Smoking cessation processes in low-SES women: The impact of time-varying pregnancy status, health care messages, stress, and health concerns

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Abstract

We tracked smoking outcomes – quitting, stage of readiness, action, motivation, self-efficacy, and confidence – over time among 943 low-SES women smokers accrued in an earlier smoking cessation intervention trial conducted in public health clinics. We assessed outcomes at 2, 6, 12 and 18 months post-initial clinic visit. Controlling for baseline characteristics and earlier program participation, we used hierarchical linear modeling to assess how intervening life events – pregnancy and exposure to subsequent clinic smoking interventions – affected smoking outcomes directly and indirectly, through the mediators, perceived stress and health concerns.

Results: All longitudinal smoking outcomes were positively related to health concerns and negatively related to perceived stress. Pregnancy favorably influenced all smoking outcomes but confidence, but exposure to additional interventions affected only motivation. Health concerns and stress partially mediated the positive impact of pregnancy.

Conclusion: Public health efforts targeted to low-SES women smokers should continue to emphasize the benefits of quitting smoking for health maintenance and incorporate more effective stress-coping mechanisms. Pregnancy increases abstinence, but preventing post-delivery relapse may require stress management and re-focusing of health concerns.

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1. Introduction

Reducing or eliminating cigarette smoking among women of childbearing age and low socioeconomic status (SES) remains an important goal for maternal and child health (Department of Health and Human Services (DHHS), 2001; Fiore et al., 2000; Morbidity and Mortality Weekly Reports (MMWR), 2004). Smoking prevalence rates among these women are higher than those among women of higher SES and do not reflect the overall decline that has occurred for the general population (DHHS, 2001). Reducing smoking in this target population will require intervention aimed at improving readiness to quit among all smokers in addition to helping smokers who are ready to quit (Glynn, Boyd, & Gruman, 1990). Limited information is currently available about the longitudinal processes that lead to quitting smoking in this population subgroup, and even less is known about the factors that may precipitate or influence changes in readiness to quit.

In this paper, we track smoking outcome changes over 18 months in a panel of 943 low socioeconomic status (SES) women smokers. The smoking outcomes are abstinence, stage of readiness to attempt cessation, motivation to quit, action toward quitting, self-efficacy to avoid smoking in high risk situations, and confidence in one's ability to quit. We assess how the trajectories of these outcomes over time are affected by a) baseline demographic and other individual characteristics, including participation in the intervention, and b) time-varying pregnancy status, recent exposure to usual health care quit smoking messages, daily stress level, and health concerns.

1.1. Our previous research with the study panel

The panel consists of women who had participated in an earlier study to evaluate a smoking cessation program in maternal and child care services in 12 Chicago area public health clinics. Detailed findings from that research are reported elsewhere (Manfredi, Crittenden, Cho, Engler, & Warnecke, 2000a; Manfredi, Crittenden, Cho, Engler, & Warnecke, 2000b; Manfredi, Crittenden, Cho, & Gao, 2004). Briefly, we found that minimal smoking interventions already existing in the clinics during the one-year period preceding experimental program implementation enhanced the motivation and readiness of women smokers to quit and increased their number of actions toward quitting (Manfredi et al., 2000a). Taking these existing interventions into account, the coordinated experimental program—offered during the one visit in which women in the intervention condition were accrued to the study — had beneficial effects on motivation and stage of readiness to quit, actions toward quitting, and the likelihood of quitting (Manfredi et al., 2000b). Longitudinal follow-up of the smokers indicated that smoking outcomes tended to improve over time for both experimental and control groups, but that exposure to the one-time, experimental brief intervention was sufficient to enhance abstinence up to six months, and to sustain improvement in action toward quitting and motivation and readiness to quit up to 18 months (Manfredi et al., 2004). Finally, among the relatively homogeneous population of women served in the public health clinics, demographic factors had little power to predict smoking outcomes (Manfredi et al., 2004). Favorable outcomes over time were diminished by years of smoking but enhanced by initial level of readiness to quit (Manfredi et al., 2004).

1.2. Current study aims

Unlike our previous research that focused on program evaluation, this paper is concerned with the effects of naturally occurring events in the life of a woman smoker on her smoking behavior. The paper

addresses the following research questions: 1) Controlling for background variables, intervention exposure and a smoker's initial levels of addiction and readiness to quit, what is the impact of intervening events in the smoker's life – namely pregnancy and further exposure to messages from health care providers during additional clinic visits – on her smoking outcomes over time? 2) To what extent are the effects of these events on outcomes mediated by health concerns and perceived stress?

2. Background

2.1. Multiple aspects of readiness to quit smoking

The above-mentioned smoking outcomes reflect elements common across multiple health behavior theories. Prochaska and DiClemente's *stages of change* (or transtheoretical) model (DiClemente et al., 1991; Prochaska, DiClemente, & Norcross, 1992; Prochaska, Redding, & Evers, 2002) has been particularly influential for explaining smoking cessation. The model has three main elements: a) the stages of readiness, b) multi-theoretical concepts of decisional balances and self-efficacy, and c) processes of change (Prochaska et al., 2002). According to the model, smokers can be found at any of five stages in a process that goes from not having any thought about cessation to final cessation and its maintenance. In the precontemplation stage there is no thought, plan or desire to quit or change. In the contemplation stage the smoker becomes aware that a problem exists and begins thinking about overcoming it. In the preparation for action stage, serious thoughts are given as to how to translate intention to quit into action, and motivation to quit may be high. The action stage begins when the smoker actually implements the plans by quitting. Quitting can be followed by either relapse or maintenance of abstinence.

Stage of readiness indicates where a smoker is situated in the process of change. However, any given stage of change involves cognitive states addressed by many theories of health behavior (hence the 'transtheoretical' label), including motivational dimensions based on decisional processes involving perceived benefits and costs of change and self-efficacy (Noar & Zimmerman, 2005). The stages of change model postulates that the content, intensity, and relevance of these other elements vary depending on stage. Finally, Prochaska et al. define processes of change as the 'covert and overt activities that people use to progress through the stages' (Prochaska et al., 2002, p. 103).

Empirically, the stage of readiness to quit variable is a measure composed of plans to quit and a recent quit attempt. In order to apply the above-mentioned more complex concepts of readiness to quit in our past research with interventions for low-SES women, we developed additional measures that a) would capture other dimensions besides plans and recent attempts to quit, and b) were sufficiently simple to be suitable for survey methods and for respondents with low education and limited interest in the survey topic. We focused on the factors that emerged from the theoretical background as directly implicated in the smoking cessation process. The resulting measures were the scales of motivation to quit, confidence in one's ability to quit, situational self-efficacy, and action toward quitting (Crittenden, Manfredi, Lacey, Warnecke, & Parsons, 1994; Crittenden, Manfredi, Warnecke, Cho, & Parsons, 1998). We also use these smoking outcomes in the present study.

Motivation is considered essential for movement forward in the process of change toward health behavior (Bandura, 1989; Becker, 1974) and motivation to quit smoking is a predictor of quitting (Curry, Grothaus, & McBride, 1997; Curry, McBride, Grothaus, Lando, & Pirie, 2001). Despite motivation, failure can occur in the absence of confidence in one's ability to engage in the specific behaviors

necessary to achieve the goal. *Confidence* reflects self-assessment of readiness to quit and of having sufficient skills to make quitting a realistic goal. Moreover, smokers often recognize specific situations in which it is difficult for them not to smoke, such as when angry or while under pressure. *Self-efficacy* refers to the assessment of one's ability to resist these situation-specific temptations to smoke. *Action* is an important predictor of future action. In a dynamic process over time, intermediate actions toward quitting are likely to occur as precursors to actual quitting. Actions may involve setting and achieving small goals, such as cutting down one's daily cigarette consumption or being able to abstain in given situations. For some smokers, these intermediate actions may have an important function in building the skills and confidence necessary to eventually quit (Crittenden et al., 1994, 1998). Conversely, failed attempted actions may result in reduced confidence and self-efficacy, which may in turn reduce motivation and readiness to quit smoking.

2.2. Time-varying factors

Prochaska and DiClemente's discussion of the processes of change implies that the various facets of readiness change over time and the change can often be precipitated by intervening events and accompanied by changes in cognitive states. The data available to this study at four points in time included two events that are particularly relevant to smoking cessation processes in reproductive age women – pregnancy and exposure to quit smoking messages in the course of intervening medical visits – and two cognitive factors that have been often associated with quitting-health concerns and stress.

As indicated later in the sample description, about a fifth of the women in the study panel were pregnant at baseline, and their pregnancy status obviously changed over the 18-month study period. Several women also became newly pregnant in the course of the study. Pregnancy is known to promote abstinence from smoking, with about 40% of women smokers quitting at some point during their pregnancies. However, most of those who quit relapse before or shortly after delivery or within one year of delivery (Adams et al., 1992; Fingerhut, Kleinmen, & Kendrick, 1990; O'Campo, Faden, Brown, & Gielen, 1992). Low-SES decreases the likelihood of a woman quitting while pregnant, but does not affect the rate of relapse (Adams et al., 1992).

Regardless of pregnancy, many of the study women had at least one clinic visit between measurement points. Given the nature of the clinics, most of these visits were for family planning, pregnancy and postpartum care, or pediatric care. During such visits, many women were exposed to at least minimal smoking cessation messages or interventions that could potentially affect their quitting behavior (Manfredi et al., 2000a). There is considerable evidence that exposure to smoking cessation interventions in health care settings increases motivation to quit and abstinence from smoking (DHHS, 2001; Fiore et al., 2000; Manfredi et al., 2000a), especially for interventions received in the context of pregnancy (Dolan-Mullen, Ramirez, & Groff, 1994).

Minimal smoking cessation messages received in the context of health care visits usually focus on the health risks of smoking and health benefits of quitting. Health concerns are an important element of motivation to quit smoking (Curry et al., 1997, 2001). The long-standing *health beliefs model* (Rosenstock, 1974) assumes that motivation to adopt a protective behavior is a direct outcome of awareness that there is a serious health risk, perceived vulnerability to the risk, and belief that action is possible to reduce the risk. Although elaborations of the model recognize that contextual factors and perceptions of costs and benefits include issues beyond health (Janz, Champion, & Strecher, 2002; Weinstein, 1993), health concerns remain at the core of the model as necessary to generate the emotional

tension that motivates considering action (Rosenstock, 1974). However, health concerns need not include correct risk knowledge and perceived severity or susceptibility to specific disease as postulated in the health beliefs model. Generalized concerns about staying healthy and fit may be just as motivating (Manfredi, Lacey, Warnecke, & Balch, 1997). Having small children and pregnancy are likely to be associated with greater health concerns regarding the health of the children or the unborn child and greater exposure to health care smoking cessation messages.

The relationship of smoking and stress has received much attention in the literature. Briefly, psychological theories assume two modes of response to stress: controlling the sources of stress or, when that is not feasible, controlling the negative emotions associated with stress (DiClemente & Prochaska, 1985; DiClemente et al., 1991). Cigarette smoking is then used or perceived to be useful as a means to help controlling these negative emotions (Bullock, Mears, Woodcock, & Record, 2001; Kassel, Stroud, & Paronis, 2003; Lacey et al., 1993; Todd, 2004). This process may be reinforced by actual physiological and psychological effects of smoking (DHHS, 2001), although recent studies have questioned the evidence for the association between a stressful event and an immediate urge to smoke (Kassel et al., 2003; Niaura, Shadel, Britt, & Abrams, 2002; Shiffman & Waters, 2004). Physiological addiction may increase stress when trying to quit by causing more severe withdrawal symptoms, increasing the likelihood of failed attempts, and consequently decreasing self-confidence after failures (Fiore et al., 2000; Rose, Chassin, Presson, & Sherman, 1996).

Stress is assumed to be an especially important barrier to quitting in low-SES individuals. Compared with more advantaged individuals, they tend to experience greater and more severe daily stressors and to have fewer material resources and less social power to actively control the sources of stress (Gottlieb & Green, 1987; Romano, Bloom, & Syme, 1991; Turner & Avison, 2003). Thus, individuals with lower SES may more often resort to the alternative coping mechanism of controlling the negative emotions triggered by the stressful events. The real or perceived utility that smoking has in controlling negative affects is likely to act as a barrier to quitting smoking, by dampening motivation, increasing temptations to quit, and decreasing confidence in the ability to quit.

Other studies have also addressed the relationships of stress and smoking with pregnancy, marital status, and living with children. Continuing to smoke during pregnancy is associated with a higher level of stress (Ludman et al., 2000). Being married generally facilitates successful smoking cessation in pregnant women (DHHS, 2001; McBride, Pirie, & Curry, 1992), but cessation may be hampered if being married is accompanied by stressful financial and emotional concerns (Bullock et al., 2001). Negative affect smoking has been attributed to the presence of children in conjunction with poverty (Chapman-Walsh, Sorensen, & Leonard, 1995; Ludman et al., 2000), but one study found that this was the case only for poor White women (Jun, Subramarian, Gortmaker, & Kawachi, 2004).

2.3. Hypotheses

Based on the background we have reviewed, we offer five hypotheses concerning the effects of time-varying events and conditions on smoking outcomes over time: 1) A woman will have more positive smoking outcomes when she is pregnant. 2) Smoking outcomes will be enhanced by recent exposure to smoking intervention messages in the course of clinic visits. 3) Health concerns will enhance smoking outcomes. 4) Greater perceived stress will be associated with poorer smoking outcomes. 5) To some extent, the effects of pregnancy and exposure to smoking intervention messages will be indirect, mediated by their effects on perceived stress and health concerns.

3. Study methods

3.1. Subjects

Research staff identified and recruited women smokers between November 1994 and July 1996 in prenatal, family planning, and pediatric services in 12 public health clinics in Chicago and two suburbs. Recruited smokers were interviewed by telephone 2, 6, 12 and 18 months later by the Survey Research Laboratory, University of Illinois at Chicago. Eligible for our analysis were the 1064 women who completed the 2-month follow-up interview in the evaluation study. Our multilevel analysis scheme maximizes statistical power by incorporating all available information from respondents who may be missing some waves of data. The longitudinal models presented in this paper are based on the 943 smokers who completed at least the 2-month interview and who had no missing data on relevant baseline measures. Of these, 71%, 57%, and 44% completed the 6-, 12-, and the 18-month interviews, respectively. Respondents had a mean of 2.7 waves of data (S.D. = 1.2), with 36% completing all four interviews, 21% with three, 21% with two, and 22% with one.

Of the women smokers in the study sample, 19% were recruited to the study in prenatal clinics, 33% in family planning clinics, and 48% in well-child clinics. The majority (78%) were African American. Their mean age was 29 years (range 18–45, mean 29 years, S.D. = 6.7) and 37% had more than high school education. They had an average of 2.1 children, 73% were single mothers, and 13% were married. Twenty-two percent worked full time. On average at baseline they had smoked 12 years, they smoked 11 cigarettes a day, they smoked in three high-risk, negative-emotion situations (out of four possible), and they waited 30 min to an hour before smoking in the morning. About 60% lived with other smokers in the household.

3.2. Study variables

3.2.1. Baseline variables

Individual demographic and other background characteristics included *age* (range 18–45), race (African American versus other), *education level* (less than high school, high school, more than high school); *employment* (full time versus part-time or not employed), *single-mother* (yes–no). Age and race were later excluded in the data analyses because age was highly correlated with years of smoking and race was not a significant predictor in any of the models. Six variables measured smoking-related factors, including *presence of other smokers in the household* (yes–no), *perceived enjoyment of smoking* (on a 4-point scale), *smoking in negative emotion situations* (the count of whether the subject reported smoking (yes–no) when upset, when angry, when having an argument, and under pressure), and *three addiction measures*: number of cigarettes smoked daily, years smoked, and how long after waking up the first cigarette is smoked. Kuder–Richardson reliability for smoking in negative-affect situations in our sample is .72.

As mentioned, the study data were collected in a previously-described program evaluation study. To control for exposure to the experimental program in the accrual clinic visit, a variable '*study group*' was the study condition (control or intervention) to which a woman had been assigned in the earlier study. Baseline measures included the initial scores on the action, motivation, confidence, and stage of readiness scales discussed below. *Motivation* and *confidence* were measured with the same scales at all measurement points, including baseline. *Action at baseline* had values of 0 to 3, calculated as the count of three possible actions in the previous year (quit for at least 24 h, tried to quit, cut down). *Stage of readiness at baseline*

was defined as described below, except that it did not include the abstinence stage because all subjects were smokers at baseline. Stage at baseline had a range from 0 to 5.

3.2.2. Time-varying variables

Smoking cessation outcomes were measured at 2, 6, 12, and 18 months. *Abstinence* was whether a subject reported being abstinent (no cigarettes in the prior 7 days) at that measurement point. *Motivation to quit* was a sum of three four-point items reflecting desire and determination to cut down and desire to quit smoking. *Confidence* was a 7-point scale constructed from the sum of two questions assessing the woman's confidence in her ability to cut down and abstain from smoking. *Situational self-efficacy* was a 4-point scale constructed from the mean of four questions that measured how confident respondents were in being able to avoid smoking when upset, when angry, when having an argument, and under pressure (each answered from 1 not at all confident to 4 very confident). *Action toward quitting* was a five-point scale. Subjects who reported abstinence were coded 4 (sustained quit) if they had also been abstinent at the previous study wave or 3 (quit now) if they had not. Respondents who were still smokers were coded 2 (24-hour quit attempt) if they had been able to stay quit for at least 24 h since the last wave. Otherwise, they were coded 1 if they had cut down their smoking or tried to quit since then, or 0 if they reported neither action. *Stage of readiness to quit*, an extension by Crittenden et al. (Crittenden et al., 1994, 1998) of Prochaska and DiClemente's stage measure (DiClemente et al., 1991; Prochaska et al., 1992), had the following categories: 1) planning no change in smoking ever; 2) seriously thinking of cutting down but not quitting; 3) seriously thinking of quitting but not within the next 6 months; 4) contemplating quitting within the next 6 months; 5) preparing for quitting; and 6) action (abstinent). The stage, motivation, confidence, and action scales have adequate reliability and validity, as described previously (Crittenden et al., 1994, 1998; Morera et al., 1998). Alpha reliability for the self-efficacy scale is .87.

Time-varying events were pregnancy status and exposure to health care interventions. At each measurement point, women were asked whether they were *currently pregnant* (yes–no) and whether they had visited the public health clinics for their own health or the health of their children. Women who had one or more health care visits were asked whether they had received advice from the health care provider, watched a video, seen posters, or received a booklet about quitting smoking, each coded yes or no. At each measurement point, *exposure to interventions* was the count of yes responses (range 0 to 4).

Time-varying mediating variables were stress and health concerns. *Stress* was measured with two items from the four-item Perceived Stress Scale (PSS-4) (Cohen & Williamson, 1988). The scale constructed with these two items (confidence in being able to handle personal problems and feeling that 'things are going my way' in the previous 30 days) had the highest reliability (.60) in the study population. *Health concerns* was constructed from responses to two 4-point scales about how much the subject was concerned about the effect of smoking on a) her own health, and b) the health of others close to her. Due to the highly skewed distribution of responses, each item was coded 1 if the subject answered 'very concerned' and 0 for any lower health concern level. The health concern scale was a count of 'very concerned' responses, with a range of 0 to 2.

3.3. Data analyses

3.3.1. Preliminary analysis for attrition bias

Attrition bias is a potential alternative explanation for effects we find in the analyses. Therefore, we conducted a preliminary analysis to evaluate this confounding factor, using multiple regression to predict

a respondent's number of measured waves in the panel on the basis of study group and the following baseline characteristics: race, education, single parenthood, full-time employment, other smokers in the household, and years of smoking (a proxy for age). Participation in the panel was greater for women who had been in the control condition of the earlier study, with more education, and who had been smoking longer. Race, full-time employment, single motherhood, and the presence of other smokers in the home were unrelated to panel retention. To assess any bias related to panel attrition, we used multiple logistic regression. Specifically, we predicted a respondent's presence in the panel at 18 months on the basis of her characteristics measured at baseline. These included age, race, and education, years of smoking, average number of cigarettes smoked daily, the action, stage of readiness, and motivation scales, the service she visited, and the clinic study group assignment. Likelihood of continuation in the panel was higher for women with more than a high school education, who had been smoking longer, and who had taken more actions toward quitting before their baseline visit. Study condition and the remaining initial characteristics were unrelated to panel attrition. Based on the results of this preliminary analysis (not shown), we controlled for education, years of smoking, daily number of cigarettes, and study group in all longitudinal models of smoking outcomes over time. Inclusion of these controls should diminish the potential influence of attrition bias on the generalizability of our findings.

3.3.2. Longitudinal data analyses

As previously reported, demographic factors had little predictive power in this relatively homogeneous panel, but outcomes over time were diminished by a woman's years of smoking and enhanced by her initial level of readiness to quit and by participation in the intervention. Controlling for these factors, we used hierarchical linear modeling to assess how a woman's outcomes are affected by intervening events – pregnancy and exposure to additional smoking cessation interventions – in her life. We assessed the direct effects of these events on smoking outcomes, as well as indirect effects through two mediating variables — perceived stress and health concerns.

To answer the two research questions, we used HLM (Raudenbush, Bryk, Cheong, & Congdon, 2000) to estimate two-level hierarchical linear models. These multi-level, restricted maximum likelihood models allowed us to take into account the lack of independence among the repeated observations of each person in our longitudinal study by specifying both within-subjects and between-subjects equations. We conceptualized the hierarchical structure of the data as repeated measures over time, nested within individuals. Level 1 in the analysis refers to the repeated measures of outcome variables, intervening events, and mediators at four different time points. Time was also included at this level in months from the baseline at each observation, centered at the first follow-up assessment 2 months after the initial clinic visit. Because abstinence is a binary outcome, the first-level equations for this variable used a logit link function to estimate the log-odds of abstinence. Stage of readiness to quit was treated as both ordinal and interval in the models, with nearly identical results. We report here only the models in which stage was assumed to be an interval variable. Level 2 data are baseline characteristics of persons — demographics, smoking history, initial measures of smoking outcomes, and study group assignment. Before adding these predictors at each level, we first specified unconditional models in order to test variability in average outcomes at 2 months and rate of change over time for each outcome, within and between individuals and clinics. We estimated models for the mediators – health concerns and perceived stress – using baseline characteristics, study group assignment, and time-varying events as predictors. For each smoking outcome, we estimated two models. The first predicts the outcome on the basis of baseline characteristics, study group assignment, time, and intervening events. The second adds the two mediating variables as predictors.

4. Results

4.1. Study sample characteristics

Table 1 summarizes the study sample characteristics described in Section 3.1 above and shows the mean scores, ranges, and standard deviations on the scales measuring pre-intervention action, motivation, and stage of readiness to quit smoking. It also presents univariate summary statistics for each time-varying, level-1 variable.

4.2. Predictors of health concerns and perceived stress

Table 2 shows the models for predicting the effects of time-varying events – pregnancy and exposure to smoking intervention messages – on the two mediators — health concerns and perceived stress — controlling for baseline characteristics, study group, and time. In these models, number of exposures did not predict either health concerns or perceived stress. However, pregnancy increased a woman's health concerns and decreased her level of perceived stress.

Table 1
Descriptive statistics for variables in the analysis

Level 1 Variables (2556 observations)	Mean	S.D.	Range
Time (centered at 2M)	5.70	5.80	0 – 16
Exposure to health messages	1.44	1.38	0 – 4
Action	1.92	1.51	0 – 5
Abstinence (Abstinent=1)	0.15	0.36	0 – 1
Motivation	10.02	2.56	3 – 12
Confidence	5.80	1.86	2 – 8
Self-efficacy in high-risk situations	2.60	0.99	1 – 4
Health concerns	1.56	0.68	0 – 2
Stage	3.87	1.48	1 – 7
Perceived Stress	2.22	0.97	1 – 5
Pregnancy (pregnant=1)	0.10	0.29	0 – 1
Level 2 Variables (N=946)			
Action at baseline	1.73	0.99	0 – 3
Stage at baseline	3.59	1.24	1 – 5
Motivation at baseline	9.49	2.72	3 – 12
Confidence at baseline	5.81	1.87	2 – 8
Study Group (intervention=1)	0.48	0.50	0 – 1
Education	2.23	0.68	1 – 3
Other smokers in house (yes=1)	0.59	0.49	0 – 1
Number of cig smoked daily	10.97	7.28	1 – 50
Years smoked	11.93	6.98	0 – 35
How long after waking 'til smoked	1.85	0.85	1 – 3
Enjoy smoking	2.74	0.87	1 – 4
Work full-time (yes=1)	0.22	0.42	0 – 1
Single mother (yes=1)	0.73	0.45	0 – 1
Smoke in neg. emotion situations	3.00	1.22	0 – 4

Table 2
Hierarchical linear models of repeated measures of mediators: health concerns and perceived stress

Fixed effect	Health concerns		Perceived stress	
	Coefficient (S.E.)	*t*-ratio	Coefficient (S.E.)	*t*-ratio
Model for intercept (status at 2M)				
Intercept	.78 (.14)	5.33**	3.04 (.21)	14.41**
Action at baseline	.01 (.02)	.49	−.02 (.03)	−.84
Stage at baseline	−.02 (.02)	−1.03	.01 (.03)	.34
Motivation at baseline	.10 (.01)	10.35**	−.01 (.01)	−1.01
Confidence at baseline	−.00 (.01)	−.57	−.05 (.01)	−3.24**
Study group (intervention)	.11 (.03)	3.10**	−.09 (.05)	−1.82†
Education	−.04 (.02)	−1.78†	−.10 (.04)	−2.67**
Other smokers in house	−.02 (.03)	−.63	−.05 (.05)	−1.09
Number of cig smoked daily	−.00 (.00)	−.92	−.01 (.00)	−1.73†
Years smoked	−.00 (.00)	−2.38*	−.01 (.00)	−1.78†
How long after waking 'til smoked	.03 (.02)	1.29	−.04 (.03)	−1.13
Enjoy smoking	−.05 (.02)	−2.55*	−.05 (.03)	−1.75†
Work full-time	−.09 (.04)	−2.25*	−.00 (.06)	−.08
Single mother	.14 (.04)	3.89**	.10 (.05)	1.91†
Smoke in neg. emotion situations	.02 (.01)	1.35	.07 (.02)	3.37**
Model for time				
Intercept	.00 (.00)	1.22	−.00 (.00)	−1.31
Model for other time-varying covariates-events				
Number of exposures	.01 (.01)	.69	.00 (.02)	.16
Pregnant	.11 (.04)	2.70**	−.13 (.05)	−2.02*
Random effects	Variance component (*df*)	χ^2	Variance component (*df*)	χ^2
Level 2 variance (respondents)				
Status at 2M	.39 (931)	2562.61**	.26 (931)	1928.04**
Level 1 variance	.48		.65	

Non-directional *p* values: †*p*<.10; *p<.05; **p<.01.

The associations of baseline measures with time-varying health concerns indicate that higher health concerns over time were positively associated with baseline motivation, with exposure to the earlier experimental intervention, and with being a single mother, and negatively associated with years smoked, enjoying smoking, and full-time employment. Perceived stress over time was associated with baseline lower education, lower confidence in one's ability to quit, and smoking to control negative emotions.

As we described earlier (Section 1.1), our previous work had indicated that smoking outcomes tended to improve over time and to continue to show an effect of exposure to the experimental intervention. A similar time trend for smoking outcomes is indicated in all the longitudinal results presented below. In contrast, neither health concerns nor perceived stress showed any linear trend with time.

4.3. Effects of baseline factors on time-varying smoking cessation outcomes

Tables 3, 4 and 5 show the models for predicting the effects of time-varying pregnancy and exposure to interventions on each outcome, controlling for baseline characteristics, study group assignment, and time. The results in these tables (Fixed effect, model for the intercept) show that

Table 3
Hierarchical logistic and linear models of repeated measures of smoking cessation outcomes: abstinence and action

Fixed Effect	Abstinence-Model I		Abstinence-Model II		Action-Model I		Action-Model II	
	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio
Model for intercept (status at 2M)								
Intercept	−2.78 (.70)	−3.97**	−2.53 (.75)	−3.35**	.48 (.32)	1.49	.52 (.33)	1.58
Action at baseline	−.10 (.08)	−1.15	−.10 (.09)	−1.15	.12 (.04)	2.85**	.11 (.04)	2.78**
Stage at baseline	.23 (.10)	2.44*	.27 (.10)	2.75**	.12 (.04)	2.68**	.13 (.04)	2.90**
Motivation at baseline	.02 (.04)	.53	−.03 (.05)	−.62	.08 (.02)	3.95**	.05 (.02)	2.52*
Confidence at baseline	.15 (.05)	3.17**	.15 (.05)	3.02**	.06 (.02)	2.57**	.05 (.02)	2.51*
Study group (intervention)	.83 (.21)	4.01**	.77 (.21)	3.64**	.46 (.09)	5.34**	.42 (.08)	4.92**
Education	−.00 (.12)	−.04	−.00 (.12)	−.03	−.05 (.06)	−.97	−.05 (.06)	−.90
Other smokers in house	−.44 (.16)	−2.75**	−.48 (.16)	−2.95**	−.12 (.08)	−1.53	−.12 (.08)	−1.54
Number of cig smoked daily	−.01 (.01)	−1.09	−.02 (.01)	−1.15	−.01 (.01)	−1.03	−.01 (.00)	−1.03
Years smoked	−.04 (.01)	−3.88**	−.05 (.01)	−3.93**	−.03 (.00)	−4.75**	−.02 (.00)	−4.63**
How long after waking 'til smoked	.25 (.10)	2.46*	.23 (.10)	2.25*	.10 (.05)	2.04*	.09 (.05)	1.86†
Enjoy smoking	−.17 (.09)	−1.84†	−.18 (.10)	−1.84†	−.10 (.04)	−2.29*	−.09 (.04)	−2.09*
Work full-time	−.25 (.19)	−1.33	−.22 (.19)	−1.15	−.06 (.09)	−.67	−.03 (.09)	−.39
Single mother	−.32 (.17)	−1.85†	−.36 (.17)	−2.00*	−.02 (.08)	−.29	−.06 (.08)	−.73
Smoke in neg. emotion situations	−.11 (.06)	−1.56	−.09 (.07)	−1.35	−.03 (.03)	−.94	−.03 (.03)	−.94
Model for time								
Intercept	.09 (.01)	6.44**	.09 (.01)	6.37**	.05 (.00)	9.75**	.05 (.00)	9.63**
Study group (intervention)	−.06 (.02)	−3.05**	−.06 (.02)	−3.16**	−.01 (.00)	−1.14	−.01 (.01)	−1.12
Model for other time-varying covariates—events								
Number of exposures	−.14 (.05)	−2.72**	−.14 (.05)	−2.70**	−.02 (.02)	−1.15	−.02 (.02)	−1.15
Pregnant	.57 (.20)	2.86**	.48 (.20)	2.36*	.35 (.08)	4.24**	.31 (.08)	3.75**
—mediators								
Health concerns	–	–	.57 (.12)	4.65**	–	–	.30 (.04)	7.32**
Stress	–	–	−.32 (.07)	−4.47**	–	–	−.09 (.02)	−3.54**

Random effects	Variance component (df)	χ^2	Variance component (df)	χ^2	Variance component (df)	χ^2	Variance component (df)	χ^2
Level 2 variance (respondents)								
Status at 2M	2.12 (931)	1208.680**	2.12 (931)	1208.69	.83 (931)	3124.42**	.78 (933)	3022.82**
Level 1 variance	–		–		.98		.96	

Non-directional p values: †$p<.10$; *$p<.05$; **$p<.01$.

Table 4
Hierarchical linear models of repeated measures of smoking cessation outcomes: Stage and motivation

Fixed effect	Stage-Model I		Stage-Model II		Motivation-Model I		Motivation-Model II	
	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio
Model for intercept (status at 2M)								
Intercept	2.24 (.32)	6.98**	2.22 (.32)	6.98**	5.28 (.49)	10.68**	4.65 (.47)	9.96**
Action at baseline	.04 (.04)	.89	.03 (.04)	.76	.02 (.06)	.35	.01 (.06)	.18
Stage at baseline	.21 (.04)	4.66**	.22 (.04)	5.09**	.29 (.07)	4.18**	.31 (.06)	5.00**
Motivation at baseline	.08 (.02)	3.88**	.04 (.02)	−1.87†	.38 (.03)	11.56**	.27 (.03)	8.85**
Confidence at baseline	.05 (.02)	2.21*	.05 (.02)	2.19*	−.00 (.03)	−.02	.00 (.03)	.06
Study group (intervention)	.35 (.08)	4.11**	.30 (.08)	3.56**	.49 (.14)	3.62**	.36 (.12)	2.85**
Education	−.03 (.06)	−.57	−.02 (.05)	−.42	−.08 (.09)	−.99	−.04 (.08)	−.54
Other smokers in house	−.20 (.08)	−2.69**	−.20 (.07)	−2.76**	−.20 (.12)	−1.76†	−.18 (.10)	−1.73†
Number of cigs smoked daily	−.00 (.00)	−.15	−.00 (.00)	−.10	.01 (.01)	1.09	.01 (.01)	1.45
Years smoked	−.02 (.00)	−2.93**	−.01 (.00)	−2.70**	−.00 (.01)	−.14	.00 (.01)	.69
How long after waking 'til smoked	.07 (.05)	1.44	.06 (.05)	1.18	.02 (.08)	.21	−.01 (.07)	−.20
Enjoy smoking	−.10 (.04)	−2.26*	−.08 (.04)	−1.96*	−.22 (.07)	−3.12**	−.16 (.06)	−2.65*
Work full-time	.07 (.08)	.78	.11 (.08)	1.25	.29 (.14)	2.11*	.38 (.12)	3.10**
Single mother	−.06 (.08)	−.73	−.11 (.08)	−1.42	.08 (.13)	.62	−.08 (.11)	−.68
Smoke in neg. emotion situations	−.03 (.03)	−.93	−.03 (.03)	−1.00	.02 (.05)	.50	.01 (.04)	.22
Model for time								
Intercept	.04 (.00)	7.74**	.04 (.00)	7.70**	.04 (.01)	4.51**	.03 (.01)	4.22**
Study group (intervention)	−.00 (.01)	−.74	−.00 (.01)	−.72	−.01 (.01)	−.70	−.01 (.01)	−.55
Model for other time-varying covariates—events								
Number of exposures	.01 (.02)	.46	.01 (.02)	.40	.11 (.03)	3.33**	.10 (.03)	3.34**
Pregnant	.34 (.08)	4.12**	.28 (.08)	3.50**	.72 (.14)	5.29**	.57 (.13)	4.38**
–mediators								
Health concerns	–	–	.43 (.04)	10.57**	–	–	1.10 (.06)	17.16**
Stress	–	–	−.10 (.02)	−4.16**	–	–	−.07 (.04)	−1.73†
Random effects	Variance component (df)	χ²	Variance component (df)	χ²	Variance component (df)	χ²	Variance component (df)	χ²
Level 2 variance (respondents)								
Status at 2M	.85 (931)	2992.60**	.72 (931)	2922.60**	1.74 (931)	2523.80**	1.27 (931)	2158.45**
Level 1 variance	.97		.94		2.75		2.60	

Non-directional p values: †p<.10; *p<.05; **p<.01.

Table 5
Hierarchical linear models of repeated measures of smoking cessation outcomes: Confidence and self-efficacy

Fixed effect	Confidence-Model I		Confidence-Model II		Self-efficacy-Model I		Self-efficacy-Model II	
	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio	Coefficient (S.E.)	t-ratio
Model for intercept (status at 2M)								
Intercept	3.30 (.37)	8.86**	3.56 (.38)	9.34**	1.84 (.21)	8.72**	2.15 (.21)	10.15**
Action at baseline	.04 (.05)	.78	.03 (.04)	.68	.05 (.03)	1.85†	.04 (.02)	1.74†
Stage at baseline	.08 (.05)	1.56	.09 (.05)	1.71†	.05 (.03)	1.75†	.06 (.03)	1.97*
Motivation at baseline	−.02 (.02)	−.79	−.04 (.02)	−1.80†	.01 (.01)	.96	−.00 (.01)	−.25
Confidence at baseline	.40 (.02)	15.53**	.39 (.02)	15.56**	.10 (.01)	6.62**	.09 (.01)	6.40**
Study group (intervention)	.21 (.10)	2.04*	.17 (.10)	1.68†	.09 (.06)	1.54	.06 (.06)	1.07
Education	.11 (.06)	1.69†	.11 (.06)	1.66†	.11 (.04)	2.96**	.10 (.04)	2.87**
Other smokers in house	.01 (.09)	.11	.01 (.09)	.07	.05 (.05)	.93	.04 (.05)	.86
Number of cigs smoked daily	−.01 (.01)	−1.04	−.01 (.01)	−1.11	−.00 (.00)	−.07	−.00 (.00)	−.23
Years smoked	−.03 (.01)	−4.40**	−.03 (.01)	−4.40**	−.00 (.00)	−1.23	−.00 (.00)	−1.29
How long after waking 'til smoked	.25 (.06)	4.37**	.24 (.06)	4.24**	.08 (.03)	2.60**	.07 (.03)	2.40*
Enjoy smoking	−.02 (.05)	−.50	−.02 (.05)	−.41	.01 (.03)	.28	.01 (.03)	.31
Work full-time	−.15 (.10)	−1.44	−.13 (.10)	−1.27	−.03 (.06)	−.56	−.02 (.06)	−.36
Single mother	−.16 (.10)	−1.63	.−.17 (.09)	−1.84†	−.04 (.05)	−.75	−.05 (.05)	−.90
Smoke in neg. emotion situations	−.08 (.04)	−2.15*	−.07 (.04)	−2.03*	−.21 (.02)	−9.99**	−.20 (.02)	−9.96**
Model for time								
Intercept	.02 (.01)	3.42**	.02 (.01)	3.27**	.01 (.00)	2.66**	.01 (.00)	2.45*
Study group (intervention)	−.00 (.01)	−.63	−.00 (.01)	−.64	−.01 (.00)	−2.06*	−.01 (.00)	−2.11*
Model for other time-varying covariates—events								
Number of exposures	−.02 (.02)	−.60	−.02 (.02)	−.63	−.01 (.01)	−.83	−.01 (.01)	−.86
Pregnant	.01 (.10)	.07	−.04 (.10)	−.35	.27 (.06)	4.67**	.23 (.06)	4.11**
−mediators								
Health concerns	–	–	.24 (.05)	4.66**	–	–	.15 (.03)	5.46**
Stress	–	–	−.15 (.03)	−4.59**	–	–	−.14 (.02)	−8.17**
Random effects	Variance component (df)	χ²	Variance component (df)	χ²	Variance component (df)	χ²	Variance component (df)	χ²
Level 2 variance (respondents)								
Status at 2M	.98 (931)	2514.34**	.93 (931)	2436.17**	.32 (931)	2665.04**	.29 (931)	2533.72**
Level 1 variance	1.57		1.56		.48		.46	

Non-directional p values: †p<.10; *p<.05; **p<.01.

Non-directional p values: †p<.10; *p<.05; **p<.01.

several baseline measures were associated with longitudinal smoking outcomes even after introducing in the model the time-varying events and mediators. As expected, each smoking outcome over time—action, stage, confidence and motivation — was strongly predicted by its corresponding baseline measure. In addition, baseline stage predicted all other longitudinal smoking outcomes. Confidence at baseline predicted all other outcomes except motivation. Baseline motivation predicted longitudinal action and stage, but was unrelated to confidence, self-efficacy, and abstinence. Baseline action predicted longitudinal self-efficacy. Having been in the intervention condition of the earlier experimental study was positively associated with all longitudinal smoking outcomes except self-efficacy.

Among the remaining baseline variables, several tended to depress outcomes. Presence of other smokers in the household was negatively related to abstinence and stage of readiness; years smoked was negatively related to abstinence, action, stage, and confidence; smoking soon after waking up had a negative effect on abstinence, action, confidence, and self-efficacy; and enjoying smoking was a negative predictor of actions toward quitting, stage, and motivation. Smoking in negative affect situations predicted less confidence and self-efficacy over time; lower education was associated with lower self-efficacy; and single motherhood, with less abstinence. However, being employed full-time increased motivation.

4.4. Effects of time-varying factors on smoking outcomes

Controlling for these baseline variables, the next sections of Tables 3, 4 and 5 (Models for time-varying covariate-events) show the effects of time-varying pregnancy and exposure to interventions on the smoking outcomes (Model I for each outcome) and of adding time-varying health concerns and perceived stress (Model II for each outcome).

Table 3 summarizes the models for abstinence and actions toward quitting. The likelihood of abstinence was enhanced by being pregnant, but negatively related to number of exposures to messages (Model I). When the mediating variables were added (Model II), health concerns increased the likelihood of abstinence and perceived stress decreased this likelihood. Controlling for these mediators, pregnancy and exposure still had significant effects, except that the effect of pregnancy was reduced somewhat. *Actions toward quitting* were unrelated to number of exposures but enhanced by pregnancy (Model I). In the second model, health concerns were positively related to actions, perceived stress was negatively related, and the positive effect of pregnancy was reduced but still significant.

The models for stage of readiness and motivation to quit are summarized in Table 4. Pregnancy had a favorable effect on both outcomes; number of exposures enhanced motivation but not stage of readiness. Health concerns were positively related to both stage of readiness and motivation, and perceived stress was negatively related to both outcomes. Controlling for these mediating variables, the effects of exposures were unchanged; the effects of pregnancy were reduced, but still significant.

Table 5 shows the models for confidence and self-efficacy. Neither type of intervening event predicted a woman's level of confidence, but this confidence was positively related to health concerns and negatively related to perceived stress. Pregnancy was associated with greater self-efficacy to avoid smoking in various high-risk situations, but number of exposures was unrelated to self-efficacy. Introducing the two mediators into the model, health concerns enhanced self-efficacy, perceived stress decreased it, and the beneficial effect of pregnancy was reduced slightly.

5. Discussion

At each post-baseline measurement point in the study panel, some women were no longer pregnant and others were newly pregnant. Our first study hypothesis was that a woman would have more favorable smoking outcomes when she is pregnant than when she is not. Our findings show that pregnancy was consistently associated with more favorable smoking outcomes, except for confidence in one's ability to quit smoking. Across the 18 months covered by the study, a woman was 1.8 times as likely to be abstinent when pregnant as when not.

The positive effect of pregnancy was partially mediated by its effects on health concerns and perceived stress. Pregnancy elevated health concerns and decreased the level of perceived stress, both of which in turn enhanced smoking outcomes. However, the direct path of pregnancy to outcomes remained significant when health concerns and stress were controlled, with a slightly lower odds ratio of 1.6 for abstinence. This means that the effect of pregnancy was only partly explained by these mediating factors. Additional factors associated with pregnancy, both physical and psychosocial, may contribute to the effect.

The association of pregnancy with quitting is consistent with the findings reported by numerous other studies and surveillance systems (DHHS, 2001; MMWR, 2004). Our findings show that pregnancy was also associated with improvements in all the various dimensions of readiness to quit, except confidence. The lack of an association of pregnancy with confidence may have to do with the often temporary nature of abstinence during pregnancy and the wording of the confidence question in terms of being able to quit permanently. Awareness of health risks to the fetus may motivate pregnant women to abstain from smoking during their pregnancy, and make them more confident that they can abstain in negative situations while pregnant, without also intending to actually quit permanently. Possible difficulties and negative experiences of abstaining while pregnant, including failure to do so, may then decrease confidence in being able to quit or stay quit when the incentive of not harming the fetus is no longer present. However, our data do not allow the testing of these speculations.

Regardless of pregnancy, many of the women at each panel point reported having visited the clinics in the months since the previous interview and being exposed to health care smoking cessation messages during those visits. Our second study hypothesis was that such exposure to health care messages would enhance smoking outcomes. However, we found that exposure to health care interventions was positively associated with only one outcome over time, motivation to quit smoking. This finding suggests that routine health care provider interventions may be effective in educating about health risk of smoking and benefits of quitting, but not in improving confidence, self-efficacy, and action. The Public Health System Guideline for Treating Tobacco in Clinical Practice (Fiore et al., 2000) recommended that smokers be provided with more intensive and structured interventions in addition to advice to quit. Indeed, our findings show that exposure to the earlier structured experimental intervention had a positive effect on all longitudinal outcomes. More difficult to explain is the finding that exposure to health care interventions was *negatively* related to abstinence. Possibly health care providers direct more such interventions to smokers and do not incorporate reinforcement strategies in their contacts with recent quitters.

Our study findings about health concerns indicated, first of all, that concerns about the health risks due to smoking were widespread among the study women despite their low-SES and relatively young age. More than two-thirds of these women were very concerned about the health risks of smoking to their own health and 85% were very concerned about the health of close others (data not shown). Despite this limited variance, consistent with our third hypothesis, health concerns were positively associated over

time with all the smoking outcomes. The findings are also consistent with the concept of health concerns as being an intrinsic element of the motivation to quit smoking, as indicated in the Health Belief Model (Rosenstock, 1974). Greater health concerns over time were strongly predicted by initial higher motivation to quit (Table 2). In turn, greater health concerns over time were most strongly associated with higher motivation over time (Table 4).

Our fourth study hypothesis was that greater perceived stress would be associated with poorer smoking outcomes. Indeed, variations over time in perceived stress had consistently negative effects on all smoking outcomes over time. The findings also support the assumption that smoking is used to deal with stress. A higher baseline level of smoking in negative emotions situations had the strongest association with higher perceived stress over time (see Table 2). In turn, higher perceived stress over time was most strongly associated with poorer self-efficacy over time (Table 5).

Our fifth study hypothesis was that the effects of pregnancy and exposure to smoking intervention messages would be mediated, to some extent, by the effects of these time-specific events on time-varying perceived stress and health concerns. This hypothesis was not supported for exposure to interventions, which was found to influence neither health concerns, perceived stress, nor smoking outcomes over time (except motivation). The hypothesis was, however, supported for pregnancy. Over time, pregnancy was associated with stronger health concerns and less perceived stress (see Table 2), and these over time mediated a portion of the effect of pregnancy on health outcomes.

Finally, the findings also indicated that all the baseline variables except number of daily cigarettes were significant predictors of longitudinal smoking outcomes, and all but one baseline variable remained significant after introducing the time-varying mediators: stress and health concerns. The positive influence of education and employment on some smoking outcomes and the negative influence of living with smokers and having greater smoking habituation (i.e., more years of smoking, smoking soon after waking, and enjoying smoking) are consistent with what is reported in the literature for smoking cessation (DHHS, 2001). The longitudinal aspect of our findings further supports causal inferences about these associations.

The models also controlled for the baseline measures of motivation, action, stage, and confidence. Not surprisingly, the longitudinal trajectory for each of these variables was predicted by its baseline value. How the baseline values of each of these variables predicted trajectories of the other variables is also of interest. For example, stage and confidence, but not motivation or action, predicted abstinence. However, baseline motivation and confidence predicted stage over time, and baseline motivation, stage and confidence were associated with more actions over time. These findings suggest mutual influences that the dimensions of readiness may have on each over in the process of change over time. Further analysis of these influences is beyond the scope of this paper but merits further attention.

5.1. Study limitations

The study has three main limitations. First, the data were collected in the course of evaluating the earlier intervention. Only about half of the study subjects were exposed to that intervention, the intervention was to be delivered to all smokers by clinic personnel as part of routine services and did not require enrollment, data were collected up to 18 months later, and we controlled in the analysis for that baseline exposure. Moreover, smokers were identified by research staff in the clinic waiting rooms by screening all incoming patients and are thus representative of the population of women smokers seen in these clinics. Nonetheless, findings could differ in a population completely untouched by a similar intervention.

Second, the study experienced substantial panel attrition. Attrition between the 2-month and the 18-month measurements (the period covered by this study) was mostly due to inability to contact subjects by telephone. This problem has to be considered in light of the target population and the study accrual methods. Responses to telephone survey are generally lower among low-SES populations, partly due to inconsistent phone availability. Moreover, the study consent was not associated with receiving any service or treatment in the clinics, but consisted only of an agreement to be called at a later time for a telephone survey. Subjects may have therefore forgotten or felt little commitment to later accept the telephone survey. These factors are unrelated to smoking cessation processes. Moreover, as indicated earlier under attrition analysis, we controlled in the analysis for the variables we found to be associated with attrition. Attrition may reduce the generalizability of the study findings to women smokers with more reliable phone access or greater predisposition to complete smoking-related surveys, but is unlikely to have biased our study findings.

Third, smoking abstinence and exposure to interventions between study waves were assessed through self-reports only. Biochemical measures are expensive, intrusive, and difficult to implement in conjunction with telephone surveys, and therefore also likely to increase the attrition problem. Overall, findings were consistent across the six smoking outcomes, for only one of which – abstinence – is self-reporting an issue. Research has found very low rates of false reports of cessation in impersonal telephone interviews such as those used in our study, with minimal pressure to offer socially desirable responses (Velicer, Prochaska, Rossi, & Snow, 1992). As indicated earlier under attrition analysis, we controlled in the analysis for the variables we found associated with attrition. In a similar vein, our measure of stress was limited to two items. Although we are encouraged by the stability and appropriateness of our findings regarding stress, future research should replicate our findings with a stronger measure.

6. Implications and conclusions

Numerous studies have mentioned the association of health concerns, stress, pregnancy and exposure to smoking cessation interventions with the likelihood of either being a smoker or of quitting among smokers. To our knowledge, however, few studies have looked longitudinally at the associations of these factors with stage of readiness, motivation, action, situational self-efficacy and confidence.

Contacts with the public health care system in the reproductive years offer opportunities to reach low-SES women who may otherwise have limited exposure to smoking cessation interventions. In this analysis, we assessed the effect of exposure to such interventions that women remembered receiving in the course of their repeated clinic visits. Such exposure was associated with improved motivation to quit, indicating at least one area in which health care professionals can influence smoking cessation. However, clearly these usual and customary interventions were less powerful then the coordinated, but nonetheless minimal It's time intervention. Greater diffusion and implementation of structured smoking cessation programs could help reduce smoking in this target population.

Pregnancy was consistently associated with better smoking outcomes. Pregnancy offers a unique window of opportunity for changing the smoking behavior of women of child-bearing age, partly because of its association with heightened health concerns and a reduction in perceived stress. Booster interventions may be needed to continue the behavioral and motivational gains beyond the pregnancy.

Our longitudinal analysis provides stronger support for the often-reported associations of health concerns and stress with smoking cessation than that available from the mostly correlational studies in the literature. Health concerns and less perceived stress were uniformly associated with more favorable

smoking outcomes, after controlling for baseline factors and pregnancy. Clinic smoking interventions routinely incorporate health concerns in their messages, health concerns were most strongly associated longitudinally with motivation, and motivation was the only outcome that improved with time-varying exposure to health care interventions. In contrast, stress had a weaker negative effect on motivation than on the other dimensions of readiness – stage, action, self-efficacy, and confidence – as well as abstinence. Stress was not affected by time-varying health care interventions, and even baseline exposure to the earlier experimental intervention had only a marginal impact on stress. Longitudinally, stress was most strongly predicted by baseline smoking in negative affect situations. These results suggest that a major goal for future smoking cessation programs in health care setting might be that of incorporating effective stress-reduction exercises.

To summarize, our study has several important and novel features: In addition to smoking cessation, it studies multiple dimensions of readiness to quit as dependent variables. These dimensions – stage, motivation, action, confidence, self-efficacy – broaden the application of the transtheoretical model of change beyond the single stage of readiness variable. Understanding change in, as well as intervening in, readiness to quit requires understanding changes in these other variables. Building on the correlational studies in the literature, our longitudinal analyses provides stronger support for the relationships observed, showing how the trajectories of these outcomes over 18 months are affected by baseline characteristics, by relevant events over time, and mediated by health concerns and stress as these vary over time. The study focuses on low-SES women smokers, a population subgroup for which available knowledge is limited and the need to influence cessation is great. We are studying changes in smoking behavior within the context of these women's lives.

Acknowledgments

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