproportionately more likely to have high stress at both time points, and non-smokers were disproportionately more likely to have low stress at both time points. Across stressor domains, there were no clear patterns between smoking behavior and stress category when the level of the stressor changed over time (i.e., high stress only at one time point).

Adjusted analyses

Psychosocial stress and smoking persistence, cessation, and relapse

In a series of adjusted models (Table 3), we investigated the independent effects of each stressor domain on smoking trajectory between baseline and follow-up. High stress at both time points was associated with increased odds of being a persistent smoker (compared to a non-smoker) for six of the nine psychosocial stress measures investigated, including relationship stress (OR = 1.34, 95 % CI 1.02–1.77), financial stress (OR = 1.64, 95 % CI 1.19–2.25), work stress (OR = 1.36, 95 % CI 1.00–1.84), perceived inequality (OR = 1.44, 95 % CI 1.10–1.88), past-year family problems (OR = 1.87, 95 % CI 1.42–2.46), and cumulative stress (OR = 1.40, 95 % CI 1.08–1.82). High financial stress and work stress at both time points were also associated with increased odds of quitting smoking (financial stress: OR = 1.61, 95 % CI 1.08, 2.40; work stress: OR = 1.50, 95 % CI = 1.03, 2.18). High stress at baseline and low stress at follow-up were also associated with increased odds of being a persistent smoker for perceived inequality (OR = 1.44, 95 % CI 1.10–1.88), past-year family problems (OR = 1.45, 1.12, 1.88), and the cumulative stress score (OR = 1.52, 95 % CI 1.15–2.02), but not for the other stress domains. Low stress at baseline and high stress at follow-up did not predict persistent smoking for any of the stressors considered; however, it did predict smoking relapse for perceived inequality (OR = 2.13, 95 % CI 1.13, 4.01). No associations were observed between work–family spillover, neighborhood stress, and discrimination and smoking trajectory.

Psychosocial stress and cessation among respondents who attempted to quit

In Table 4, we examined whether high levels of psychosocial stress at baseline and/or follow-up were associated with greater odds of unsuccessful versus successful cessation, among respondents who reported an attempt to quit smoking during the study period. Relative to individuals who quit smoking during the study period (i.e., ex-smokers), individuals who failed in their attempt to quit smoking had approximately twice the odds of high stress at both time points for relationship stress (OR = 2.02, 95 % CI 1.22, 3.35), perceived inequality (OR = 1.90, 95 % CI 1.16, 3.12), and past-year family problems (OR = 1.92, 95 % CI 1.19, 3.10). In addition, high stress at baseline but not at follow-up was also associated with greater odds of a failed quit attempt for relationship stress (OR = 1.70, 95 % CI 1.05, 2.75), perceived inequality (OR = 1.66, 95 % CI 1.03, 2.68), and the cumulative score (OR = 1.61, 95 % CI 1.02, 2.55).

In sensitivity analyses, we replicated the models presented in Tables 3 and 4 with additional adjustment for negative affect at baseline. In general, the results presented in Table 3 were similar when negative affect at baseline was adjusted for. Relationship stressors and perceived inequality were more substantially attenuated relative to other stressors; the coefficients for high relationship stress at both time points (OR = 1.23, 95 % CI 1.23–1.64) and high perceived inequality at both time points (OR = 1.30, 95 % CI 0.99–1.71) were no longer a significant predictors of persistent smoking when negative affect was included. Results were unchanged when negative affect was included in the models that examined unsuccessful versus successful cessation among smokers who attempted to quit during the study period (i.e., Table 4). Finally, we did not find evidence for effect modification by age, gender, income, or education.

Discussion

In this national cohort of US adults followed over 9–10 years, high levels of psychosocial stress related to relationships, finances, work stress, perceived inequality, past-year family problems, and cumulative stress at baseline and follow-up were associated with greater odds of continued smoking over the course of the study. Among respondents who attempted to quit smoking during the study period, those who were unsuccessful in their quit attempt had greater odds of high relationship stress, perceived inequality, past-year family problems, and cumulative stress at baseline and follow-up. Importantly, these associations were observed while adjusting for both income

Table 2 Distribution of stress trajectories by smoking pattern

	Full sample % (*n*)	Stratified by smoking status				
		Persistent smoker (M1 and M2) %	Ex-smoker (quit between M1 and M2) %	Relapsed smoker (ex-smoker M1, smoker M2) %	Non-smoker (M1 and M2) %	χ^2 *p* value
Relationship stress						
High–high	11.96 (591)	14.51	5.66	2.15	77.68	0.15
High–low	11.99 (592)	14.36	6.01	3.67	75.96	
Low–high	12.13 (599)	14.24	6.36	2.30	77.09	
Low–low	63.92 (3,157)	12.16	7.19	1.74	78.91	
Financial stress						
High–high	7.98 (394)	20.41	10.55	3.68	65.37	<.001
High–low	10.36(512)	15.72	7.24	1.68	75.37	
Low–high	9.31 (460)	17.39	7.17	2.93	72.51	
Low–low	72.35 (3,573)	11.17	6.23	1.86	80.73	
Work stress						
High–high	9.92 (490)	15.93	9.25	1.22	73.60	0.11
High–low	13.95(689)	15.31	7.30	1.60	75.79	
Low–high	14.18 (700)	13.83	6.66	2.16	77.36	
Low–low	61.95 (3,059)	11.77	6.28	2.32	79.63	
Work–family spillover						
High–high	10.80 (533)	14.30	7.99	2.29	75.70	0.80
High–low	11.28 (557)	13.80	7.57	2.15	76.47	
Low–high	13.63 (673)	11.65	6.26	2.53	79.57	
Low–low	64.29 (3,175)	12.91	6.53	1.95	78.61	
Inequality						
High–high	11.61 (573)	20.16	7.50	2.24	70.11	<.001
High–low	12.21 (603)	16.92	7.56	3.83	71.69	
Low–high	12.43 (614)	13.91	6.73	3.40	75.96	
Low–low	63.75 (3,148)	10.71	6.49	1.47	81.34	
Neighborhood						
High–high	12.06 (595)	14.57	7.84	3.04	74.55	0.09
High–low	12.48 (616)	15.07	7.09	2.08	75.77	
Low–high	13.45 (664)	15.08	7.28	2.73	74.91	
Low–low	62.01 (3,062)	11.76	6.38	1.76	80.09	
Discrimination						
High–high	12.55 (620)	15.91	7.97	2.15	73.98	0.14
High–low	11.26 (556)	14.69	7.27	2.08	75.96	
Low–high	11.42 (564)	13.26	8.20	3.19	75.36	
Low–low	64.77 (3,199)	12.04	6.19	1.88	79.89	
Recent problems						
High–high	10.91 (539)	19,535	6.33	2.15	72.16	0.003
High–low	13.13 (648)	15.55	7.34	2.16	74.95	
Low–high	13.02 (643)	12.62	6.61	1.82	78.95	
Low–low	62.94 (3,108)	11.38	6.75	2.11	79.75	
Cumulative stress score						
High–high	12.87 (636)	18.36	7.53	2.38	71.73	<.0001
High–low	11.16 (551)	18.35	7.55	2.94	71.16	
Low–high	11.17 (551)	14.33	7.42	2.48	75.77	
Low–low	64.80 (3,200)	10.72	6.37	1.81	81.10	

High stress defined as top quartile of stress distribution. Column percents are presented for the full sample; row percents are presented for stratified sample

Table 3 Multinomial regression models: trajectory of stress in relation to smoking pattern; adjustment for age, gender, race, education, and income

	Non-smoker	Persistent smoker OR (95 % CI)	Ex-smoker OR (95 % CI)	Relapsed ex-smoker OR (95 % CI)	Wald F *p* value
Relationship stress[a]					
High–high	1.00	1.34 (1.02, 1.77)*	0.91 (0.61, 1.36)	1.47 (0.74, 2.90)	0.17
High–low	1.00	1.14 (0.85, 1.51)	0.90 (0.61, 1.32)	2.08 (1.18, 3.65)*	
Low–high	1.00	1.23 (0.95, 1.61)	0.93 (0.65, 1.34)	1.36 (0.73, 2.50)	
Low–low	1.00	1.00	1.00	1.00	
Financial stress					
High–high	1.00	1.64 (1.19, 2.25)*	1.61 (1.08, 2.40)*	1.88 (0.95, 3.71)	0.07
High–low	1.00	1.23 (0.92, 1.65)	1.05 (0.71, 1.57)	0.77 (0.35, 1.72)	
Low–high	1.00	1.28 (0.93, 1.77)	1.03 (0.62, 1.70)	1.28 (0.57, 2.89)	
Low–low	1.00	1.00	1.00	1.00	
Work stress[b]					
High–high	1.00	1.36 (1.00, 1.84)*	1.50 (1.03, 2.18)*	0.56 (0.23, 1.38)	0.22
High–low	1.00	1.28 (0.98, 1.67)	1.08 (0.74, 1.58)	0.67 (0.34, 1.33)	
Low–high	1.00	1.14 (0.86, 1.49)	1.07 (0.75, 1.52)	0.88 (0.47, 1.64)	
Low–low	1.00	1.00	1.00	1.00	
Work–family spillover[b]					
High–high	1.00	1.09 (0.81, 1.47)	1.33 (0.91, 1.93)	1.30 (0.67, 2.55)	0.76
High–low	1.00	1.01 (0.74, 1.36)	1.10 (0.76, 1.61)	1.08 (0.55, 2.13)	
Low–high	1.00	0.83 (0.63, 1.09)	0.94 (0.65, 1.36)	1.22 (0.68, 2.18)	
Low–low	1.00	1.00	1.00	1.00	
Perceived inequality[b, c]					
High–high	1.00	1.44 (1.10, 1.88)**	1.00 (0.67, 1.48)	1.38 (0.62, 3.06)	0.02
High–low	1.00	1.39 (1.06, 1.82)*	1.06 (0.73, 1.54)	2.51 (1.42, 4.44)**	
Low–high	1.00	1.13 (0.84, 1.52)	0.97 (0.66, 1.42)	2.13 (1.13, 4.01)*	
Low–low	1.00	1.00	1.00	1.00	
Neighborhood					
High–high	1.00	1.04 (0.79, 1.38)	1.10 (0.75, 1.62)	1.40 (0.74, 2.68)	0.92
High–low	1.00	1.18 (0.90, 1.55)	1.06 (0.73, 1.54)	0.97 (0.50, 1.90)	
Low–high	1.00	1.12 (0.83, 1.52)	1.06 (0.68, 1.65)	1.33 (0.69, 2.55)	
Low–low	1.00	1.00	1.00	1.00	
Discrimination					
High–high	1.00	1.29 (0.96, 1.72)	1.26 (0.86, 1.84)	1.04 (0.52, 2.06)	0.55
High–low	1.00	1.23 (0.92, 1.63)	1.16 (0.78,1.73)	1.02 (0.40, 2.58)	
Low–high	1.00	0.99 (0.74, 1.33)	1.27 (0.89, 1.82)	1.50 (0.78, 2.88)	
Low–low	1.00	1.00	1.00	1.00	
Recent problems[a, c]					
High–high	1.00	1.87 (1.42, 2.46)***	1.14 (0.77, 1.69)	1.09 (0.57, 2.09)	0.01
High–low	1.00	1.45 (1.12, 1.88)**	1.24 (0.88, 1.74)	1.10 (0.59, 2.04)	
Low–high	1.00	1.02 (0.78, 1.34)	1.01 (0.70, 1.47)	0.78 (0.39, 1.60)	
Low–low	1.00	1.00	1.00	1.00	
Cumulative stress score[a, b, c]					
High–high	1.00	1.40 (1.08, 1.81)*	1.10 (0.76, 1.61)	1.16 (0.61, 2.22)	0.22
High–low	1.00	1.52 (1.15, 2.02)**	1.11 (0.76, 1.63)	1.46 (0.80, 2.65)	

Table 3 continued

	Non-smoker	Persistent smoker OR (95 % CI)	Ex-smoker OR (95 % CI)	Relapsed ex-smoker OR (95 % CI)	Wald F p value
Low–high	1.00	1.08 (0.81, 1.45)	1.09 (0.73, 1.62)	1.12 (0.55, 2.26)	
Low–low	1.00	1.00	1.00	1.00	

* $p < .05$; ** $p < .01$; *** $p < .0001$

All models account for potential clustering among siblings and twins, and are adjusted for age (years, 4 categories: ≤34, 35–44, 45–54, 55+); gender (male, female); race/ethnicity (5-category: White, Black, Hispanic, Other); income (4 categories, ≤$25,000, $25,000–44,999, $45,000–69,999, $70,000+); education (3 categories: less than or equal to high school, some college, bachelor's degree+)

[a] Adjusted for covariates in Note 1, in addition to marital/partner status at baseline and follow-up (not married at baseline and follow-up, married at baseline and follow-up, married at baseline not at follow-up, not married at baseline married at follow-up)

[b] Adjusted for covariates in footnote a, in addition to employment at baseline and follow-up (not working at baseline and follow-up, working at baseline and follow-up, working at baseline not at follow-up, not working at baseline working at follow-up)

[c] Adjusted for covariates in Note 1, in addition to report of having any children (baseline)

and education, which suggests that chronically high psychosocial stress is associated with increased risk for persistent smoking, beyond the effect of socioeconomic status (SES).

Our results extend cross-sectional studies of psychosocial stress and smoking by longitudinally evaluating a diverse set of stressors in relation to smoking behavior in a large national cohort. Overall, the findings are consistent with the large number of cross-sectional studies showing that psychosocial stress is associated with smoking behavior [7–9] and expands on a small prospective literature showing that stressful life events [12] and work stress [13] are associated with continued smoking. Our findings are also partially consistent with a previous MIDUS study by Block and colleagues [36] which analyzed weight change between MIDUS I and MIDUS II using many of the same stressor scales included in the present study. This study found that relationship stress, family strain, and perceived constraints in life were significant predictors of weight gain among overweight and obese women, and job stress and financial strain among overweight and obese adults of either sex [36].

There were several unexpected findings that are important to acknowledge. First, persistently high financial and work stressors were also associated with greater odds of quitting smoking. This finding illustrates that quitting may occur even in the context of persistent high stress. The rising cost of cigarettes may motivate some smokers to quit when they experience financial or work stress; these findings are partially supported by a recent systematic review which concluded that price increases in tobacco may be more effective in reducing smoking among lower-income individuals and those with manual occupations compared to higher-income individuals, or those with higher occupational status [37]. Second, for several psychosocial stressors, high stress at baseline and low stress at follow-up were associated with greater odds of persistent smoking (Table 3), and unsuccessful cessation attempts (Table 4), although these associations were slightly smaller than the associations for persistently high levels of stress. These findings suggest that high stress may have a sustained influence on smoking behavior. Third, the cumulative stress score was not a better predictor of smoking behavior relative to certain individual stressor domains. This finding can be explained by the fact that some stressor domains did not even show a modest association with smoking behavior (e.g., neighborhood stress, work–family conflict). Additional research is needed in order to identify which particular domains are most important to include in a composite to predict odds of smoking persistence and relapse.

Although our study cannot establish a temporal ordering between stress and smoking at baseline, a temporal relationship between stress and persistent smoking is supported by experimental studies showing that induced stress reduces an individual's ability to resist smoking and increases smoking intensity and reward [18]. Chronically high exposure to psychosocial stress may be linked to smoking through several mechanisms. Psychosocial stress may be related to smoking behavior by its influence on self-control. Smokers who would like to quit, but are exposed to high levels of psychosocial stress, may have an insufficient capacity to control their urges to smoke [11]. Alternatively, smoking may be conceptualized as coping behavior whereby nicotine is used to self-medicate to maintain a state of internal stability (i.e., homeostasis) [38, 39]. Smokers may also underestimate their health risks with continued smoking, as previously demonstrated in the initial survey of the MIDUS cohort [40].

Smokers commonly report smoking because it helps them to regulate their mood and to mitigate negative affect when confronted with stressors [19, 41]. In contrast to both

Table 4 Odds of unsuccessful smoking cessation among smokers who attempted to quit between baseline and follow-up: adjustment for age, gender, race, education, and income ($n = 766$)

	Quit between W1 and W2 (non-smoker at W2) ($n = 334$)	Unsuccessful quit attempt between W1 and W2 ($n = 432$) OR (95 % CI)	Wald F p value
Relationship stress[a]			
High–high	1.00	2.02 (1.22, 3.35)**	0.02
High–low	1.00	1.70 (1.05, 2.75)*	
Low–high	1.00	1.48 (0.92, 2.36)	
Low–low	1.00	1.00	
Financial stress			
High–high	1.00	1.12 (0.67, 1.86)	0.72
High–low	1.00	1.12 (0.68, 1.86)	
Low–high	1.00	1.39 (0.75, 2.55)	
Low–low	1.00	1.00	
Work stress[b]			
High–high	1.00	0.83 (0.50, 1.38)	0.86
High–low	1.00	1.06 (0.67, 1.69)	
Low–high	1.00	1.02 (0.64, 1.64)	
Low–low	1.00	1.00	
Work–family spillover[b]			
High–high	1.00	0.97 (0.60, 1.56)	0.82
High–low	1.00	1.20 (0.75, 1.92)	
Low–high	1.00	0.92 (0.57, 1.48)	
Low–low	1.00	1.00	
Perceived inequality[b, c]			
High–high	1.00	1.90 (1.16, 3.12)*	0.04
High–low	1.00	1.66 (1.03, 2.68)*	
Low–high	1.00	1.30 (0.78, 2.19)	
Low–low	1.00	1.00	
Neighborhood			
High–high	1.00	1.00 (0.61, 1.62)	0.86
High–low	1.00	1.22 (0.76, 1.95)	
Low–high	1.00	1.06 (0.61, 1.86)	
Low–low	1.00	1.00	
Discrimination			
High–high	1.00	1.26 (0.79, 1.99)	0.53
High–low	1.00	1.20 (0.71, 2.03)	
Low–high	1.00	0.82 (0.50, 1.33)	
Low–low	1.00	1.00	
Recent problems[a, c]			
High–high	1.00	1.92 (1.19, 3.10)**	0.06
High–low	1.00	1.28 (0.82, 2.01)	
Low–high	1.00	0.98 (0.61, 1.57)	
Low–low	1.00		
Cumulative stress score[a, b, c]			
High–high	1.00	1.57 (0.98, 2.51)	0.10
High–low	1.00	1.61 (1.02, 2.55)*	
Low–high	1.00	1.01 (0.60, 1.70)	
Low–low	1.00	1.00	

* $p < .05$; ** $p < .01$; *** $p < .0001$

All models account for potential clustering among siblings and twins, and are adjusted for age (years, 4 categories: ≤34, 35–44, 45–54, 55+); gender (male, female); race/ethnicity (5-category: White, Black, Hispanic, Other); income (4 categories, ≤$25,000, $25,000–44,999, $45,000–69,999, $70,000+); education (3 categories: less than or equal to high school, some college, bachelor degree +)

[a] Adjusted for covariates in Note 1, in addition to marital/partner status at baseline and follow-up (not married at baseline and follow-up, married at baseline and follow-up, married at baseline not at follow-up, not married at baseline married at follow-up)

[b] Adjusted for covariates in Note 1, in addition to employment at baseline and follow-up (not working at baseline and follow-up, working at baseline and follow-up, working at baseline not at follow-up, not working at baseline working at follow-up)

[c] Adjusted for covariates in Note 1, in addition to report of having any children (baseline)

of these models, the stress induction model of smoking proposes that smoking actually causes stress and negative affect [41]. To address this possibility, we performed a sensitivity analysis to examine whether our findings were maintained following adjustment for negative affect, since negative affect could theoretically function as a mediator of the relationship between stress and smoking or a confounder of this association. While most associations were relatively unchanged in models that adjusted for negative affect, the effect estimates for chronically high relationship stress and perceived inequality and persistent smoking were attenuated and became non-significant. Thus, the observed associations between relationship stressors and perceived inequality with persistent smoking may be influenced in part by elevations in negative affect (with unknown temporality). This is consistent with findings from a 3-year randomized placebo-controlled smoking cessation trial, which found that persistent smokers had increased negative affect over the course of the study [42].

Several limitations should be considered in evaluating results of this study. First, we were unable to account for changes in smoking behavior or psychosocial stress during the period between baseline and follow-up. However, the purpose of our study was to examine the long-term relationship between exposure to psychosocial stressors at multiple time points and smoking behavior over time, which constitutes a distinctive contribution to the field.

Second, the MIDUS sample is limited to English-speaking US adults, and therefore, our conclusions cannot be generalized to non-English speakers, younger adults, or adolescents. However, previous research has demonstrated significant health benefits to quitting smoking among both younger and older individuals; thus, it is an important issue for older populations as well [43]. Third, the MIDUS interview included non-standard items for categorizing individuals as smokers or non-smokers (i.e., it does not ask respondents if they have smoked 100 cigarettes in their lifetime). However, current and ex-smokers reported the number of cigarettes smoked per day in the year that they smoked most heavily, which allowed us to check that individuals categorized as smokers or ex-smokers had smoked at least one cigarette per day during the period in their life that they smoked most heavily. Fourth, some of the psychosocial stressor domains were measured more comprehensively than others; this may have led to null findings for some stressor domains. Fifth, the stressor scales did not have pre-defined cut-off values for high versus low levels of stress; therefore, the definition of "high stress" was specific to this particular sample (as opposed to a cut-off value based on nationally representative data). Finally, our findings may have been influenced by loss to follow-up between the MIDUS I and MIDUS II surveys.

Future research can extend results from the present study in order to improve the applicability of these findings for intervention development. This area of research will benefit from greater attention to buffering factors, given that intrapersonal characteristics (e.g., personality, coping styles, behavior), interpersonal characteristics (e.g., subjective and objective measures of social support), and environmental context (e.g., availability of cigarettes, local smoking laws, and prevalence) could modify associations between certain stressors and smoking status over time. In addition, new measurement and analytic strategies are needed to facilitate incorporation of both subjective and objective measures of stressors.

In conclusion, our results suggest that attending to specific types of psychosocial stressors, particularly relationship stress, perceived inequality, and serious problems within the immediate family may be an important component of smoking cessation efforts. Along with proven strategies to promote smoking cessation including smoke-free laws, improved access to effective quitting treatments, cigarette price increases, and media campaigns [1], our findings suggest a need for research on interventions that address material and psychological resources to cope with stressors [44]. Specifically, research is need to investigate whether cessation outcomes can be improved by (a) helping individuals develop effective coping strategies to manage stress, and/or (b) helping individuals and communities to intervene and improve conditions that contribute to stress. These findings also have relevance for clinicians; patients who have experienced high levels of psychosocial stress over the long term may require more intensive interventions (that potentially include stress management and reduction strategies) in order to successfully quit smoking.

Acknowledgments The MIDUS study was supported by a grant from the National Institute on Aging (P01-AG020166) to conduct a longitudinal follow-up of the MIDUS (Midlife in the U.S.) investigation. The original study was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development. This research was also supported by a grant from National Cancer Institute (P50-CA148596) to the Harvard Lung Cancer Disparities Center. The first author is supported by a postdoctoral fellowship at the Center on the Developing Child sponsored by the Robert Wood Johnson Foundation.

Conflict of interest The authors have no financial disclosures or conflicts of interest to report.

Appendix: Components of 8 stress domains

1. **Relationship stress**
   - i. *Family strain (responses range 1–4, from "often" to "never")*
     - (a) Not including your spouse or partner, how often do members of your family make too many demands on you?
     - (b) How often do they criticize you?
     - (c) How often do they let you down when you are counting on them?
     - (d) How often do they get on your nerves?
   - ii. *Friend strain (responses range 1–4, from "often" to "never")*
     - (a) How often do your friends make too many demands on you?
     - (b) How often do they criticize you?
     - (c) How often do they let you down when you are counting on them?
     - (d) How often do they get on your nerves?
   - iii. *Marital risk scale*
     - (a) During the past year, how often have you thought your relationship might be in trouble? (responses range 1–5, from "never" "all the time")
     - (b) Realistically what do you think the chances are that you and your partner will eventually separate? (responses range 1–4, not likely at all → very likely)

(c) How much do you and your spouse or partner disagree on the following issues?

a. Money matters, such as how much to spend, save or invest?
b. Household tasks, such as what needs doing and who does it?
c. Leisure time activities, such as what to do and with whom? (responses range 1–4, from "not at all" to "a lot")

iv. *Spouse/partner strain scale (responses range 1–4, from "a lot" to "not at all")*
How much:

(a) Does your spouse/partner really care about you?
(b) Does he/she understand the way you feel about things?
(c) Does he/she appreciate you?
(d) Do you rely on him/her for help if you have a serious problem?
(e) Can you open up to him/her if you need to talk about your worries?
(f) Can you relax and be yourself around him/her?

2. **Financial stress scale**

(a) In general, would you say you (and your family living with you) have more money than you need, just enough money for your needs, or not enough money to meet your needs? (responses range 1-3, from "more $ than you need" to "not enough $")
(b) How difficult is it for you (and your family) to pay your monthly bills? (responses range 1-4, from "very difficult" to "not at all difficult")

3. **Work stress** (responses range 1-5, from "all of the time" to "never", unless otherwise noted)

i. *Skill discretion*

(a) How often do you learn new things at work?
(b) How often does your work demand a high level of skill or expertise?
(c) How often does your job provide you with a variety of things that interest you?

ii. *Decision authority*

(a) On your job, how often do you have to initiate things—such as coming up with your own ideas, or figuring out on your own what needs to be done?
(b) How often do you have a choice in deciding how you do your tasks at work?
(c) How often do you have a choice in deciding what tasks you do at work?
(d) How often do you have a say in decisions about your work?
(e) How often do you have a say in planning your work environment—that is, how your workplace is arranged or how things are organized?
(f) How often do you control the amount of time you spend on task?

iii. *Demands scale*

(a) How often do have to work very intensively—that is, you are very busy trying to get things done?
(b) How often do different people or groups at work demand things from you that you think are hard to combine?
(c) How often do you have too many demands made on you?
(d) How often do you have a lot of interruptions?

iv. *Coworker support*

(a) How often do you get help and support from your coworkers?
(b) How often are your coworkers willing to listen to your work-related problems?

v. *Supervisor support*

(a) How often do you get the information you need from your supervisor or superiors?
(b) How often do you get help and support from your immediate supervisor?
(c) How often is your immediate supervisor willing to listen to your work-related problems?

vi. *Risk of injury on the job*

(a) To what extent, over the past 10 years, have you been exposed to the risk of accidents or injuries on your job?

vii. *Job insecurity (response ranges 1–5, from "excellent" to "poor")*

(a) If you wanted to stay in your present job, what are the chances that you could keep it for the next 2 years?

4. **Work–family spillover** (responses range 1–5, from "all of the time" to "never")

i. *Negative work-to-family spillover*

(a) Your job reduces the effort you can give to activities at home.
(b) Stress at work makes you irritable at home.
(c) Your job makes you feel too tired to do the things that need attention at home.
(d) Job worries or problems distract you when you are at home.

ii. *Negative family-to-work spillover*

(a) Responsibilities at home reduce the effort you can devote to your job.
(b) Personal or family worries and problems distract you when you are at work.
(c) Activities and chores at home prevent you from getting the amount of sleep you need to do your job well.
(d) Stress at home makes you irritable at work.

5. **Perceived inequality** (responses range 1–4, from "a lot" to "not at all")

i. *Perceived inequality in family*

(a) I feel good about the opportunities I have been able to provide for my children.
(b) It seems to me that family life with my children has been more negative than most people's.
(c) Problems with my children have caused me shame and embarrassment at times.
(d) As a family, we have not had the resources to do many fun things together with the children.
(e) I believe that I have been able to do as much for my children as most other people.
(f) I feel a lot of pride about what I have been able to do for my children.

ii. *Perceived inequality in home*

(a) I live in as nice a home as most people.
(b) I am proud of my home.
(c) Most people live in a better neighborhood than I do.
(d) I don't like to invite people to my home because I do not live in a very nice place.
(e) I feel very good about my home and neighborhood.
(f) It feels helpless to try to improve my home and neighborhood situation.

iii. *Perceived inequality in work*

(a) I feel cheated about the chances I have had to work at good jobs.
(b) When I think about the work I do on my job, I feel a good deal of pride.
(c) I feel that others respect the work I do on my job.
(d) Most people have more rewarding jobs than I do.
(e) When it comes to my work life, I've had opportunities that are as good as most people's.
(f) It makes me feel discouraged that other people have much better jobs than I do.

6. **Neighborhood stress** (responses range 1–4, from "a lot" to "not at all")

(a) I feel safe being out alone in my neighborhood during the daytime.
(b) I feel safe being out alone in my neighborhood at night.
(c) I could call on a neighbor for help if I needed it.
(d) People in my neighborhood trust each other.

7. **Discrimination**

i. *Lifetime discrimination (yes/no response)*
You were:

(a) Discouraged by a teacher or advisor from seeking higher education.
(b) Denied a scholarship.
(c) Not hired for a job.
(d) Not given a promotion.
(e) Fired.
(f) Prevented from renting or buying a home in the neighborhood you wanted.
(g) Prevented from remaining in a neighborhood because neighbors made life so uncomfortable.
(h) Hassled by the police.
(i) Denied a bank loan.
(j) Denied or provided inferior service by a plumber, car mechanic, or other service provider.

ii. *Everyday discrimination (responses range 1–4, from "often" to "never")*

(a) You are treated with less courtesy than other people.
(b) You are treated with less respect than other people.
(c) You receive poorer service than other people at restaurants or stores.
(d) People act as it if they think you are not smart.
(e) People act as if they are afraid of you.
(f) People act as if they think you are dishonest.

(g) People act as if they think you are not as good as they are.
(h) You are called names or insulted.
(i) You are threatened or harassed.

8. **Past-year problems in immediate family** (asked separately for (i) spouse/partner, (ii) parents, (iii) children; yes/no responses)

(a) Chronic disease or disability?
(b) Frequent minor illness?
(c) Emotional problems (such as sadness, anxiety)?
(d) Alcohol or substance problems?
(e) Financial problems, such as low income or heavy debts?
(f) Problems at school or at work (such as failing grades, poor job performance)?
(g) Difficulty finding or keeping a job?
(h) Marital or partner relationship problems?
(i) Legal problems (such as involved in law suits, police changes, traffic violations)?
(j) Difficulty getting along with people?

References

1. CDC (2011) Vital signs: current cigarette smoking among adults aged ≥18 years—United States, 2005–2010. MMWR 60: 1207–1212
2. Orleans CT, Mabry PL, Abrams DB (2010) Increasing tobacco cessation in America a consumer demand perspective. Am J Prev Med 38(3):S303–S306. doi:10.1016/j.amepre.2010.01.013
3. Centers for Disease Control (2010) Vital signs: current cigarette smoking among adults aged ≥18 years—United States, 2009. MMWR 59(35):1135–1140
4. CDC (2011) Early release of selected estimates based on data from the 2010 National Health Interview Survey. http://www.cdc.gov/nchs/data/nhis/earlyrelease/earlyrelease201106.pdf
5. Thoits PA (2010) Stress and health: major findings and policy implications. J Health Soc Behav 51:S41–S53. doi:10.1177/0022146510383499
6. Webb MS, Carey MP (2008) Tobacco smoking among low-income black women: demographic and psychosocial correlates in a community sample. Nicotine Tob Res 10(1):219–229. doi:10.1080/14622200701767845
7. Stein RJ, Pyle SA, Haddock CK, Poston WSC, Bray R, Williams J (2008) Reported stress and its relationship to tobacco use among US military personnel. Milit Med 173(3):271–277
8. Berg CJ, Thomas JL, Guo HF, An LC, Okuyemi KS, Collins TC, Ahluwalia JS (2010) Predictors of smoking reduction among blacks. Nicotine Tob Res 12(4):423–431. doi:10.1093/ntr/ntq019
9. Slopen N, Dutra LM, Williams DR, Mujahid MS, Lewis TT, Bennett GG, Ryff CD, Albert MA (2012) Psychosocial stressors and cigarette smoking among African American adults in midlife. Nicotine Tob Res. doi:10.1093/ntr/nts011
10. Koob GF, Nestler EJ (1997) The neurobiology of drug addiction. J Neuropsychiatr Clin Neurosci 9(3):482–497
11. Muraven M, Baumeister RF (2000) Self-regulation and depletion of limited resources: does self-control resemble a muscle? Psychol Bull 126(2):247–259
12. McKee SA, Maciejewski PK, Falba T, Mazure CM (2003) Sex differences in the effects of stressful life events on changes in smoking status. Addiction 98(6):847–855
13. Ayyagari P, Sindelar JL (2010) The impact of job stress on smoking and quitting: evidence from the HRS. B E J Econ Anal Policy 10(1):27
14. Siahpush M, Carlin J (2006) Financial stress, smoking cessation and relapse: results from a prospective study of an Australian national sample. Addiction 101:121–127
15. Turner RJ, Wheaton B, Lloyd DA (1995) The epidemiology of social stress. Am Sociol Rev 60(1):104–125
16. Niaura R, Shadel WG, Britt DM, Abrams DB (2002) Response to social stress, urge to smoke, and smoking cessation. Addict Behav 27(2):241–250
17. Childs E, de Wit H (2010) Effects of acute psychosocial stress on cigarette craving and smoking. Nicotine Tob Res 12(4):449–453. doi:10.1093/ntr/ntq061
18. McKee SA, Sinha R, Weinberger AH, Sofuoglu M, Harrison ELR, Lavery M, Wanzer J (2011) Stress decreases the ability to resist smoking and potentiates smoking intensity and reward. J Psychopharmacol 25(4):490–502. doi:10.1177/0269881110376694
19. Kassel JD, Stroud LR, Paronis CA (2003) Smoking, stress, and negative affect: correlation, causation, and context across stages of smoking. Psychol Bull 129(2):270–304. doi:10.1037/0033-2909.129.2.270
20. Khantzian EJ (1997) The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. Harv Rev Psychiatry 4(5):231–244. doi:10.3109/10673229709030550
21. Wills TA, Shiffman S (1985) Coping and substance use: a conceptual framework. In: Shiffman S, Wills TA (eds) Coping and substance use. Academic Press, New York, pp 3–24
22. Parrott AC (1994) Individual differences in stress and arousal during cigarette smoking. Psychopharmacology 115(3):389–396. doi:10.1007/bf02245082
23. Brim OG, Ryff CD, Kessler RC (eds) (2004) How healthy are we? A National study of well-being at midlife. University of Chicago Press, Chicago
24. Radler BT, Ryff CD (2010) Who participates? Accounting for longitudinal retention in the MIDUS National Study of health and well-being. J Aging Health 22(3):307–331
25. Walen HR, Lachman ME (2000) Social support and strain from partner, family, and friends: costs and benefits for men and women in adulthood. J Soc Pers Relatsh 17(1):5–30. doi:10.1177/0265407500171001
26. Karasek R (1985) Job content questionnaire and user's guide. University of Massachusetts, Lowell
27. Grzywacz JG (2000) Work-family spillover and health during midlife: is managing conflict everything? Am J Health Promot 14(4):236–243. doi:10.4278/0890-1171-14.4.236
28. Ryff CD, Magee WJ, Kling KC, Wing EH (1999) Forging macro-micro linkages in the study of psychological well-being. In: Ryff CD, Marshall VW (eds) The self and society in aging processes. Springer, New York, pp 247–278
29. Keyes CLM (1998) Social well-being. Soc Psychol Q 61(2):121–140. doi:10.2307/2787065
30. Kessler RC, Mickelson KD, Williams DR (1999) The prevalence, distribution, and mental health correlates of perceived discrimination in the United States. J Health Soc Behav 40(3):208–230
31. Lantz PM, House JS, Mero RP, Williams DR (2005) Stress, life events, and socioeconomic disparities in health: results from the Americans' changing lives study. J Health Soc Behav 46(3):274–288
32. Slopen N, Lewis TT, Gruenewald TL, Mujahid MS, Ryff CD, Albert MA, Williams DR (2010) Early life adversity and inflammation in African Americans and whites in the midlife in

the United States survey. Psychosom Med 72(7):694–701. doi:10.1097/PSY.0b013e3181e9c16f
33. Mroczek DK, Kolarz CM (1998) The effect of age on positive and negative affect: a developmental perspective on happiness. J Pers Soc Psychol 75(5):1333–1349
34. Raghunathan TE, Lepkowski JM, Van Hoewyk J, Solenberger P (2001) A multivariate technique for multiply imputing missing values using a sequence of regression models. Surv Methodol 27(1):85–95
35. Raghunathan TE, Van Hoewyk J, Solenberger P (2002) IVEware: imputation and variance estimation software user guide. University of Michigan, Ann Arbor, MI
36. Block JP, He YL, Zaslavsky AM, Ding L, Ayanian JZ (2009) Psychosocial stress and change in weight among US adults. Am J Epidemiol 170(2):181–192. doi:10.1093/aje/kwp104
37. Thomas S, Fayter D, Misso K, Ogilvie D, Petticrew M, Sowden A, Whitehead M, Worthy G (2008) Population tobacco control interventions and their effects on social inequalities in smoking: systematic review. Tob Control 17(4). doi:10.1136/tc.2007.023911
38. Sinha R (2008) Chronic stress, drug use, and vulnerability to addiction. In: Addiction reviews 2008, vol 1141. Annals of the New York Academy of Sciences. Blackwell Publishing, Oxford, pp 105–130. doi:10.1196/annals.1441.030
39. Sinha R (2001) How does stress increase risk of drug abuse and relapse? Psychopharmacology 158(4):343–359. doi:10.1007/s002130100917
40. Ayanian JZ, Cleary PD (1999) Perceived risks of heart disease and cancer among cigarette smokers. JAMA 281(11):1019–1021. doi:10.1001/jama.281.11.1019
41. Aronson KR, Almeida DM, Stawski RS, Klein LC, Kozlowski LT (2008) Smoking is associated with worse mood on stressful days: results from a national diary study. Ann Behav Med 36(3):259–269. doi:10.1007/s12160-008-9068-1
42. Piper M, Kenford S, Fiore M, Baker T (2011) Smoking cessation and quality of life: changes in life satisfaction over 3 years following a quit attempt. Ann Behav Med 1–9. doi:10.1007/s12160-011-9329-2
43. Taylor DH, Hasselblad V, Henley SJ, Thun MJ, Sloan FA (2002) Benefits of smoking cessation for longevity. Am J Public Health 92(6):990–996
44. Davis J, Fleming M, Bonus K, Baker T (2007) A pilot study on mindfulness based stress reduction for smokers. BMC Complement Altern Med 7(1):2