Factors associated with changing cigarette consumption patterns among low-intensity smokers: Longitudinal findings across four waves (2008–2012) of ITC Mexico Survey

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ABSTRACT

Background: Light and intermittent smoking has become increasingly prevalent as smokers shift to lower consumption in response to tobacco control policies. We examined changes in cigarette consumption patterns over a four-year period and determined which factors were associated with smoking transitions.
Methods: We used data from a cohort of smokers from the 2008–2012 ITC Mexico Survey administrations to investigate transitions from non-daily (ND; n = 669), daily light (DL; ≤5 cigarettes per day (cpd); n = 643), and daily heavy (DH; > 5 cpd; n = 761) smoking patterns. To identify which factors (i.e., sociodemographic measures, perceived addiction, quit behavior, social norms) were associated with smoking transitions, we stratified on smoking status at time *t* (ND, DL, DH) and used multinomial (ND, DL) and binomial (DH) logistic regression to examine transitions (quitting/reducing or increasing versus same level for ND and DL, quitting/reducing versus same level for DH).
Results: ND smokers were more likely to quit at follow-up than DL or DH smokers. DH smokers who reduced their consumption to ND were more likely to quit eventually compared to those who continued as DH. Smokers who perceived themselves as addicted had lower odds of quitting/reducing smoking consumption at follow-up compared to smokers who did not, regardless of smoking status at the prior survey. Quit attempts and quit intentions were also associated with quitting/reducing consumption.
Conclusions: Reducing consumption may eventually lead to cessation, even for heavier smokers. The findings that perceived addiction and quit behavior were important predictors of changing consumption for all groups may offer insights into potential interventions.

1. Introduction

Recently, even as smoking prevalence has decreased in several high-income countries (Coady et al., 2012; Kilgore et al., 2014; Kotz, Fidler, & West, 2012; Lund, Lund, & Kvaavik, 2011; Pierce, White, & Messer, 2009), the prevalence of light smoking (i.e., < 10 cigarettes per day (CPD)) and intermittent smoking (i.e., non-daily) has increased, suggesting a shift in smoking behavior to lower consumption patterns

(Kilgore et al., 2014; Kotz et al., 2012; Lund et al., 2011; Pulvers et al., 2015; Schauer, Malarcher, & Mowery, 2016). While light and intermittent smoking (LITS) patterns are an emerging phenomenon in high-income countries, population-based surveys have consistently shown that these patterns are highly prevalent and even dominant in many low- and middle-income countries (LMICs), such as India, Indonesia, Thailand, and Brazil (The GATS Atlas: Global adults tobacco survey, 2015). Mexico is also among these countries, as about two-thirds of

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smokers are either non-daily smokers or daily smokers who consume ≤ 5 CPD (PAHO-INSP, 2010).

Compared to non-smokers, light and intermittent smokers face substantial health risks, including increased risk for cancer, myocardial infarction, and cardiovascular mortality (Bjartveit & Tverdal, 2005; Kawachi et al., 1994; Luoto, Uutela, & Puska, 2000; Okuyemi et al., 2002; Prescott, Scharling, Osler, & Schnohr, 2002; Rosengren, Wilhelmsen, & Wedel, 1992). Still, heavy smokers who substantially reduce their cigarette consumption have decreased mortality risk compared to those who continue to smoke at similar rates (Gerber, Myers, & Goldbourt, 2012). Despite health risks that vary with smoking intensity, little is known about how LITS develops over an individual's smoking history. The majority of studies about smoking transitions among adult smokers either do not distinguish between levels of smoking intensity (Bondy et al., 2013; Hassmiller, Warner, Mendez, Levy, & Romano, 2003; Hennrikus, Jeffery, & Lando, 1996; Lindstrom & Isacsson, 2002), use retrospective study designs to assess baseline smoking status (Hassmiller et al., 2003), or study specific population groups (e.g., older population (Lindstrom & Isacsson, 2002) or working populations (Hennrikus et al., 1996)).

Previous studies that distinguish between non-daily and daily light smoking groups suggest that non-daily smokers may exhibit a more stable smoking pattern compared to daily light smokers. For example, very light daily smokers (i.e., 5 or fewer cigarettes per day) appear to be more likely to increase consumption over time, compared to non-daily smokers (Levy, Biener, & Rigotti, 2009). On the other hand, despite exhibiting lower nicotine dependence (Levy et al., 2009) and greater intention to quit (Cooper et al., 2010), non-daily smokers are not more likely to attempt to quit or successfully quit compared to very light daily smokers (Zhu, Sun, Hawkins, Pierce, & Cummins, 2003). Non-daily smokers are more likely to successfully quit at follow-up periods compared to individuals smoking > 5 cigarettes per day (Levy et al., 2009; Swayampakala et al., 2013; Zhu et al., 2003).

In prior research, lower levels of perceived addiction, and nicotine dependence have been shown to be associated with light and/or intermittent smoking compared to heaver smoking, and with transitioning from higher to lower levels of smoking intensity (Cabriales, Suro Maldonado, & Cooper, 2016; Coggins, Murrelle, Carchman, & Heidbreder, 2009; Edwards, Bondy, Kowgier, McDonald, & Cohen, 2010; Reitzel et al., 2009; Reyes-Guzman et al., 2017; Swayampakala et al., 2013). Compared to heavier smokers, light or nondaily smokers are more likely to be younger (Blanco et al., 2014; CDC, 1998; Reyes-Guzman et al., 2017; Wang, Sung, Yao, Lightwood, & Max, 2017), employed (Blanco et al., 2014), married (Wang et al., 2017), Hispanic or Non-Hispanic Black (Reyes-Guzman et al., 2017; Rodriquez, Oh, Perez-Stable, & Schroeder, 2016; Trinidad et al., 2009; Wang et al., 2017), to have made a quit attempt in the past year (Swayampakala et al., 2013), to have had a later age of initiation (Reyes-Guzman et al., 2017), and to have higher levels of education (CDC, 1998; Reyes-Guzman et al., 2017; Wang et al., 2017). There is mixed evidence regarding the relationship between smoking patterns and both gender (CDC, 1998; Trinidad et al., 2009; Wang et al., 2017) and acculturation (Blanco et al., 2014; Rodriquez, Stoecklin-Marois, Hennessy-Burt, Tancredi, & Schenker, 2015). Changes in social norms—particularly those that reduce the social acceptability of tobacco use—have also been associated with reduced smoking (Alamar & Glantz, 2006; Evans-Polce, Castaldelli-Maia, Schomerus, & Evans-Lacko, 2015; Hammond, Fong, Zanna, Thrasher, & Borland, 2006; Stuber, Galea, & Link, 2008).

Our study adds to existing research by focusing on predictors of smoking transitions in Mexico. Using data from four waves of the International Tobacco Control (ITC) Mexico Survey, we investigated the changes in cigarette consumption patterns of non-daily, daily light, and daily heavy smokers in Mexico over a four-year period (2008–2012), and determined which factors were associated with progression to heavier smoking levels, lighter smoking levels, or quitting. We examined measures of addiction, social norms, and quit behavior, in addition to sociodemographic factors.

2. Methods

2.1. Data source and respondents

The ITC Mexico Project started in 2006, with six waves of data collection through 2012 (Swayampakala et al., 2013). Stratified, multi-stage sampling was used across seven cities, with face-to-face interviews of a random sample of current smokers (i.e., smoked at least 100 cigarettes in lifetime and smoked at least once in previous week). Smokers were followed up over time, and replenishment samples were used to maintain sample size.

In the present study, data collected from the seven cities that participated in waves 3–6 were analyzed. Wave 3 was administered in November–December of 2008, wave 4 in January–February of 2010, wave 5 in April–May 2011, and wave 6 in October–December 2012. Two types of analytic samples were used in this study: (1) in the smoking transition analysis, respondents had at least three waves of data (n = 502 non-daily, 473 daily light, 569 daily heavy smokers); (2) in the analysis to determine factors associated with smoking transitions, respondents had at least two waves of data (n = 2073 smokers; n = 4106 observations) (see Appendix Fig. 1).

2.2. Outcome measures

2.2.1. Smoking transitions

Smoking status was determined by asking respondents at each wave to report daily or non-daily smoking, as well as the average number of cigarettes they smoked on the days they smoked. Based on the response to these questions, smoking intensity was classified as: non-daily, daily light (daily smoking ≤ 5 CPD), and daily heavy (daily smoking > 5 CPD) smokers (see Table 1 for sample sizes). These categories generally reflect tertiles of consumption intensity in Mexico (GATS Encuesta Global de Tabaquismo en Adultos, México, 2009), and are also informed by previous research that considered the low levels of smoking among Latinos residing in the US, particularly those of Mexican heritage (Kaplan et al., 2014; Zhu, Pulvers, Zhuang, & Baezconde-Garbanati, 2007). Also, separating DL smokers from other daily smokers allows for a detailed examination of potential differences in factors associated with smoking transitions for this understudied group of adult smokers.

Smoking transitions were determined based on smoking status at time t and $t + 1$. At follow-up, people who had quit for > 30 days were coded as quitters, as suggested by previous research (IARC, 2008). Transitions were then determined based on whether a participant had quit smoking or changed their level of smoking. Non-daily smokers could be classified as quitting, staying at the same level, or increasing (to daily light or daily heavy) at follow-up. Daily light smokers could be classified as quitting/reducing (to non-daily), staying at the same level, or increasing (to daily heavy) at follow-up. Daily heavy smokers could be classified as quitting/reducing (to non-daily or daily light) or staying at the same level.

2.3. Independent variables

2.3.1. Measures of addiction

Respondents were asked at what age they smoked their first cigarette, categorized using a median split (≤ 16 years, > 16 years) (Breslau, Fenn, & Peterson, 1993; Hu, Davies, & Kandel, 2006). Perceived addiction to cigarettes was ascertained from the question "Do you consider yourself addicted to cigarettes?" (categories: yes, very much, yes, but not much, no). Although we collected data on nicotine dependence using the Heaviness of smoking index (HSI), we did not include it in our analyses partly because our analytic samples are defined by one of the two HIS measures (i.e., CPD). Furthermore, the distribution of HSI

Table 1
Selected characteristics of adult Mexican smokers, ITC Mexico Survey 2008–2012.

Covariates of interest	Non-daily (n$_{smokers}$ = 669)	Daily light (n$_{smokers}$ = 643)	Daily heavy (n$_{smokers}$ = 761)	p-Value
	32%	31%	37%	
Age				< 0.0001
18–24	20%	19%	13%	
25–39	42%	36%	31%	
40–54	26%	26%	34%	
> 54	13%	20%	22%	
Female gender	40%	41%	33%	< 0.0001
Marital status				< 0.0001
Married/partnered	69%	65%	67%	
Single	24%	22%	20%	
Other	7%	13%	14%	
Education				< 0.0001
Primary education or less	28%	30%	38%	
Middle school	33%	32%	29%	
Vocational school/high school/incomplete university	29%	27%	24%	
University & postgraduate	10%	10%	9%	
Monthly household income (pesos)				0.007
0–3000	27%	25%	25%	
3001-5000	30%	28%	29%	
5001-8000	21%	21%	20%	
> 8000	16%	16%	18%	
Missing	6%	10%	8%	
Quit behavior				
Intend to quit in next six months	22%	16%	14%	< 0.0001
Attempted to quit in previous year	42%	33%	26%	< 0.0001
Measures of addiction				
Age at first cigarette ≤16 years	50%	53%	61%	< 0.0001
Perceived addiction				< 0.0001
Not at all	42%	21%	6%	
Little	48%	51%	32%	
Very much	10%	28%	62%	
Social norms				
Descriptive norms				
Partner/spouse smoking status				0.025
Yes	25%	26%	23%	
No	41%	35%	40%	
No partner	34%	39%	37%	
Number of smokers in five closest friends				0.074
None	10%	10%	11%	
1 to 3	48%	46%	42%	
4 or 5	43%	44%	47%	
Subjective norms				
Important people believe I should not smoke				0.275
Agree/strongly agree	78%	79%	76%	
Societal norm[a]	2.65 (0.88)	2.67 (0.86)	2.66 (0.88)	0.8519
Wave of participation				0.309
3	30%	29%	29%	
4	37%	35%	39%	
5	33%	36%	33%	
Time in sample				0.569
1	52%	51%	51%	
2	33%	32%	34%	
3	16%	17%	15%	

[a] Mean(std). Responses measured on 5-point Likert scale, with higher values indicating stronger anti-smoking sentiment.

among Mexican smokers is highly skewed, with most Mexican smokers (69%) having a score of 0 on a scale of 0 to 6 (Swayampakala et al., 2013). This percentage is higher among non-daily smokers (91%) and daily light smokers (84%). HSI's inclusion of the CPD measure we use to define our analytic sample and its lack of variation limits its utility for our analysis. Instead, we used perceived addiction as a proxy measure of nicotine dependence, as it is an important predictor of smoking susceptibility among youth (Okoli, Richardson, Ratner, & Johnson, 2009; O'Loughlin et al., 2002), and predicts quit behavior above and beyond smoking intensity among adult Mexican smokers (Swayampakala et al., 2013).

2.3.2. Social norms

Socially embedded norms around smoking can influence smokers to change their smoking behaviors (Dohnke, Weiss-Gerlach, & Spies, 2011; van den Putte, Yzer, & Brunsting, 2005). Three markers of social norms were measured in this study: descriptive norms, subjective norms, and anti-smoking societal norms. Descriptive norms are perceptions of others' behavior (Stuber et al., 2008), and were ascertained by asking respondents, "Of the five closest friends or acquaintances that you spend time with on a regular basis, how many of them are smokers?" (categories: none, 1 to 3, 4 to 5). Spouse/partner smoking status was coded as smoking spouse/partner, not smoking spouse/partner, and not living with a spouse/partner. Subjective norms are "the expectation of significant others that one should adopt a specific behavior" (van den
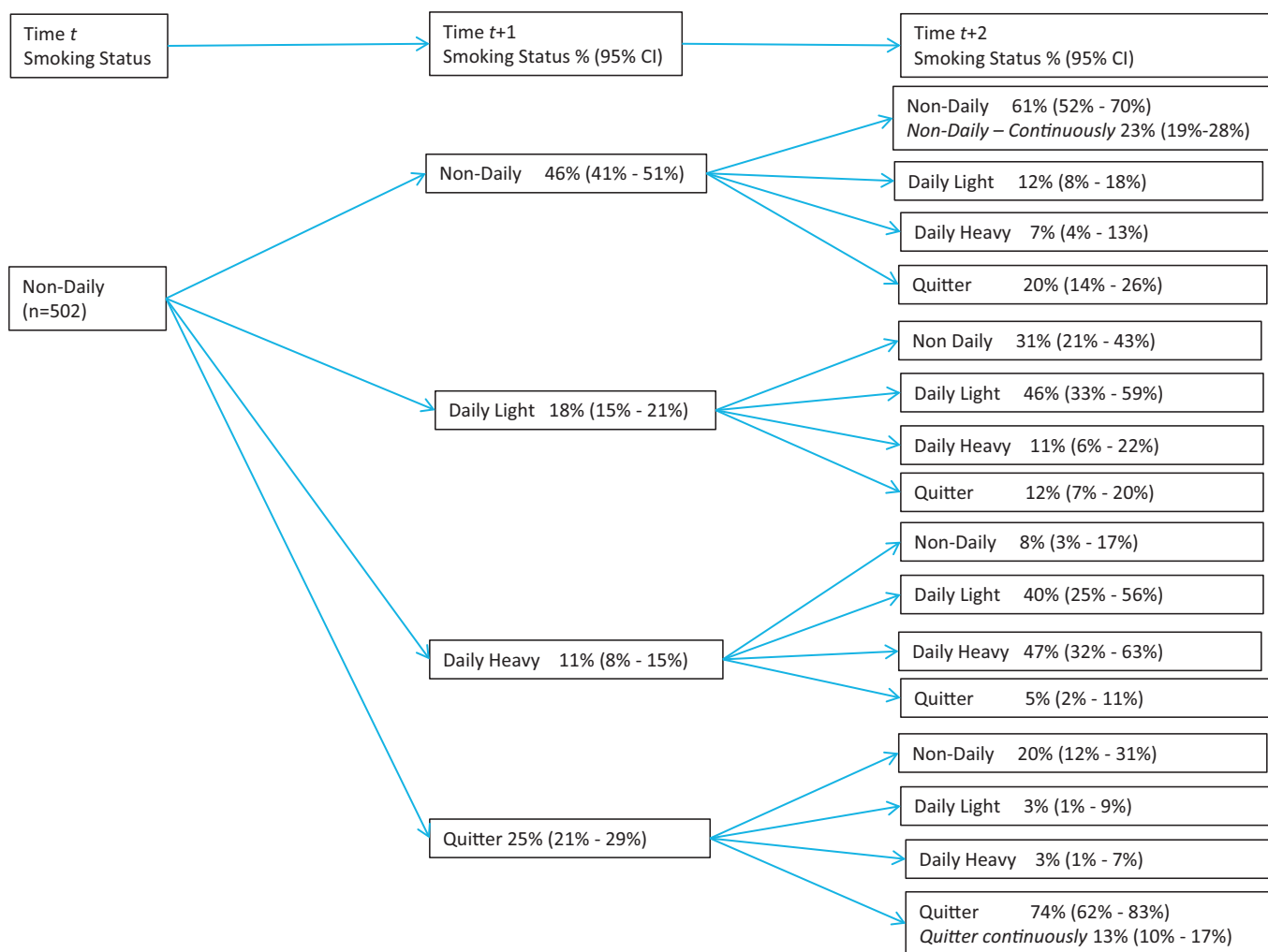
Fig. 1. Smoking transitions from time t to t + 1 and t + 2 among smokers who were non-daily smokers at time t.

Putte et al., 2005). This was ascertained by asking smokers whether "People who are important to you believe that you should not smoke" (categories: agree/strongly agree, neutral/disagree/strongly disagree). Anti-smoking societal norms were measured by combining three items that assessed smoker's perception of social norms against smoking at a more general, societal level: "There are fewer and fewer places where you feel comfortable smoking," "Mexican society disapproves of smoking," and "People who smoke are more and more marginalized." These items were used in previous studies to measure anti-smoking societal norms (Thrasher, Boado, Sebrie, & Bianco, 2009), and predict smoking cessation (Hammond et al., 2006). Response options were on a five-point Likert scale and averaged to create an index (Cronbach's alpha = 0.62).

2.3.3. Quit behavior

Quit intentions were categorized as intending to quit within the next six months versus not. Quit attempts were categorized as making a quit attempt between waves versus not.

2.3.4. Socio-demographic covariates

We also measured self-reported age; gender; marital status (married/partnered, single, other); educational attainment (primary education or less, middle school, vocational school/high school/incomplete university); and monthly household income (0–3000 pesos, 3001–5000, 5001–8000, > 8000, missing) of the respondents when they first entered the study.

2.4. Statistical analysis

All analyses were performed in Stata 13 and were adjusted for the complex survey design and weighted to account for likelihood of participant selection. Analyses were stratified by smoking status at time t (wave 3 or 4) to examine smoking transitions at $t + 1$ and $t + 2$ (i.e., first and second follow-up periods). Bivariate statistics with omnibus chi-square tests were used to examine differences in covariates of interest across the three smoking categories: non-daily, daily light and daily heavy. Next, we calculated the conditional probabilities and 95% confidence intervals (CI) for each possible smoking transition category (i.e., quitting, increase/reduce smoking consumption, continue smoking at the same level) over two consecutive follow-up waves. Finally, we conducted logistic regression analyses and provided p-values to assess (a) the odds of quitting smoking at $t + 1$ as a function of smoking status at t, (b) the odds of quitting at $t + 2$ as a function of whether the person increased/decreased smoking or remained stable at $t + 1$, and (c) the odds of being stable across the two follow-up periods as a function of smoking status at t.

To identify factors associated with smoking transitions at time $t + 1$, we pooled observations from all possible waves of follow-up, treating data from each wave as a separate observation while adjusting for the non-independence of observations for individual smokers using the cluster command in the svyset procedure. Fully adjusted models were stratified by smoking status at time t, and included all variables in each block of independent variables (i.e., measures of addiction, social

norms, and quit behavior) along with the socio-demographic variables, the wave of participation, and time in the sample. The outcomes of interest were stratified by smoking status at time *t*, and were: quitting, increasing consumption, or remaining stable for non-daily smokers; quitting/reducing, increasing consumption, or remaining stable for daily light smokers; quitting/reducing or remaining stable for daily heavy smokers. Multinomial logistic regression models were run for non-daily and daily light smokers at time *t*, and logistic regression models were run for daily heavy smokers at time *t*, with remaining stable as the referent category.

3. Results

3.1. Characteristics of smokers by level of cigarette consumption

Table 1 shows the baseline characteristics of the cohort of smokers by smoking status categories. DH smokers were more likely to be older, male, and have a primary education or less, compared to non-daily smokers; daily light smokers were similar to non-daily smokers for gender and education, but were older. Daily heavy and daily light smokers were less likely to report quit intention in the next six months and quit attempts in the past year, and had higher perceived addiction, compared to non-daily smokers.

3.2. Smoking transitions across two follow-up periods

The figures present a set of estimated transition probabilities between smoking status categories from one wave to the next, with a maximum of three consecutive waves for the non-daily (Fig. 1), daily light (Fig. 2), and daily heavy (Fig. 3) smokers at time *t*. Across all three waves, daily light smoking was the least common smoking pattern for Mexican smokers. Daily heavy smoking was the most stable group, with about 60% of smokers remaining daily heavy from *t* to *t + 1*, and about one-third of daily heavy smokers remaining in the same category across the three consecutive interviews.

Continuing non-daily smokers (i.e., those reported being non-daily smoker at time *t* and *t + 1*) had a greater probability of maintaining the non-daily smoking status at time *t + 2* or successfully quitting at *t + 2* than increasing smoking consumption to daily heavy smoking at *t + 2*. From the logistic regression analysis, compared to daily light and daily heavy smokers, non-daily smokers were more likely to quit from time *t* to *t + 1* (non-daily$_{prob}$ = 25%, 95% CI 21%–29%; daily light$_{prob}$ = 14%, 95% CI 11%–18%; daily heavy$_{prob}$ = 9%, 95% CI 6%–12%; p < 0.001). Non-daily smokers also had a higher probability of staying quit across the two follow-up periods, compared to daily light and daily heavy smokers at time *t* (non-daily$_{prob}$ = 13%, 95% CI 10%–17%; daily light$_{prob}$ = 8%, 95% CI 6%–11%; daily heavy$_{prob}$ = 4%, 95% CI 2%–6%; p < 0.01).

A daily light smoker at time *t* who transitioned to non-daily smoking at *t + 1* was more likely to continue smoking at the same level at *t + 2* than to increase consumption to daily heavy smoking status. Continuing daily heavy smokers at time *t* and *t + 1* had greater probability of maintaining the daily heavy smoking status at time *t + 2* or reducing to daily light smoking at *t + 2* than of successfully quitting or becoming a non-daily smoker by *t + 2*. From the logistic regression analysis, a daily heavy smoker at time *t* had a higher probability of being quit at *t + 2* (15%, 95% CI 7%–29%) if his/her smoking consumption was reduced to non-daily at *t + 1* than if he/she continued to be daily heavy (4%, 95% CI 2%–8%; p < 0.01).

3.3. Factors associated with smoking transition at the follow-up period

Table 2 presents factors associated with smoking transitions at the successive follow-up period. Three blocks of variables are assessed: measures of addiction, social norms, and quit behavior.

3.3.1. Baseline non-daily smokers

Compared to non-daily smokers who reported no perceived addiction to smoking, non-daily smokers who reported little or high levels of addiction to smoking had lower odds of quitting and higher odds of increasing consumption by follow-up. Non-daily smokers who had a non-smoking partner/spouse or who did not have a partner/spouse had higher odds of quitting by follow-up than staying stable, compared to non-daily smokers who had a smoking partner/spouse. Non-daily smokers with strong subjective norms (i.e., perception of what important people in their life think about their smoking) had lower odds of increasing their smoking consumption at the follow-up period than remaining stable, compared to non-daily smokers without strong subjective norms. Attempting to quit at least once in the previous year was associated with higher odds of having quit by the follow-up period, compared to no attempt (OR = 1.53, 95% CI 1.03–2.27).

3.3.2. Baseline daily light smokers

Compared to daily light smokers who did not perceive themselves as addicted, daily light smokers who perceived themselves as addicted had lower odds of quitting/reducing cigarette consumption by follow-up, and daily light smokers who reported high levels of addiction had higher odds of increasing consumption by the follow-up period (OR$_{very\ much\ vs\ not\ at\ all}$ = 2.02, 95% CI 1.17–3.48). Regarding social norms, stronger anti-smoking societal norms were associated with lower odds of increasing consumption at follow-up among daily light smokers at time *t*.

Compared to daily light smokers who had not attempted to quit in previous year, those who had attempted to quit had lower odds of increasing consumption by the follow-up period (OR = 0.62, 95% CI 0.41–0.94). Intending to quit in the next 6 months was associated with a higher odds of quitting/reducing cigarette consumption by the follow-up period, compared to not intending to quit (OR = 1.80, 95% CI 1.18–2.73).

3.3.3. Baseline daily heavy smokers

Compared to daily heavy smokers who reported no addiction to smoking, daily heavy smokers who reported high levels of addiction had lower odds of quitting/reducing cigarette consumption by follow-up. Intending to quit in next 6 months was associated with higher odds of quitting/reducing cigarette consumption by follow-up, compared to not intending to quit.

4. Discussion

Our study found that, compared to daily heavy and daily light smokers, non-daily smokers were more likely to quit at follow-up, although about a quarter of non-daily smokers at time *t* continued as non-daily smokers throughout follow-up. Daily heavy smoking was the most stable group across follow-up, although a considerable proportion of daily light (26%) and daily heavy (13%) smokers at time *t* reduced their consumption to non-daily status. Moreover, daily heavy smokers who reduced their cigarette consumption to non-daily were more likely to quit eventually than daily heavy smokers who continued as daily heavy. For all three smoking groups, perceived addiction and measures of quit behavior were important predictors of changing cigarette consumption at follow-up. However, social norm measures were only important predictors of changing consumption among non-daily smokers.

Our results regarding LITS are consistent with previous findings in the literature. For example, the finding that a quarter of baseline non-daily smokers continued as non-daily smokers throughout follow-up is in line with continuing smoking rates found in longitudinal studies conducted on LITS from the US (Hennrikus et al., 1996; Hyland, Rezaishiraz, Bauer, Giovino, & Cummings, 2005; Levy et al., 2009; Lindstrom & Isacsson, 2002; Zhu et al., 2003). We also found that a considerable proportion of baseline daily light and daily heavy smokers reduced their consumption to non-daily status. This finding is consistent
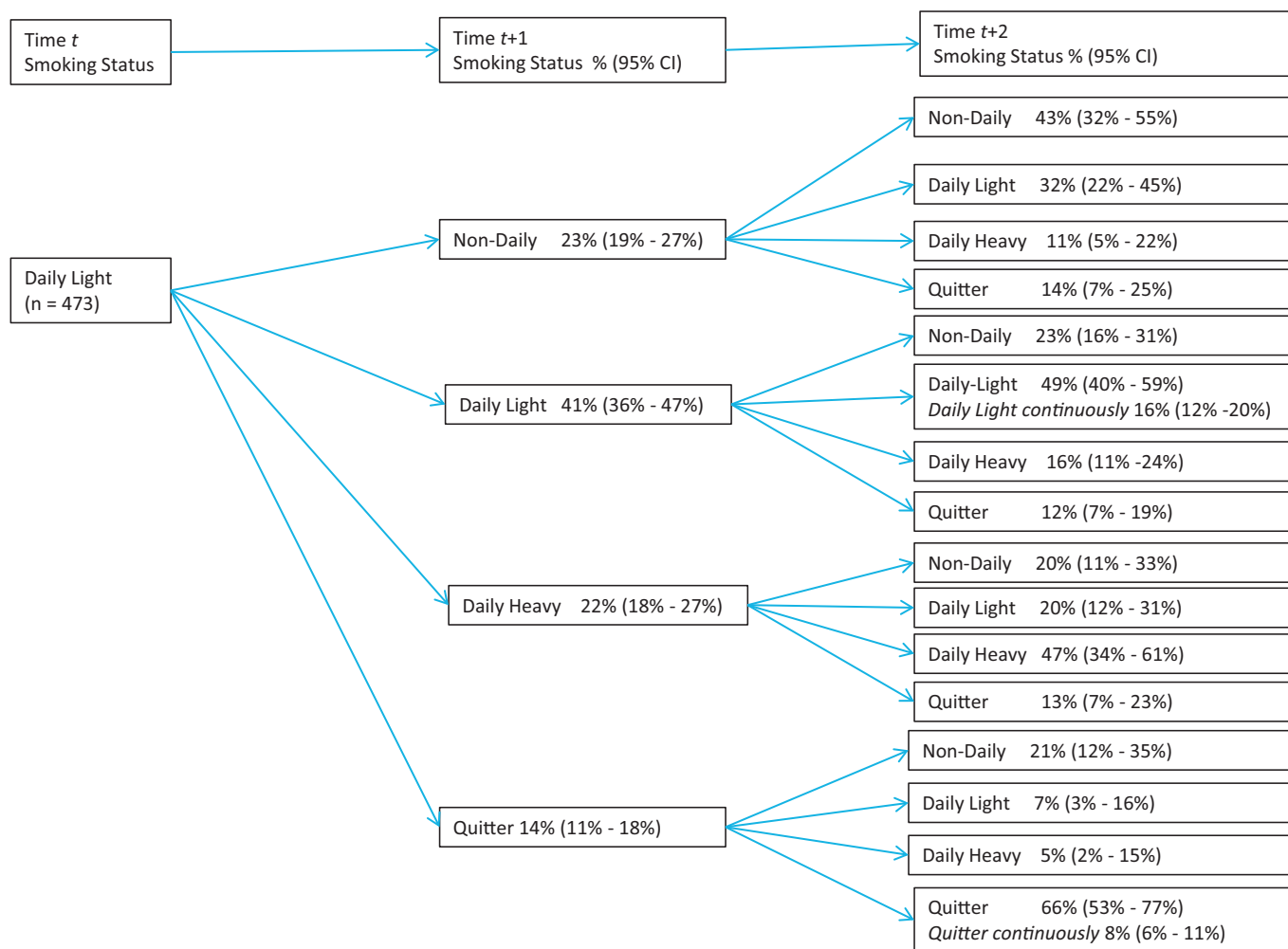
Fig. 2. Smoking transitions from time t to t + 1 and t + 2 among smokers who were daily-light smokers at time t.

with recent studies from the US that showed non-daily smokers as a mixed population of continuous non-daily smokers, as well as smokers who have transitioned from daily smoking to non-daily but may have difficulty in achieving abstinence (Bondy et al., 2013; Schauer, Malarcher, & Berg, 2014; Scheuermann, Mburu, Mathur, & Ahluwalia, 2015; Shiffman, 2009). Future research is needed to identify ideal strategies that could help a greater proportion of non-daily smokers quit completely, as most of the available evidence on cessation interventions is based on smokers with relatively high daily consumption (PHS. 2008 PHS Guideline Update Panel, Liaisons, and Staff, 2008). Lighter smokers are less likely to receive smoking cessation advice from physicians in Mexico (Alonso, 2012), although increasing physician recommendations for cessation counseling may promote cessation in that group. Some recent research indicates that mobile health interventions (e.g., text messages) support smoking cessation among light smokers (Cupertino et al., 2018), and could be integrated into health serviced and promoted through campaigns.

We found that daily light smokers at time *t* were more likely to either increase their consumption to daily heavy or to reduce to non-daily than to quit at *t + 1*. However, once they converted to non-daily smokers at *t + 1*, they were less likely to increase their consumption to DH levels at *t + 2* than to maintain at non-daily status. It is unclear whether this reduction in smoking is a deliberate step for eventual quitting. This is an important finding given the evidence about the decreased mortality risk associated with reducing smoking consumption (Gerber et al., 2012).

Our findings suggest that perceived addiction was an important

factor predicting smoking transition in all three groups, demonstrating its importance beyond physical addiction levels. Smokers who perceived themselves as addicted had lower odds of quitting/reducing smoking consumption at follow-up compared to smokers who perceived themselves as not at all addicted, regardless of baseline smoking status. In addition, non-daily and daily light smokers who perceived themselves as addicted had higher odds of increasing their consumption at follow-up compared to smokers who did not. These findings are in line with previous research on adults and adolescents in the US showing that perceived addiction is associated with both susceptibility to smoking and relapse following a quit attempt (Edwards et al., 2010; Okoli et al., 2009; O'Loughlin et al., 2002). Given that LITS are less likely to receive any cessation advice at a doctor's office (Swayampakala et al., 2013), perceived addiction could be used as an important measure in clinical settings for referral to cessation services for LITS.

For all three smoking groups, quit attempts or quit intentions were associated with changes in cigarette consumption at follow-up, which is in line with findings from previous literature (Levy et al., 2009; Zhu et al., 2003). Making a quit attempt in the past year was associated with quitting/reducing consumption at follow-up among non-daily and daily light smokers. Among daily light and daily heavy smokers, intending to quit in next 6 months was associated with quitting/reducing consumption at follow-up.

Another important finding of this study was that social norms were more important for baseline non-daily, but not daily light and daily heavy, smokers. Research on smoking-related stigma suggests that
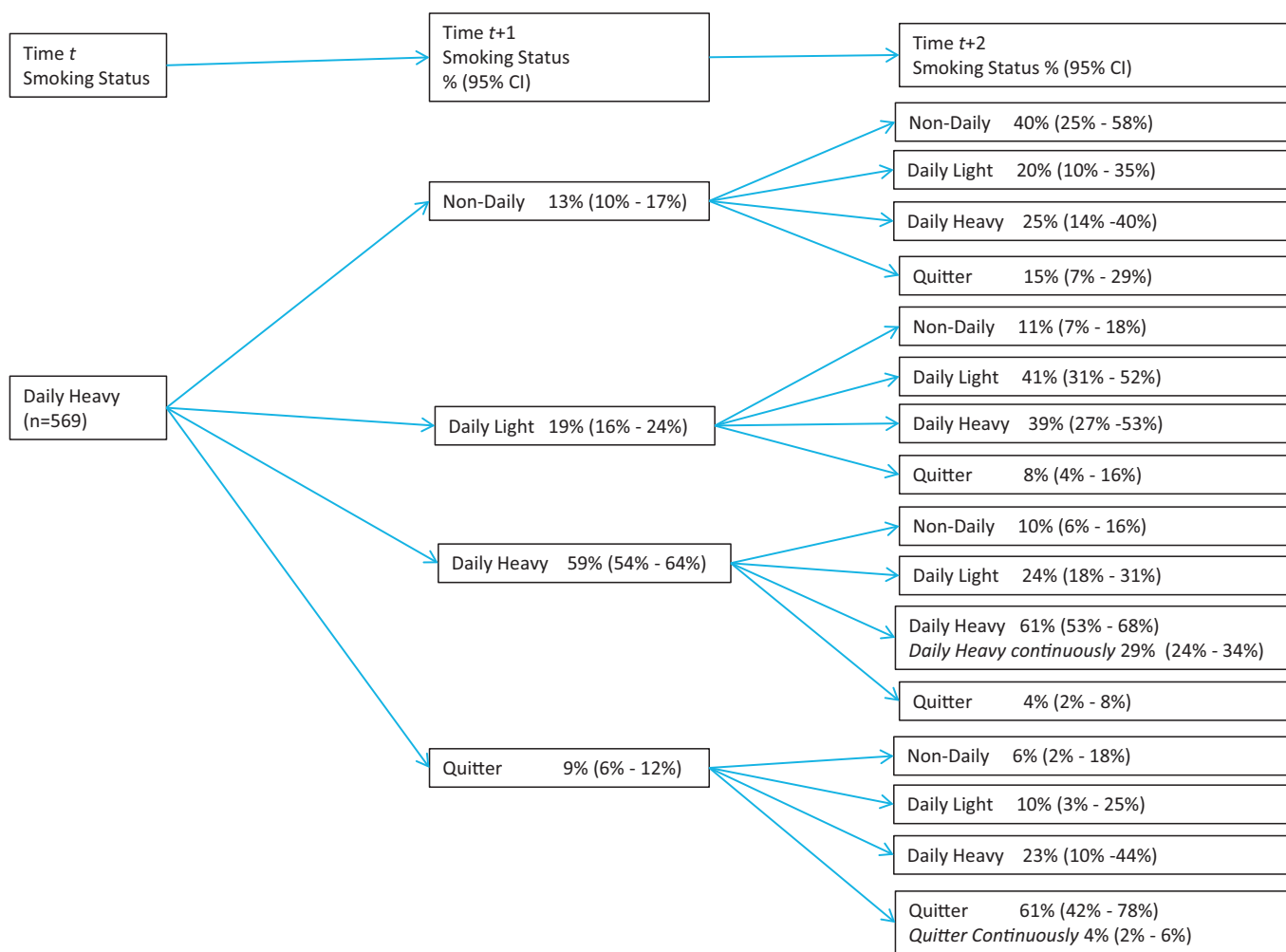
Fig. 3. Smoking transitions from time t to t + 1 and t + 2 among smokers who were daily heavy smokers at time t.

social norms may play a role in reducing smoking (Alamar & Glantz, 2006; Evans-Polce et al., 2015; Hammond et al., 2006; Stuber et al., 2008), but that responses to stigma-inducing smoking policies are variable. In some cases, stigmatization may lead to social isolation and the entrenchment of smoking behavior among continuing smokers (Bell, McCullough, Salmon, & Bell, 2010; Bell, Salmon, Bowers, Bell, & McCullough, 2010; Stuber et al., 2008; Thompson, Pearce, & Barnett, 2007). The lack of association between subjective norms and quit behavior among daily light and daily heavy smokers might indicate that their quit behavior was primarily influenced by personal factors such as perceived addiction and intention to quit.

4.1. Limitations

Our data only cover a limited period of the smoking history for our respondents. There could be unobserved changes in smoking status between study time points. This study was conducted during the time of rapid implementation of several tobacco control policies in Mexico. Even though LITS patterns were established before the stronger tobacco control environment in Mexico (Franco-Marina, 2007), our results may reflect changes in cigarette consumption in response to the policy implementation.

Across the three smoking groups at time *t*, about one-fourth of the sample in each group was lost to follow-up at *t + 2*. This loss to follow-up could have introduced selection bias. Across the three smoking groups, smokers who were not lost to follow-up at *t + 2* were more likely to have reported the same smoking status at *t* and *t + 1* compared

to smokers who were lost to follow-up. Hence, we may have underestimated the proportion of smokers who made a transition from *t + 1* to *t + 2*. However, for perceived addiction, social norms measures, and quit intentions, those who were lost to follow-up were not statistically different from the smokers who were not, suggesting that the influence of attrition may be minimal in the analysis looking at the factors associated with smoking transitions.

All measures were self-reported and may be prone to social desirability bias, which may have resulted in the overestimation of social norms and underestimation of smoking intensity levels. Our study may also suffer from omitted variable bias. We did not assess some potentially important covariates of smoking behaviors, like anxiety disorders and depression, which are associated with greater smoking intensity (Johnson & Novak, 2009; Massak & Graham, 2008). As overall smoking prevalence declines in response to tobacco control policies and programs, smoking can become increasingly concentrated among populations with psychological comorbidities and substance use disorders (Stanton et al., 2016; Weinberger et al., 2017). Future research should investigate their prevalence and importance in explaining LITS patterns of smoking, including in countries that have only recently adopted strong tobacco control policies recommended by the Word Health Organization's Framework Convention on Tobacco Control. Lastly, the generalizability of these findings might be limited by data collection in seven major cities in Mexico and no rural areas. However, these seven cities include all major regions of the country, and about 78% of Mexicans live in urban areas (INEGI, 2006).

Table 2

Factors associated with smoking transition at follow-up stratified by smoking status at time t.

	ND smokers		DL smokers		DH smokers
	Quitter vs stable	Increase vs stable	Quit or reduce vs stable	Increase vs stable	Quit or reduce vs stable
	Adjusted OR[a] (95% CI)	Adjusted OR[a] (95% CI)	Adjusted OR[a] (95% CI)	Adjusted OR[a] (95% CI)	Adjusted OR[a] (95% CI)
Block-I: measures of addiction					
Age at first cigarette					
> 16 years	REF	REF	REF	REF	REF
≤16 years	1.00	0.78	1.02	1.38	0.84
	[0.68–1.49]	[0.57–1.08]	[0.77–1.37]	[0.93–2.05]	[0.63–1.13]
Perceived addiction					
Not at all	REF	REF	REF	REF	REF
Little	**0.60***	**1.64***	**0.60****	1.10	0.87
	[0.40–0.91]	**[1.11–2.42]**	**[0.41–0.87]**	[0.66–1.83]	[0.46–1.65]
Very much	**0.34***	**1.94***	**0.39*****	**2.02***	**0.47***
	[0.14–0.83]	**[1.06–3.55]**	**[0.25–0.62]**	**[1.17–3.48]**	**[1.26–0.85]**
Block II: measures of social norms					
Descriptive norms					
Partner/spouse smoking status					
Yes	REF	REF	REF	REF	REF
No	**1.63***	0.95	1.02	1.06	0.99
	[1.01–2.61]	[0.61–1.49]	[0.68–1.54]	[0.65–1.72]	[0.67–1.47]
No partner	**2.03****	1.18	0.87	2.20	1.85
	[1.25–3.30]	[0.77–1.83]	[0.40–1.92]	[0.79–6.13]	[0.99–3.46]
Number of smokers in five closest friends					
None	REF	REF	REF	REF	REF
1 to 3	0.99	1.40	1.17	1.03	0.78
	[0.61–1.61]	[0.71–2.74]	[0.64–2.14]	[0.56–1.92]	[0.49–1.23]
4 or 5	0.75	1.25	1.06	1.16	0.99
	[0.43–1.32]	[0.64–2.45]	[0.59–1.91]	[0.59–2.26]	[0.62–1.58]
Subjective norms					
Important people believe I should not smoke					
Not agree	REF	REF	REF	REF	REF
Agree/strongly agree	0.74	**0.63***	0.90	1.15	1.10
	[0.45–1.21]	**[0.42–0.95]**	[0.57–1.41]	[0.66–2.00]	[0.74–1.61]
Societal norms	1.04	1.01	1.15	**1.38****	0.91
	[0.80–1.35]	[0.83–1.23]	[0.94–1.40]	**[1.10–1.73]**	[0.77–1.08]
Block III: quit behavior					
Attempted to quit in the previous year					
No	REF	REF	REF	REF	REF
Yes	**1.53***	1.00	1.31	**0.62***	0.91
	[1.03–2.27]	[0.70–1.44]	[0.94–1.82]	**[0.41–0.94]**	[0.65–1.27]
Intending to quit in next 6-months					
No	REF	REF	REF	REF	REF
Yes	1.28	0.65	**1.80****	1.07	**1.59***
	[0.85–1.93]	[0.43–1.00]	**[1.18–2.74]**	[0.59–1.95]	**[1.04–2.41]**

*** p < 0.001.
** p < 0.01.
* p < 0.05.
[a] Adjusted for all the variables in each block and also for socio-demographics (age, gender, education & income) and time-in sample.

5. Conclusions

To the best of our knowledge, this is the first study in a middle-income country to examine changes in smoking consumption patterns and factors that are associated with these changes. By stratifying analyses by smoking status at time *t*, we were able to identify the factors that were associated with quitting/reducing smoking or increasing consumption among non-daily, daily light, and daily heavy smokers. Future research should aim to investigate whether there is any differential impact of tobacco control policies, programs, and interventions across different smoking intensity groups.

Declaration of interests

All authors declare that they have no conflicts of interest.

Appendix A

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┌─────────────────────────────┐
│   From waves III to V:      │
│ N_smokers = 2871 & N_obs = 5267 │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│ At least one wave of follow-up data: │
│ N_smokers = 2100 & N_obs = 4136 │
└─────────────────────────────┘
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Analytic Sample 1: Smoking transition analysis	Analytic Sample 2: Factors associated with smoking transitions
Baseline smokers with at least two waves of follow-up	Smokers with at least one wave of follow-up and no missing smoking status:
Non-Daily smokers = 502	$N_{smokers} = 2073$ & $N_{obs} = 4106$
Daily light smokers = 473	
Daily heavy smokers = 569	
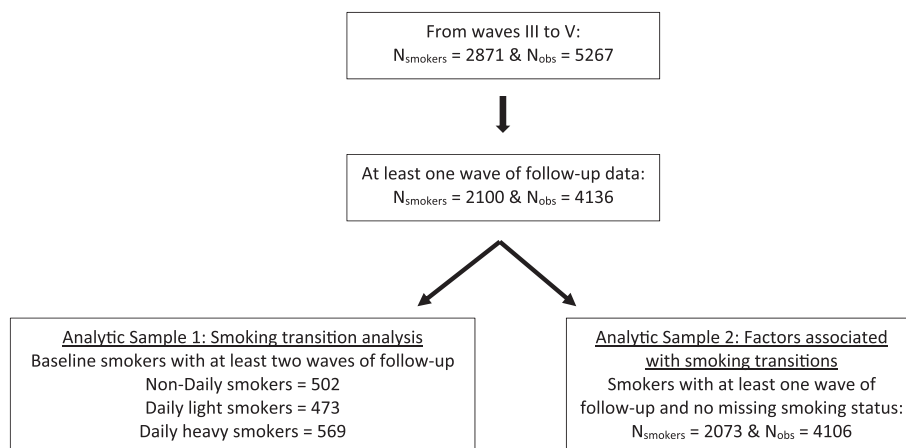
Appendix Fig. 1. Flow-chart depicting the sample size.

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