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UNIVERSITY OF CALIFORNIA, SAN DIEGO
SAN DIEGO STATE UNIVERSITY

Two Groups of Occasional Smokers:
Different Pathways with the Same Outcome

A dissertation submitted in partial satisfaction of the
Requirements for the degree Doctor of Philosophy

in

Clinical Psychology

by

Quyên B. Nguyen

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2010

The dissertation of Quyen B. Nguyen is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Chair

University of California, San Diego
San Diego State University

2010

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ACKNOWLEDGEMENTS

I want to thank Dr. Shu-Hong Zhu, my dissertation committee chair, for his guidance through the dissertation process from the very beginning to this very end. Dr. Zhu has also been a great research mentor and advisor during my years of graduate training. I am grateful for having had the opportunities to learn how to do good research and to work on interesting research projects.

I also wish to thank my dissertation committee members—Dr. Elder, Dr. Klonoff, Dr. Myers, and Dr. Norman—for serving on my committee and also for helping me in many other important ways during my graduate career.

Study 2, in part, is published in *Nicotine & Tobacco Research*, 2009. Nguyen, Quyen B.; Zhu, Shu-Hong. The dissertation author was the primary investigator and the primary author of this paper.

Study 3, in part, is currently being prepared for submission for publication. Nguyen, Quyen B.; Zhu, Shu-Hong. The dissertation author was the primary investigator and author of this material.

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ABSTRACT OF THE DISSERTATION

Two Groups of Occasional Smokers:
Different Pathways with the Same Outcome

by

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Doctor of Philosophy in Clinical Psychology

University of California, San Diego, 2010
San Diego State University, 2010

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Occasional (non-daily) smokers pose difficulties for classic withdrawal-based addiction theory because they can regularly go without cigarettes for days with no apparent discomfort. Occasional smokers can be further divided into two subgroups: (1) occasional smokers who used to smoke daily, also known as former-daily occasional smokers (FDO) and (2) occasional smokers who never smoked daily (NDO). Little is known about the situations under which occasional smokers typically smoke their cigarettes, and even less is known about how daily smokers transition to occasional smoking.

Three exploratory studies were conducted to examine the following questions. (1) What proportions of smokers are occasional and daily smokers, and how have the respective proportions changed as social norms become increasingly anti-smoking and as smoking continues to decline? (2) When are occasional smokers most likely to smoke, and how do they compare with daily smokers? (3) How do daily smokers transition to smoking occasionally? When they first cut back to smoking only about half the days in a month, which days are they most likely

to forgo? The first study analyzed data from the 1996, 1999, 2002, and 2005 California Tobacco Surveys (CTS); the second used data from the 2002 CTS Young Adult Supplement, which includes questions on smoking situations; and the third focused on 152 occasional smokers recruited from the Internet for detailed interviews on smoking situations.

The studies found that occasional smokers represent substantial proportions of all current smokers. Moreover, as the overall smoking prevalence declined from 17.7% in 1996 to 14.2% in 2005, the proportions of occasional smokers did not decrease, as would be predicted by their significantly higher cessation rates compared to that of daily smokers. The proportion of FDO smokers increased, though not significantly, from 1996 to 2005: 12.3% to 14.2% for men and 12.9% to 16.8% for women. The NDO proportion increased from 11.9% to 15.3% for men and decreased slightly from 10.6% to 9.5% for women; but again neither change is statistically significant. The pattern of smoking situations for FDO smokers was quite similar to that of NDO smokers, with greater overall likelihood of smoking in social or episodic situations (i.e., socializing with friends or going out) rather than solitary or routine situations (i.e., working or driving). Both differed significantly from that of daily smokers who tended to smoke across a variety of situations. Most FDO smokers (64.3%) had converted to occasional smoking through quitting smoking completely and then returning to smoking non-daily, rather than by cutting down their consumption gradually.

Based on these findings we propose a model explaining how daily smokers could transition to occasional smoking. The minority of daily smokers who cut down gradually to non-daily smoking first forgo those days involving routine, solitary situations, such as at home with no other smokers present. The majority who quit daily smoking and later relapse to occasional smoking restrict their smoking mostly to days that involve episodic social situations, such as at parties. In either case, the results from the present three studies show that FDO smokers are virtually indistinguishable from NDO smokers in their current smoking situations, suggesting their previous smoking pattern has very limited influence on their current smoking behavior.

General Introduction

Overview of occasional smoking

For many decades, the typical smoker was believed to smoke a pack a day (Giovino et al., 1994). Surveys did not separate occasional, or non-daily, smoking from daily smoking, perhaps because occasional smoking was perceived as uncommon.

More recently, occasional smoking has received recognition in research studies. Starting in the 1990s, population surveys differentiated occasional smoking from daily smoking (Centers for Disease Control and Prevention (CDC), 1994a; Centers for Disease Control and Prevention (CDC), 1994b; Evans et al., 1992). Based on these recent surveys, the proportion of adult smokers who smoke occasionally ranged from 13-30% (Burns, Major, & Shanks, 2003; Centers for Disease Control and Prevention (CDC), 2008; Evans et al., 1992; Gilpin & Pierce, 2002; Hassmiller, Warner, Mendez, Levy, & Romano, 2003; Tong, Ong, Vittinghoff, & Perez-Stable, 2006; Trinidad et al., 2009; Wortley, Husten, Trosclair, Chrismon, & Pederson, 2003; Zhu, Sun, Hawkins, Pierce, & Cummins, 2003).

Like regular smoking, occasional smoking and low-rate daily smoking have been associated with adverse health effects. Occasional smoking has been linked to shortness of breath or exhaustion after “regular activities” and, to some extent, to coughing or a sore throat (An et al., 2009). In one study, compared to people who never smoked, occasional smokers were at increased risk for smoking-related cancers, including of the bladder, kidney, pancreas, esophagus/trachea, and lung (Bjerregaard et al., 2006). Another study showed that male occasional smokers were at increased risk for total mortality and cardiovascular mortality compared to men who never smoked (Luoto, Uutela, & Puska, 2000). In addition, men and women who smoked 1-4 cigarettes per day were more likely to die from lung cancer or from heart disease than those who never smoked (Bjartveit & Tverdal, 2005). In one study, men who smoked 1-4 cigarettes per day were more likely to have coronary heart disease events than non-smoking men (Rosengren, Wilhelmsen, & Wedel, 1992), while another study indicated that women who smoked 3-5 grams a day (equivalent to 3-5 cigarettes) had greater risk of myocardial

infarction and total mortality compared to women who never smoked (Prescott, Scharling, Osler, & Schnohr, 2002). All together, these studies indicate that there is no safe level for smoking.

Adult occasional smokers are not merely uptake, or new, smokers or social smokers. Since new smokers typically start smoking occasionally before progressing to heavier smoking (Mayhew, Flay, & Mott, 2000; Russell, 1979; Wellman, DiFranza, Savageau, & Dussault, 2004), one argument is that occasional smokers are uptake smokers. However, most adult occasional smokers are not uptake smokers—about 62–87% across different studies (Evans et al., 1992; Hassmiller et al., 2003; Henrikus, Jeffery, & Lando, 1996). Another argument is that occasional smokers are social smokers, usually described as primarily smoking with other people or self-identifying as social smokers (Husten, 2009). However, in a population study, only 35-40% of young adult occasional smokers reported smoking only with other people (Gilpin, White, & Pierce, 2005). Furthermore, an ecological momentary assessment study of occasional smokers indicated that only 29% of cigarettes were smoked when socializing (Shiffman, Kirchner, Ferguson, & Scharf, 2009).

In population-based surveys, occasional smoking is characterized by certain demographics and smoking characteristics. Occasional smokers tend to be young, educated, and non-White (Biener & Albers, 2004; Evans et al., 1992; Finney Rutten, Augustson, Doran, Moser, & Hesse, 2009; Hassmiller et al., 2003; Shavers, Lawrence, Fagan, & Gibson, 2005; Tong et al., 2006; Trinidad et al., 2009; Wortley et al., 2003; Zhu et al., 2003). Findings are mixed about whether occasional smokers tend to have higher income or be male (Evans et al., 1992; Finney Rutten et al., 2009; Hassmiller et al., 2003; Tong et al., 2006; Trinidad et al., 2009; Wortley et al., 2003; Zhu et al., 2003).

Nicotine dependence

Occasional smokers smoked an average of 15 days out of the past 30 days and 6 or fewer cigarettes on the days they smoke (Gilpin & Pierce, 2002; Hassmiller et al., 2003; Trinidad et al., 2009; Zhu et al., 2003). Occasional smokers' low cigarette consumption presents a

challenge to the classic withdrawal-based view of nicotine addiction. According to this view, nicotine produces reinforcing primary and secondary effects (Fernando, Wellman, & Difranza, 2006; Perkins, Grottenthaler, & Wilson, 2009; Shiffman, 1991). With continued smoking over time, smokers build up tolerance to nicotine and increase their cigarette consumption (Benowitz, 1999; Fernando et al., 2006; Shiffman, 1991). They need to smoke regularly to maintain a certain level of nicotine in their bodies to avoid experiencing withdrawal symptoms (Fernando et al., 2006; Shiffman, 1991). The development of tolerance after repeated exposure to nicotine has been empirically demonstrated in mice and rat studies (Hendry & Rosecrans, 1982; Marks, Burch, & Collins, 1983; Stolerman, Fink, & Jarvik, 1973) and to some extent in human studies (Perkins, Epstein, Stiller, Marks, & Jacob, 1989; Perkins et al., 1994).

Although this classic addiction view applies to regular daily smokers, it does not pertain to occasional smokers. The reason is that the half-life of nicotine is 2–3 hours (Benowitz, 1999; Benowitz, 2008; Shiffman et al., 1992) and occasional smokers regularly go a whole day or longer without smoking. Thus, occasional smokers do not regularly smoke enough cigarettes to maintain plasma nicotine levels. Providing some support for this, in one study, after low-rate smokers abstained from smoking, there was no change in their withdrawal scores 12 or even 24 hours after abstinence (Rubinstein, Benowitz, Auerback, & Moscicki, 2009).

Two groups of occasional smokers have further implications for classic withdrawal-based addiction theory: (1) former-daily occasional (FDO) smokers are daily smokers who cut down their smoking to become occasional smokers and (2) never-daily occasional (NDO) smokers are smokers who never developed a daily smoking habit but continued smoking occasionally. Contrary to classic addiction theory, NDO smokers did not build a tolerance to nicotine and progress to addicted, daily smoking. They did not become addicted despite having enough exposure to nicotine, defined as having smoked at least 100 cigarettes. On the other hand, FDO smokers changed their cigarette consumption when they switched to occasional smoking. As daily smokers, some of these FDO smokers had smoked fewer than five cigarettes per day, which is considered below the threshold of nicotine dependence (Benowitz & Henningfield, 1994).

Yet other FDO smokers had smoked more than five cigarettes per day, which is above the threshold for nicotine dependence (Benowitz & Henningfield, 1994). The latter group of FDO smokers had somehow switched from being nicotine-dependent to no longer nicotine-dependent.

As a whole, occasional smokers do not smoke or react to cigarettes differently than addicted or daily smokers. For example, in a study of adolescents, occasional smokers did not differ from daily smokers on their cigarette-smoking behaviors, such as number of puffs per cigarette, average puff volume, or total puff volume (Corrigall, Zack, Eissenberg, Belsito, & Scher, 2001). Similarly, in a study of adult smokers, “tobacco chippers”—who smoke five or fewer cigarettes per day and include occasional smokers—did not differ from regular daily smokers on number of puffs per cigarette, puff time, time between puffs, and time smoking a cigarette (Brauer, Hatsukami, Hanson, & Shiffman, 1996). Also, after smoking a cigarette, tobacco chippers and heavy smokers showed similar proportional increases of physical indicators, including carbon monoxide, saliva cotinine, serum nicotine, heart rate, and blood pressure (Brauer et al., 1996; Shiffman, 1989; Shiffman, Fischer, Zettler-Segal, & Benowitz, 1990; Shiffman et al., 1992). Thus, the above studies support the idea that occasional smokers do not differ from daily smokers on smoking topography as well as physical responses to smoking.

A possible factor to take into account is that occasional smokers may concurrently use other tobacco products besides cigarettes. Thus, they might not appear addicted to nicotine based on their occasional cigarette smoking. With the other supplemental tobacco products, perhaps occasional smokers actually are addicted. However, concurrent use of other tobacco products is low among occasional smokers, ranging from 6% to 10% (Backinger et al., 2008), so it is not a major factor in studies of occasional smoking.

Another issue to consider in occasional smoking is nicotine metabolism. Slower nicotine metabolism due to CYP2A6 gene activity has been linked to lower risk of dependence and also lower tobacco consumption (Schoedel, Hoffmann, Rao, Sellers, & Tyndale, 2004; Tyndale, Pianezza, & Sellers, 1999; Tyndale & Sellers, 2001). It has also been associated with slower progression of nicotine dependence among adolescent smokers (Audrain-McGovern et al., 2007).

One study revealed that slower metabolizers might have lower puff volume per cigarette compared to normal metabolizers, though they did not smoke fewer cigarettes (Strasser, Malaiyandi, Hoffmann, Tyndale, & Lerman, 2007). Taken together, these studies suggest nicotine metabolism is a possible protective factor against developing nicotine dependence. This has not been fully explored with occasional smokers.

The nicotine metabolism issue gets more complicated when considering ethnicity. For Asians, slower nicotine metabolism has been associated with lower tobacco consumption as well as lower nicotine intake per cigarette (Benowitz, Perez-Stable, Herrera, & Jacob, 2002). For Blacks, the pattern is slightly different, with slower nicotine metabolism but higher nicotine intake per cigarette compared to Whites (Perez-Stable, Herrera, Jacob, & Benowitz, 1998). However, despite differences in cigarette consumption, there was no difference in nicotine intake per cigarette or nicotine metabolism for Hispanics/Latinos compared to Whites (Benowitz et al., 2002).

Population trends for occasional smoking

Regarding interest in quitting, occasional smokers differ from regular daily smokers. Specifically, studies show that occasional smokers are more motivated to quit smoking (Henrikus et al., 1996; Tong et al., 2006; Zhu et al., 2003). In addition, occasional smokers are more likely to have made a recent quit attempt, recent defined as in the previous three months to a year (Henrikus et al., 1996; Wortley et al., 2003; Zhu et al., 2003). Those studied were also less likely to smoke at a two-year follow-up than daily smokers were (Henrikus et al., 1996; Wetter et al., 2004; Zhu et al., 2003). For example, at a two-year follow-up for the 1990 CTS, 36% of occasional smokers no longer smoked, in contrast to 12% for daily smokers (Zhu et al., 2003).

Occasional smokers' interest in quitting is reflected in their less stable smoking status over time. In a longitudinal population survey, among FDO smokers, 39% had been occasional smokers two years prior (Gilpin, Cavin, & Pierce, 1997). About 36% of FDO smokers smoked

daily two years before, and 25% had quit (Gilpin et al., 1997). NDO smokers had greater stability; 66% were occasional smokers two years before (Gilpin et al., 1997). About 23% of NDO smokers had quit two years prior, while 11% were still daily smokers (Gilpin et al., 1997). In contrast to the two occasional smoker groups, 94% of regular daily smokers who smoked more than five CPD were also in the same cigarette consumption category as two years before (Gilpin et al., 1997).

Given the higher quit rate for occasional smokers, the proportion of occasional smokers among current smokers could be expected to decrease over time. However, national surveys indicate that the proportion of current smokers who smoke occasionally has stayed around 18-19% from 1993 to 2004 (Centers for Disease Control and Prevention (CDC), 2005). By contrast, the proportion of heavy daily smokers (25 cigarettes per day or more) went down from 19.1% to 12.1%. However, the proportions of lighter daily smokers went up: from 2.9% to 4.8% for low-rate daily smokers (four or fewer cigarettes per day) and from 20.6% to 28.4% for those who smoked 5-14 cigarettes daily (Centers for Disease Control and Prevention (CDC), 2005).

No population-based studies have been conducted regarding the smoking prevalence of FDO smoking and NDO smoking, or the proportions of current smokers who are FDO smokers or NDO smokers. Such studies could examine the stability of FDO and NDO smoking prevalence or smoking proportions over time at the population level.

Former-daily smoking but currently occasional smoking

In this dissertation, occasional smokers were separated into former-daily smokers and never-daily smokers due to the primary interest in dependence and cigarette consumption. Occasional smokers are roughly split half and half into former-daily and never-daily (Gilpin & Pierce, 2002; Hassmiller et al., 2003).

Former-daily smoking is typically defined as having smoked daily for at least six months (Gilpin & Pierce, 2002; Hassmiller et al., 2003). This six-month cutoff is based on the World Health Organization's guidelines for identifying established daily smokers (Pierce, 1989). Based

on this definition, it is possible that never-daily occasional smokers may have previously smoked daily, but not cumulatively for six months. There is also the possibility that NDO smokers could become daily smokers at some point in the future, though this likelihood is reduced after smokers have smoked for about three years (Evans et al., 1992).

Though FDO smokers are a relatively understudied subgroup of occasional smokers, the few existing studies reveal interesting details about FDO smoking history. Longitudinal studies confirm that daily smokers do transition to occasional smoking (Etter, 2004; Hennrikus et al., 1996; Lindstrom, Isacson, & Malmo Shoulder-Neck Study Group, 2002; Zhu et al., 2003), so FDO smokers are not misreporting their smoking history in cross-sectional surveys. With respect to smoking history, in one population-based study, half the FDO smokers had last smoked daily five years prior to the survey (Gilpin et al., 1997). Though not significant, there was a trend that the fewer the cigarettes regularly smoked, the longer the time FDO smokers last smoked daily (Gilpin et al., 1997). In another sample, FDO smokers had last smoked daily an average of 4.25 years, with a median of two years (Gilpin & Pierce, 2002).

Still unexplored is how FDO smokers transition from daily smoking to occasional smoking. A model was presented depicting how daily smokers could modify their level of cigarette consumption to become occasional smokers (Zhu et al., 2003). One pathway is when daily smokers cut down their consumption to occasional smoking. (Zhu et al., 2003). Another possible pathway is when daily smokers quit and then relapse to occasional smoking (Zhu et al., 2003). A related issue is how exactly FDO smokers converted from smoking every day to about every other day: Which smoking days or situations did they cut out when they reduced their smoking? Which smoking days or situations did they pick up when they slipped or relapsed?

Another question left unanswered in the literature is whether, having reached a lower level of smoking, FDO smokers are satisfied with their current level of smoking, or if they are actively reducing or quitting smoking. Perhaps, as one survey from Australia indicates, since FDO smokers reduced their level of smoking, they might consider themselves already quit or not really a smoker (Morley, Hall, Hausdorf, & Owen, 2006). Thus, a concern is that smokers'

smoking reduction undermines the possibility of their trying to quit in the future (Hughes & Carpenter, 2006). However, studies have shown that a reduction in the number of cigarettes smoked predicts future quitting (Broms, Korhonen, & Kaprio, 2008; Farkas, 1999; Hughes & Carpenter, 2006; McDermott, Dobson, & Owen, 2008), and this could very well apply to FDO smokers. On the other hand, a more recent longitudinal study found that reduced consumption did not influence future smoking cessation attempts (Yong, Borland, Hyland, & Siahpush, 2008). To date, no studies have looked at recent quitting among FDO smokers (Hughes & Carpenter, 2006).

Parallel to FDO smokers, cases can be found of dependent users later becoming controlled users with other substances. For example, although controlled drinking among former alcoholics and problem drinkers had been at the center of a decades long controversy (Marlatt, 1983; Sobell & Sobell, 1995), recent population survey studies indicate that, in fact, a substantial percentage of formerly alcohol-dependent individuals report being controlled drinkers (Cunningham, Lin, Ross, & Walsh, 2000; Sobell, Cunningham, & Sobell, 1996). In one population survey, among those with previous alcohol dependence, about half were no longer alcohol-dependent but still drank alcohol (Dawson, 1996). Another example is heroin; a subset of chippers, or non-daily users, reported previously using heroin daily, often multiple times a day (Harding, Zinberg, Stelmack, & Barry, 1980). This idea of chipping has been applied to tobacco, and similarly, a subgroup of tobacco chippers used to be heavier daily smokers (Hajek, West, & Wilson, 1995; Shiffman, Paty, Kasssel, Gnys, & Zettler-Segal, 1994).

Former-daily occasional vs. never-daily occasional. One issue is how former-daily occasional (FDO) smokers compare to never-daily occasional (NDO) smokers. By definition, FDO and NDO smokers differ in their history of daily smoking for at least six months. If FDO and NDO are similar on current smoking behaviors, such as smoking situations or cigarette consumption, then this might suggest that daily smoking history has little influence once daily smokers reduce to occasional smoking. Thus, once daily smokers transition to occasional smoking, they behave much like long-term or never-daily occasional smokers. On the other

hand, if FDO and NDO differ on aspects of their current smoking, this might indicate different possibilities, including that the FDO smokers and NDO smokers were different types of smokers to begin with or that FDO smokers retained some of their previous smoking history. In the latter possibility, perhaps FDO smokers are halfway between NDO smokers, their current smoking category, and daily smokers, their former smoking category.

Based on a population study, the demographics of FDO and NDO smokers differ (Gilpin et al., 1997). A majority of FDO smokers were White (60%), in contrast to 40% for NDO smokers (Gilpin et al., 1997). With respect to age, about half of FDO smokers were at least 40 years old while only 30% of NDO smokers were (Gilpin et al., 1997). In terms of smoking initiation age, FDO smokers tend to start smoking at earlier, with 68% starting before 20, which is greater than 44% for NDO smokers (Gilpin et al., 1997). These demographic differences could suggest that these two occasional-smoking groups differ in their current smoking behaviors.

In fact, FDO smokers do differ from NDO smokers on smoking history and cigarette consumption. Specifically, in one California survey, FDO smokers were more likely than NDO smokers to have reduced their smoking in the past, 79.9% vs. 41.9% respectively (Gilpin & Pierce, 2002). This may have occurred when they switched from daily to occasional smoking. In terms of cigarette consumption, more FDO smokers smoked more than half of the past 30 days compared to NDO smokers, 66% vs. 40% respectively (Gilpin et al., 1997). In addition, FDO smokers' average number of cigarettes on smoking days was higher than that of NDO smokers, 2.9 and 1.7 respectively (Gilpin & Pierce, 2002). FDO smokers were also more likely to rate themselves as addicted than NDO smokers were (Gilpin et al., 1997; Gilpin & Pierce, 2002).

On the other hand, FDO smokers are similar to NDO smokers when it comes to quitting patterns. In one population survey, similar percentages of FDO and NDO smokers reported having quit for at least a year cumulatively, 57% and 54% respectively (Gilpin et al., 1997). In another survey, the same percentage (61%) of FDO and NDO smokers reported an expectation to cut down in six months (Gilpin & Pierce, 2002). FDO and NDO smokers also did not differ on readiness to quit smoking (Gilpin et al., 1997; Gilpin & Pierce, 2002). The two previous surveys

focused on lifetime history for quitting of FDO and NDO smokers. However, to date, there have been no studies about recent quitting behaviors for FDO smokers or NDO smokers. Recent quitting behavior is an important predictor of future smoking behavior: A previous study showed that for smokers, the longest quit attempt during the last year, together with cigarettes smoked per day, was a better predictor of later smoking cessation than readiness or motivation to quit alone (Abrams, Herzog, Emmons, & Linnan, 2000).

Former-daily occasional smokers are important to study theoretically and practically. Theoretically, because FDO smokers successfully modify their level of nicotine dependence, they do not fit the classic addiction profile. FDO smokers probably smoke for non-dependence reasons, which have not been fully explored. Practically, understanding FDO smokers has potential implications for how to reduce cigarette consumption at the population level. Much of the existing literature, theories, and campaigns has targeted more heavy daily smokers and not light smokers, such as occasional smokers (Fagan & Rigotti, 2009).

Converted vs. native chippers. FDO and NDO smokers have analogues in tobacco chippers: Converted tobacco chippers had previously smoked heavily (≥ 15 cigarettes per day) while native tobacco chippers had always smoked at a low rate. Two studies have compared converted chippers and native chippers, but samples for these studies were limited to 65 White smokers (Shiffman et al., 1994) and 61 new mothers (Hajek et al., 1995). Previous research shows that as a group, converted chippers had smoked more cigarettes in their lifetime than did native chippers (Shiffman et al., 1994). In spite of that, converted and native chippers were similar on addiction measures, including time to first cigarette, perceived addiction, craving when not smoking, and average withdrawal severity when not smoking (Shiffman et al., 1994). They also did not differ on biochemical measures, such as saliva and serum cotinine levels and exhaled carbon monoxide (Hajek et al., 1995; Shiffman et al., 1994). On current cigarette consumption, the two chipper groups had a similar number of smoking days per week as well as average daily smoking rate (Shiffman et al., 1994). With respect to smoking situations, similar percentages of converted and native chippers reported often or almost always smoking after a

meal, while drinking coffee or tea, while concentrating, while talking on the phone, during leisure time, and when others are smoking (Hajek et al., 1995). In terms of smoking motivation, native and converted chippers had similar scores on smoking for pleasurable relaxation, sedation, stimulation, automatic smoking, and dependence (Hajek et al., 1995). These two studies indicate many similarities between converted and native chippers on current smoking behaviors. One caveat is that these studies of tobacco chippers may not apply to occasional smokers due to the small sample sizes as well as the limited sample of smokers (White or new mothers). More studies are needed that focus specifically on occasional smokers from a representative sample of the population.

Conceptual framework

Though classic withdrawal-based addiction theory does not explain occasional smoking, other theories might help with the conceptualization of FDO smoking and NDO smoking.

Self-image theory. How smokers see themselves is important. For example, occasional smokers may not consider themselves to be “real smokers” due to their low smoking rate (Levinson et al., 2007). Also, most of their day-to-day situations do not involve smoking (Zhu, Pulvers, Zhuang, & Baezconde-Garbanati, 2007). Thus, occasional smokers may not even consider smoking or even experience an urge to smoke in many situations (Orford, 2001). Self-image theory may be particularly relevant to NDO smokers who have not been daily smokers for a substantial period of time, for example six months.

Social norms theory. Another factor that may influence occasional smoking is social norms, which can be injunctive (should people smoke?) or descriptive (how many people smoke?) (Hamilton, Biener, & Brennan, 2008; Lewis, DeVellis, & Sleath, 2002).

At the population level, tobacco control strategies can influence social norms by decreasing secondhand smoke through restrictions, opposing pro-tobacco efforts, making tobacco less available, or promoting tobacco cessation (California Department of Health Services, Tobacco Control Section (CDHS/TCS), 2006). Through such efforts, tobacco control

may have contributed to relatively high rates of light and occasional smoking (Pierce, White, & Messer, 2009; Shiffman, 2009). Social norms could also influence smoking uptake among smokers, so occasional smokers are less likely to become daily, dependent smokers, leading to more NDO smokers. On the other hand, they could encourage regular smokers to reduce their smoking or to quit smoking, leading to more FDO smokers.

At the social network level, smoking or quitting behaviors can spread through members. As an example, according to a longitudinal study, an individual's chance of smoking decreased when a spouse or partner, sibling, friend, or co-worker quit smoking (Christakis & Fowler, 2008). In addition, smokers were often connected to other smokers in the social network (Christakis & Fowler, 2008), and clusters of nonsmokers were typically separate from clusters of smokers (Christakis & Fowler, 2008). Social influence on smokers depended on the nature of the relationship: siblings and spouses/partners influenced smokers across different smoking intensities, while friends and coworkers affected only low-level smokers (1-4 cigarettes a day) (Christakis & Fowler, 2008). Mechanisms for social influence could involve network "norms about the acceptability of smoking" as well as network behaviors like "asking [smokers] not to smoke" or "sharing cigarettes" (Christakis & Fowler, 2008).

Having a low proportion of smokers in the social network may be a protective factor for light smokers. In one study, among social non-daily smokers as well other non-daily smokers, 24.0-28.4% report that none of their relatives smoke, while 51.5%-57.6% report that most relatives do not smoke (Gilpin et al., 2005). Similarly, 7.1-11.1% of social non-daily and other non-daily smokers responded that none of their friends smoke, and 53.9-55.1% reported most of their friends do not smoke (Gilpin et al., 2005). These percentages for non-daily smokers were significantly higher than for daily smokers (Gilpin et al., 2005). In networks with a low proportion of smokers, smoking may not be considered the norm in the social network. The non-smoking majority in the social network may exert some influence on smokers on smoking or quitting behaviors.

Previous studies about social network smoking did not divide occasional smokers into FDO and NDO smokers. An unanswered question is whether smokers in FDO and NDO smokers' social networks represent a majority or a minority. Future studies could also compare FDO and NDO smokers regarding the proportions of smokers among their social network members. Another related issue is the relationship between any changes in the proportion of smokers in the social network and any associated change in smoking or quitting behaviors, especially for FDO smokers.

Stimulus control theory. Another theory relevant to occasional smoking is stimulus control theory, which posits that cigarette smoking is a learned behavior and that smokers pair situations with smoking (Lando, 1993). Over time, these situations become triggers or cues for smoking (Lando, 1993).

Because these cues for smoking were learned, they can also be unlearned. For example, smokers can break the learned stimulus control association by smoking on a schedule rather than in response to a given situation (Lando, 1993). Another option is to limit smoking to certain situations, such as only smoking outside or delaying the first cigarette of the day (Lando, 1993).

Because tobacco-addicted heavy smokers smoke to maintain plasma nicotine levels and avoid withdrawal symptoms, their smoking may not be as influenced by situational cues (Baumeister, Heatherton, & Tice, 1994; Herman, 1974). On other hand, light smokers, like occasional smokers, may be less influenced by nicotine addiction but more influenced by situational cues (Baumeister et al., 1994; Herman, 1974). Supporting this idea, the stimulus control relationship was stronger for tobacco chippers than for heavy daily smokers in one study (Shiffman & Paty, 2006).

Progression to tobacco dependence may correspond to weakening of this stimulus control, so that regular smokers do not smoke in certain situations but across a number of different situations (Shiffman & Paty, 2006). In the other direction, as a smoker transitions to lighter cigarette consumption, such as the FDO smoker, stimulus control may strengthen. One

challenge to establishing stimulus control is that heavy smokers smoke in so many situations (Shiffman & Paty, 2006). However, heavy smokers did show a stronger association with smoking in more solitary/routine situations, such as in a car or while waiting, than did chippers (Shiffman & Paty, 2006).

Regardless of whether or how stimulus control theory applies to occasional smokers, occasional smokers clearly do not smoke for reasons related to physical addiction. So why do occasional smokers smoke? This question has been addressed by asking smokers to rate different smoking outcome expectancies on likelihood and/or desirability (Brandon & Baker, 1991; Jeffries et al., 2004). Though occasional smokers and daily smokers had similar mean scores on the negative consequences of smoking scale on the Smoking Consequences Questionnaire, occasional smokers had significantly lower mean scores on positive reinforcement/sensory satisfaction, negative reinforcement/negative affect reduction, and appetite/weight control (Brandon & Baker, 1991). Similarly, in a study of African American smokers, compared to moderate and heavy daily smokers, occasional smokers had lower subscale mean scores on most positive expectancies subscales: negative affect reduction, taste-sensorimotor manipulation, social facilitation, and boredom reduction control (Jeffries et al., 2004). However, there were no differences between occasional and daily smokers on negative expectancies subscales, specifically stimulation state enhancement, health risk, negative physical feelings, and negative social impression (Jeffries et al., 2004). This pattern of results suggests that occasional smokers find the effects of smoking less reinforcing than do daily smokers.

The smoking motivations of occasional smokers can also be inferred from the situations in which they smoke. In an ecological momentary assessment study of occasional smokers (Shiffman et al., 2009), the most reported smoking situation was while in transition (46% of all cigarette events), defined as at the start or finish of an activity or while moving from one place to another (Shiffman et al., 2009). The next highest was at home, with 40% of all cigarette events (Shiffman et al., 2009). Other smoking situations were with other people (29%) and while drinking alcohol (19%) (Shiffman et al., 2009), both of which could be considered social and

episodic. However, with more solitary or routine activities, such as in a car, on break, or with coffee, occasional smokers did not tend to endorse them (all $\leq 8\%$) (Shiffman et al., 2009). These results are consistent with a survey study, in which more occasional smokers endorsed smoking in social/episodic situations, such as drinking alcohol or with friends, compared to the more solitary/routine situations, such as after meals, while studying, or when watching TV (Hines, 1995).

No studies have separately examined the smoking motivations or smoking situations of FDO and NDO smokers. Given FDO smokers' daily smoking history, FDO and NDO smokers could be expected to differ on their current smoking motivations or situations. On the other hand, previous studies comparing converted and native chippers indicate similarities in smoking situations and motivations (Hajek et al., 1995; Shiffman et al., 1994). Major limitations of the previous studies on converted and native chippers are the limited sample size and limited representativeness of the samples (Hajek et al., 1995; Shiffman et al., 1994). Understanding the situations that lead FDO and NDO smokers to smoke provides an indication of why they smoke.

Self-regulation theory. Self-regulation refers to attempts by individuals to change their normal behaviors, cognitions, or emotions (Baumeister et al., 1994). With respect to cigarette smoking, smokers can "stop themselves" from smoking (Baumeister et al., 1994). Smokers could regulate their voluntary responses: buying a pack of cigarettes, carrying a pack of cigarettes, getting a cigarette from someone (i.e., bumming), lighting a cigarette, or puffing on a cigarette (Sayette, 2004). Occasional smokers use different self-regulation strategies, such as not smoking a whole cigarette and limiting their daily intake, more than moderate or heavy daily smokers do (Okuyemi et al., 2002). With other occasional substance use, approaches include limiting using in certain places, situations, and times (King & Tucker, 2000), avoiding using every day for a period of time or even two days in a row (Powell, 1973; Zinberg, Harding, Stelmack, & Marblestone, 1978), or adhering to a budget, (Harding et al., 1980; Zinberg et al., 1978).

One self-regulation strategy involves whether smokers get their cigarettes from other people or buy their own cigarettes. Studies show that how smokers obtain cigarettes is related to

how much they smoke. For example, in one study, for youth smokers who usually borrowed cigarettes, they tended to smoke less than those who usually bought their own: 6.3 days out of a month and 1.9 cigarettes per day compared to 21.7 days and 6.8 cigarettes a day (Katzman, Markowitz, & McGeary, 2007). Similarly, more occasional smokers (60% or higher) reported generally getting or buying cigarettes from friends, while more regular daily smokers (60% or higher) typically purchased their own cigarettes (Croghan, Aveyard, Griffin, & Cheng, 2003; Leatherdale, 2005).

A hypothesized self-regulation strategy for low-frequency smokers is not to carry cigarettes with them (Zhu et al., 2007). Not having cigarettes readily available could make it less likely for individuals to smoke cigarettes even when they experience a craving or an urge to smoke (Zhu et al., 2007). To date, cigarette-carrying behavior has not been examined for smokers in general, or even low-frequency smokers like occasional smokers. Since occasional smokers by definition do not smoke every day, they do not need to carry cigarettes with them every day. A point of interest would be how FDO and NDO smokers compare on their current cigarette carrying behavior. Perhaps they are similar due to their low-frequency smoking, or perhaps they are different due to their different smoking histories.

Present studies

The present series of three studies addresses gaps in the literature about former-daily occasional smokers. To date, it is unknown whether FDO smokers have made recent quit attempts, how they transition to occasional smoking, what their motivations for smoking are, and what their social network smoking looks like.

Study 1. The first study focused on the adult smoking population trends in California and addressed two sets of questions. First, what proportions of established smokers are FDO, NDO, and daily, and how have these proportions changed over time? Related to this first question, are FDO and NDO smokers motivated to quit smoking, as suggested by making a recent quit attempt? Or do they seem satisfied with their current level of smoking and thus do not try to quit?

Based on the literature, there is a discrepancy between high quitting rates for occasional smokers (Henrikus et al., 1996; Tong et al., 2006; Zhu et al., 2003) and relatively stable occasional smoking proportions (Centers for Disease Control and Prevention (CDC), 2005). The present study employed cross-sectional data from multiple time points, building on previous studies that relied on cross-sectional data from a given year (Gilpin et al., 1997; Gilpin & Pierce, 2002). Although the data are not longitudinal, using multiple survey years allows for the examination of trends over time. For this study, data from the California Tobacco Survey (CTS) were analyzed across a nine-year period: 1996, 1999, 2002, and 2005.

Study 2. The objective of the second study was to get a more detailed picture of FDO smokers. There were two main research questions. The first was in what situations are FDO and NDO smokers most likely to smoke, and how do they compare to daily smokers? Previous studies of occasional smokers' motivation to smoke did not separate FDO smokers from NDO smokers (Brandon & Baker, 1991; Hines, 1995; Jeffries et al., 2004; Shiffman et al., 2009; Wetter et al., 2004). In the present study, motivation to smoke was examined by comparing smokers' frequency of smoking in specific situations as well as their smoking outcome expectancies. By studying these smoking situations, hypotheses can be made about which days FDO smokers first forgo when they transition from smoking every day to about half the days in a given month. The second question was what proportion of an FDO smoker's social networks also smokes? Smokers in the social environment can serve as cues for smoking as well as sources for cigarettes. The social network is one factor shaping smokers' social norms. The data source here was the 2002 CTS, which included a special addendum of questions for young adult smokers aged 18-29.

Study 3. Building on Studies 1 and 2, the third study was designed to provide more detailed information about FDO smokers. There were three questions. First, how likely are FDO and NDO smokers to smoke in different situations? This question is similar to the one from Study 2, but this study used a different questionnaire based on ecological momentary assessment studies with tobacco chippers (Shiffman & Paty, 2006). Second, do FDO and NDO smokers

usually carry cigarettes with them? One way that occasional smokers could keep their smoking low is not to carry cigarettes (Zhu et al., 2007), a self-regulation strategy. Third, how did FDO smokers transition from daily smoking to occasional smoking? Did they gradually cut down their smoking consumption, or did they quit smoking completely and then relapse to occasional smoking?

Analytic approach

Reference groups. In the present series of studies, NDO smokers were used as a reference group. Comparisons between FDO and NDO smokers could shed light on whether daily smoking history potentially makes a difference in current smoking behaviors. In addition to NDO smokers, daily smokers were included as another reference in Studies 1 and 2. Daily smokers provide an anchor for how much FDO smokers may have changed when they switched to occasional smoking. Unlike the other two studies, Study 3 did not include daily smokers as a reference group since the more important comparison was between FDO and NDO smokers.

Figure 1 outlines how respondents were categorized as FDO, NDO, and daily smokers. Respondents were considered smokers if they answered “yes” to “Have you smoked at least 100 cigarettes in your entire life?” Current smoking status was assessed with the question, “Do you smoke cigarettes every day, some days or not at all?” Smokers were categorized as daily smokers if they answered “every day” and occasional smokers if they answered “some days.”

A follow-up question assessed ever-daily smoking history: “Have you ever smoked daily for six months or more?” Occasional smokers were classified as former-daily occasional (FDO) smokers if they reported previously smoking for at least six months. Otherwise, occasional smokers were considered never-daily occasional (NDO) smokers.

All smokers vs. established smokers. The sample for the three studies consisted of established smokers rather than all smokers. A three-year cutoff for starting smoking was chosen to exclude uptake smokers. The cutoff is based on the results of a previous study, which suggests that occasional smokers who have smoked for at least three years are likely to remain occasional smokers instead of progressing to daily smoking (Evans et al., 1992).

In the California Tobacco Surveys, smokers were asked their age of smoking initiation: "How old were you when you smoked your first whole cigarette?" Respondents' age of smoking initiation and age at the time of the survey were used to estimate how long respondents had been smoking. The resulting variable was used to differentiate established smokers from uptake smokers, using the three-year cutoff.

Stratification by sex. A decision was made to stratify the analyses by sex, in light of sex differences in smoking and quitting. One sex difference is higher smoking prevalence for men than for women; in 2008, the smoking prevalence was 23.1% for men and 18.3% for women (Centers for Disease Control and Prevention (CDC), 2009). Though the analyses could have been stratified by other variables such as ethnicity or age, smoking-related sex differences were the best documented in the literature. In addition, the noted sex differences appear to have the greatest potential implications for FDO and NDO smoking.

Men and women also differ on how they smoke their cigarettes and on how much withdrawal they experience. Although men and women did not differ in their physiological responses to smoking, such as heart rate and expired carbon monoxide (Eissenberg, Adams, Riggins, & Likness, 1999), women's cigarette puffs tended to be smaller and shorter than men's (Battig, Buzzi, & Nil, 1982; Eissenberg et al., 1999). In addition, after smoking a cigarette, overall women reported greater decreases in desire to smoke, concentration difficulty, and withdrawal relief than did men (Eissenberg et al., 1999; Xu et al., 2008). After forced abstinence from smoking, women also reported higher levels of negative affect, concentration problems, and withdrawal symptoms (Leventhal et al., 2007; Xu et al., 2008). For women, withdrawal symptoms may be confounded with premenstrual syndrome symptoms (Carpenter, Upadhyaya, LaRowe, Saladin, & Brady, 2006; O'Hara, Portster, & Anderson, 1989).

Although men and women scored similarly on many smoking motivation factors (Brandon & Baker, 1991; Copeland, Brandon, & Quinn, 1995; Livson & Leino, 1988), sex differences on specific motivations did emerge across different studies. Overall, women seemed more likely to smoke to control their weight or appetite compared to men (Brandon & Baker, 1991; Copeland et

al., 1995; Presson, Chassin, & Sherman, 2002; Ward, Klesges, Zbikowski, Bliss, & Garvey, 1997). Thus, gaining weight after quitting smoking was a concern for women more than men (Sorensen & Pechacek, 1987). In addition, female smokers endorsed smoking to reduce negative affect or emotions more often than did male smokers (Brandon & Baker, 1991; Livson & Leino, 1988; Russell, Peto, & Patel, 1974; Ward et al., 1997)). Similarly, in another study, women tended to smoke in negative emotional situations or social situations while men did so with attention-needing tasks (Ward et al., 1997). Women were also more likely than men to report smoking for pleasure (Livson & Leino, 1988) and social facilitation (Presson et al., 2002; Ward et al., 1997). Given the sex differences in smoking motivations, the smoking situation analyses in the present series of studies were stratified by sex.

Besides smoking motivation, women and men also differ in quitting behaviors. In one study, women were less likely to feel confident about quitting smoking than did men (Audrain et al., 1997). In another study, female smokers also quit more frequently for more immediate reasons, such as to save money, but less frequently for health reasons (Curry, Grothaus, & McBride, 1997). Although a few studies indicated no sex differences in quit rates (Killen, Fortmann, Varady, & Kraemer, 2002; Pirie, Murray, & Luepker, 1991), many others showed that women were less likely than men to quit smoking or stay quit (Bjornson et al., 1995; Fortmann & Killen, 1994; Perkins, 1996; Perkins & Scott, 2008; Royce, Corbett, Sorensen, & Ockene, 1997; Scharf & Shiffman, 2004). In addition, women were more likely to want to cut down their smoking rather than quit smoking completely (Blake et al., 1989; Sorensen & Pechacek, 1987). Indeed, in one study, even though men and women did not differ on quitting in the year before the survey, women were more likely to cut down than were men (Blake et al., 1989). All together, these sex differences in quitting could indicate greater likelihood of female smokers becoming FDO over time.

A few studies outside the tobacco literature highlight sex differences in social support and the social network. There are mixed results about whether women's social networks are larger or at least the same size as men's (Antonucci & Akiyama, 1987; Caldwell, Bogat, & Cruise, 1989;

Jones, Bloys, & Wood, 1990; Stokes & Wilson, 1984; Turner, 1994). Nevertheless, in one study, women had more frequent in-person or phone contact with their social network members and also had more people they could confide in than did men (Turner, 1994). Women also reported more time getting social and emotional support from their social network each day than did men (Hirsch, 1979). Among older adults, women were more likely to give and receive support from friends and children in addition to their spouses or partners (Antonucci & Akiyama, 1987). However, men were more likely to give and receive support only with their spouses or partners (Antonucci & Akiyama, 1987). Thus, sex differences in social networks provide additional support for stratifying the social network analyses in the current series of studies.

Study 1: Introduction

The main goal of Study 1 was to explore the proportions of FDO and NDO smokers out of established smokers over time. There are currently no longitudinal surveys that track FDO smokers. The present study relied on cross-sectional California Tobacco Survey data from 1996 to 2005. No a priori hypothesis was made about whether the FDO proportions changed from 1996 to 2005 or the direction of the change.

Another objective of Study 1 was to compare FDO smokers to NDO smokers and daily smokers on motivation to quit, which was defined as making a quit attempt in the year prior to a survey. Previous studies indicate that a smoker's quitting history (e.g., recent quit attempts) and cigarette consumption together were stronger predictors of successful quitting than intention to quit (Abrams et al., 2000; Farkas et al., 1996). Similar to the first objective, past-year quit attempt rates were examined over a nine-year period. The hypothesis was that FDO smokers would be more motivated to quit smoking than NDO smokers were. This is based on previous studies showing that although FDO and NDO smokers did not differ on their readiness to quit (Gilpin et al., 1997; Gilpin & Pierce, 2002), FDO smokers were more likely to have cut down their smoking (Gilpin & Pierce, 2002), which has been associated with making a later quit attempt (Hughes & Carpenter, 2006).

Study 1: Methods

Data source

The California Tobacco Survey (CTS) is a telephone-based survey about tobacco use in a representative sample of the California population. Surveys were conducted in 1990/1991, 1992, 1993, 1996, 1999, 2002, and 2005. The 1992 CTS is the first version that included a question about whether occasional smokers ever smoked daily for six months. However, because occasional smoking was assessed differently in 1992 than later years, the 1992 data were not included in the analyses. The data source for Study 1 was the 1996, 1999, 2002, and 2005 CTS.

Interviewers conducted brief screenings with an adult from each contacted household to assess household members' demographics and smoking status (Gilpin, White, & Berry, 2004). The contact rates for the initial screening interviews were 55% for 1996 (Pierce, Berry, Gilpin, Rosbrook, & White, 1998), 51% for 1999 (Gilpin, Pierce, Berry, & White, 2000), 46% for 2002 (Gilpin et al., 2004), and 35% for 2005 (Al-Delaimy, Messer, Pierce, Trinidad, & White, 2007). Based on screening information, individuals were selected for more extensive interviews, and the response rates for these interviews were 74% for 1996 (Pierce et al., 1998), 68% for 1999 (Gilpin et al., 2000), 63% for 2002 (E. A. Gilpin et al., 2004), and 49% for young adults and 56% for older adults for 2005 (Al-Delaimy, Messer, Pierce et al., 2007). Technical reports are available online (UCSD-San Diego Data Services (UCSD-SSDS), 2008).

Sample

Question 1: Proportions of current smokers. After applying the three-year cutoff for smoking initiation, the resulting unweighted sample sizes were 8,501 for 1996, 5,525 for 1999, 5,349 for 2002, and 3,842 for 2005.

Question 2: Motivation to quit smoking. Excluding uptake smokers, the resulting unweighted sample sizes were 8,479 for 1996, 5,508 for 1999, 5,336 for 2002, and 3,826 for 2005.

Assessment

Demographic information. Respondents' sex, age, ethnicity, and educational level were assessed in the survey. For respondents with missing data on these four demographic variables, values were imputed using the hot-deck method WESDECK (Gilpin, Pierce, Berry, & White, 2003).

Quitting history. Current daily and occasional smokers were asked, "Were you smoking at all around this time 12 months ago?" Those who answered "No" were considered to have made a quit attempt in the year before the survey. For those who reported smoking 12 months

before the survey, they were asked about recent quitting: “During the past 12 months, have you quit smoking intentionally for one day or longer?” Smokers who responded “yes” were also classified as having made a quit attempt in the previous year.

Analyses

Below are the details of the analyses for each research question.

Question 1: Proportions of current smoking. The weighted proportions of FDO and NDO smokers out of all established smokers were estimated using the SAS SURVEYFREQ procedure. For the proportion of FDO smokers, the numerator was the number of FDO smokers, and the denominator consisted of all established smokers. Similarly, the proportion of NDO smokers was estimated using the number of NDO smokers in the numerator and number of established smokers in the denominator.

Because demographic changes from year to year could suppress or exaggerate trends, the proportions of smokers who were FDO, NDO, and daily smokers in 1996, 1999, and 2002 were standardized based on the demographics of the 2005 CTS population. A direct standardization procedure was used (Al-Delaimy, Messer, & White, 2007; Fleiss, 1981), and analyses were conducted separately by sex. The selected demographic categories were ethnicity (White, Hispanic, Black, Other), age (18-24, 25-44, 45-64, 65+), and education (no college, at least some college), resulting in 32 demographic groups (4 x 4 x 2). Each demographic category represents a proportion of the total population: The number of people in that demographic category divided by the total number in the population. For a given specific survey year, the proportions of smokers who were FDO, NDO, and daily were estimated for each of the 32 demographic groups, using the population weights for that specific survey year. Then, for each of the 32 demographic groups, the resulting weighted smoking proportions and the 2005 population-based proportions were multiplied. These products were summed across the 32 demographic groups to yield the standardized smoking proportions.

A similar procedure was used to calculate 95% confidence intervals for standardized smoking proportions. The proportions represented by the 32 demographic groups from the 2005 CTS population were used to calculate the standardized standard errors (Buescher, 1998), which were used to construct the 95% confidence intervals. Smoking proportions were considered significantly different if their 95% confidence intervals did not overlap, similar to a previous study about smoking prevalence (Gilpin & Pierce, 2002).

Question 2: Quit attempt. Weighted percentages of smokers who made a quit attempt in the year before the survey were estimated using the SAS-callable SUDAAN procedure PROC CROSSTABS. 95% confidence intervals were presented for each estimate.

FDO smokers were compared to NDO smokers and to daily smokers on past-year quit attempts within each survey year. Differences were considered statistically significant at the $p < .05$ level, after adjusting for age, ethnicity, and education. These adjustments were conducted using the SAS-callable SUDAAN weighted logistic regression procedure, PROC RLOGIST.

Study 1: Results

Question 1: Proportions of current smokers

Figures 2 and 3 show the standardized weighted proportions of established smokers who are considered NDO, FDO, and daily. In these figures, the proportions for 1996, 1999, and 2002 were standardized based on the demographics for the 2005 CTS.

Figure 2 shows the results for male established smokers. In 1996, about three-fourths established smokers smoked daily. Also the FDO and NDO proportions were both around 12%. From 1996 to 1999, the FDO proportion significantly increased. The NDO proportion also increased, though not significantly. On the other hand, the proportion of daily smokers significantly decreased. In 2002, there was a slight increase of the FDO proportion, and the NDO smoking proportion remained relatively unchanged. However, the proportion of daily smokers continued to decrease. In 2005, the smoking proportions did not significantly change from the 2002 estimates, except for a slight increase for NDO. Overall, from 1996 to 2005, the FDO and

the NDO proportions increased, but not significantly, for male established smokers, but the daily smoking proportion significantly went down.

Figure 3 displays the results for female established smokers. Across all survey years, the FDO proportion was generally greater than the NDO proportion, in contrast to the pattern for male smokers. In 1996, about three-fourths of female established smokers smoked daily, and between 11 and 13% were FDO or NDO. From 1996 to 1999, the FDO proportion increased, nearly significantly. NDO proportions slightly and not significantly increased; however, the daily smoking proportion significantly decreased. The 2002 occasional smoking proportions did not change much from 1999: with slight decreases for FDO and NDO. However, the daily smoking proportion significantly declined. For 2005, the smoking proportions also did not significantly change: with a slight decrease for daily, a slight increase for FDO, and no change for NDO. Overall, for women, from 1996 to 2005 the FDO proportion increased but not significantly. There were slight decreases in the NDO and daily smoking proportions, but these were also not significant.

Question 2: Motivation to quit smoking

Table 1 displays the percentages of FDO, NDO, and daily smokers who quit in the year prior to each survey year. The first column shows the past-year quit attempt rates for FDO, NDO, and daily smokers for the 1996 CTS. For both men and women, about 80% of FDO smokers had made a quit attempt, while around 75% of NDO smokers had. FDO smokers did not significantly differ from NDO smokers, after adjusting for age, education, and ethnicity. However, FDO smokers' quit rates were significantly higher than daily smokers' rate, which was around 45% for both men and women (p 's < .05). In subsequent CTS years, the pattern was similar to the 1996 results. The one exception was for the 2002 CTS: FDO smokers' quit rates were significantly higher than NDO smokers' – 90% vs. 79% for men (p < .001) and 86% vs. 76% for women (p < .01).

Study 1: Discussion

Across the nine-year period, a majority of FDO smokers as well as NDO smokers reported a quit attempt in the year prior to the survey, while about half of daily smokers did. This finding does not support the hypothesis that FDO smokers would have higher past-year quit attempt rates than NDO smokers. Although FDO and NDO smokers arrived at occasional smoking from two different pathways, they were similar on motivation to quit. This suggests that neither FDO nor NDO smokers were content with remaining low-frequency smokers (Zhu et al., 2003), but they wanted to quit smoking.

Given that quit rates are so high for both FDO and NDO smokers compared to daily smokers, it might be expected that FDO and NDO proportions would decrease while daily proportions increase. For the most part, FDO and NDO proportions did increase though not significantly. There was not a decrease in proportions, suggesting that daily smokers and new uptake smokers continually replace FDO smokers and NDO smokers, respectively. In the case of FDO smokers, they are likely replenished as the daily smoking prevalence goes down (Backinger et al., 2008; Gilpin & Pierce, 2002), and daily smokers decrease the number of cigarettes they smoke each day in the U.S. (Al-Delaimy et al., 2007; Burns et al., 2003; Gilpin & Pierce, 2002).

For women, occasional smokers were generally more likely to come from former-daily smokers than never-daily smokers, based on the present study's results. This FDO-NDO pattern suggests that among women, daily smokers convert to occasional smoking at a high rate at the population level. This is consistent with previous studies showing that women were more likely to cut down rather than quit smoking completely (Blake et al., 1989; Sorensen & Pechacek, 1987).

Study 2: Introduction

One major question to consider is whether after daily smokers transition to occasional smoking (i.e., FDO smokers), are they more like never-daily occasional smokers, or are they more like daily smokers, their former smoking category? In Study 1, FDO smokers were more like NDO smokers on past-year quit attempt rates; both FDOs and NDOs had higher rates than daily smokers. In the present study, more FDO and NDO smokers' behaviors were examined.

Another interest of Study 2 is FDO smokers' transition from daily to occasional smoking, a process that eventually leads them to forgo smoking on some days. A longitudinal follow-up of a representative sample of the smoking population is needed to examine this issue satisfactorily. This study used existing cross-sectional survey data from the 2002 CTS Young Adult Supplement to infer indirectly how the transition might have occurred. The survey assessed how frequently FDO smokers and other smokers in various situations, categorized as social/episodic vs. solitary/routine. By comparing FDO responses to those of daily smokers, it was deduced in which situations FDO smokers were likely to forgo smoking when they go from daily to occasional smoking.

To explore this question, FDO smokers' responses to questions on smoking situations were compared to the responses of NDO and of daily smokers. Comparing FDO smokers to NDO smokers as well as to daily smokers provides an additional gauge of the extent to which FDO smokers change when switching from daily to occasional smoking. While NDO smokers never progressed to daily smoking, FDO smokers most likely started smoking occasionally, progressed to daily smoking, then eventually transitioned back to occasional smoking. How much FDO and NDO smokers are alike in their current smoking behavior provides additional information for developing hypotheses on how FDOs change from smoking daily to smoking non-daily. Because of their different smoking histories, it was expected that FDO and NDO smokers would differ on their motivation to smoke.

Another interest of Study 2 is to examine smokers in FDO smokers' social networks. Smokers in the social environment can serve as cues for smoking and also as sources for

cigarettes. Smoking and quitting behaviors have been shown to spread through social networks over time (Christakis & Fowler, 2008). Daily smokers have more smokers in their social network than occasional smokers do (Ridner, 2005; Wetter et al., 2004), so it was expected that FDO smokers would have a higher percentage of smokers in their social networks than do NDO smokers.

Young adult smokers are a unique age group to study in terms of light and intermittent smoking. For 2001/2002, 18 to 29 year olds in the U.S. had the highest proportion (22%) of very light smokers (fewer than 5 CPD) among all smokers (Pierce et al., 2009). This age group also had the greatest increase in prevalence of very light smoking from 4.7% in 1992/1993 in to 6.0% in 2001/2002 (Pierce et al., 2009).

Study 2: Methods

Data source

The data source for Study 2 was the supplemental survey to the ongoing California Tobacco Survey (CTS) (Gilpin et al., 2004). This supplement, conducted in 2002, added questions on smoking situations for respondents 18–29 years old. Interviews were in Spanish or English. There was a screening survey with each contacted household (response rate 45.7%), and young adults 18–29 years old identified at screening were chosen for extensive interviews (response rate 58.6%). Detailed information about the survey is available online in CTS technical reports (UCSD-San Diego Data Services (UCSD-SSDS), 2008).

Study sample

In the supplemental survey, 9455 adults aged 18-29 were interviewed. Of these, 18.4% were current smokers. To avoid mixing established occasional smokers with those who smoked occasionally because they were still in the uptake process, this study included only current smokers who had started smoking at least three years prior to the survey (Evans et al., 1992). This yielded a final study sample of 1,581 current smokers aged 18-29.

Assessment

Smoking history. FDO smokers were asked, “How long has it been since you smoked on a daily basis?” This allowed an estimation of when they transitioned from daily to occasional smoking.

Smoking situations. Smokers were first given an introduction to a set of questions on smoking situations: “People smoke in a variety of situations. Please consider each of the following situations and tell me if you smoke cigarettes frequently, sometimes, rarely, or never. If it doesn't apply to you, say ‘not applicable.’” Then they were presented with a list of eight situations: “while socializing with friends,” “at parties,” “at clubs/bars,” “while working/studying,” “when taking a break at work or school,” “in your home or apartment,” “outside in public places,” and “driving in your car.” They were asked to choose among the response categories: “frequently,” “sometimes,” “rarely,” “never,” and not applicable.

Social network smoking. One set of questions dealt with the number of smokers among the respondents’ a) close relatives, b) close friends, c) co-workers, and d) party companions. Response options were “all of them smoke,” “most of them smoke,” “most of them do not smoke,” and “none of them smoke.”

Smoking outcome expectancies. Two survey questions dealt with smoking outcome expectancies: “Smoking helps me to control my stress level” and “Smoking helps me control my weight.” Response options for these two questions were “agree” or “disagree.”

Other questions. Smokers were also asked if they agreed or disagreed with the statement “I only smoke when other people are smoking.” In a separate question, smokers were asked about their sources of cigarettes: “Do you generally buy your own cigarettes or get them from others?”

Analyses

The eight smoking situations appeared to fall into two semantic subgroups. “While socializing with friends,” “at parties,” and “at clubs/bars” refer to social/episodic activities that are

episodic for most people. “Driving in your car,” “while working/studying,” and “in your home or apartment” tend to be more solitary/routine activities. The situation of “taking a break at work or school” could be both social and routine. The situation “outside in public places” was excluded in the analysis because it was not clear how smokers interpreted “public places.” In presenting the data, the remaining seven situations were rearranged in the following order: social/episodic situations first, solitary/routine situations next, and “taking a break” last, rather than in the order in which they appeared in the survey.

The response categories for the smoking situations are “frequently,” “sometimes,” “rarely,” “never,” and “not applicable.” Because it is probably easiest for smokers to say they smoke “sometimes” in any given situation, the answer “frequently” was used as an indication of their likelihood of smoking in each situation.

All percentages were weighted with population weights and 95% confidence intervals were estimated using SAS-callable SUDAAN 9.0.1 with the replicate-weight jackknife method. The CTS technical report has more detailed sampling and weighting procedures (Gilpin et al., 2004). The data in Tables 3 and 4 were also adjusted for age, ethnicity, and educational level, with analyses presented separately for men and women.

Study 2: Results

Sample characteristics

Overall, 39.6% of these young adult smokers were occasional smokers. Among these occasional smokers, 53.5% were NDO smokers, and 46.5% were FDO smokers.

Table 2 shows the demographics and smoking characteristics of all three groups: daily, NDO, and FDO smokers. Overall, there were more males than females, and about 60% were in the 18-24 age group. About 30% of the sample had attended college part-time or full-time in the previous year (not shown in table), and both NDO and FDO smokers were more likely than daily smokers to have college degrees. NDO smokers were more likely to be Hispanic.

In terms of smoking history, all three groups had started smoking around age 15, with NDO smokers starting at a slightly older age and having smoked for a slightly shorter time than daily smokers. NDO smokers tended to smoke on fewer days than did FDO smokers in any given month (10.3 vs. 12.9 days). On their smoking days, they also consumed fewer cigarettes than did FDO smokers (3.1 vs. 4.1 cigarettes).

On average, daily smokers smoked 12.6 cigarettes per day. This is a relatively low smoking rate, but it is dramatically higher than that of NDO or FDO smokers.

FDO smokers measured the same as daily smokers in terms of age of initiation and number of years smoking. On average, they reported that the last time they smoked daily was 21.6 months before the survey. The older group reported a longer time since daily smoking than did the younger group (29.1 months for ages 25-29 vs. 16.1 months for ages 18-24).

Smoking situations

Table 3 presents seven smoking situations, showing the percentages of young adult smokers who answered “frequently” for each. The top half of the table presents the data for male smokers. First, the male NDO and daily smokers are discussed (Columns 1 and 3). Not surprisingly, a large percentage of male daily smokers reported frequent smoking in most situations, ranging from “at parties” (77.5%) to “while working/studying” (34.4%). In contrast, male NDO smokers were less likely to report frequent smoking across all situations. About one third reported frequent smoking in social/episodic situations (the first three situations in Column 1), but they were much less likely to report smoking in routine/solitary situations, such as driving or working/studying (around 10%). The most striking contrast involved the situation labeled “when taking a break at work or school.” About three quarters of daily smokers reported frequent smoking during breaks, but less than 10% of NDO smokers did.

The middle column shows the data for FDO smokers. They did not differ from NDO smokers on two episodic situations: “while socializing” and “at clubs/bars.” However, their percentage falls between that of daily smokers and NDO smokers for the other episodic situation,

“at parties.” Here FDO smokers were more likely to smoke than were NDO, but less likely than were daily smokers. The same holds true for FDO smokers “when taking a break at work or school.” In routine situations such as “driving” and “working/studying,” FDO and NDO smokers were alike: neither group reported frequent smoking then.

The bottom half of Table 3 shows data for female smokers. The data patterns for female daily and NDO smokers are similar to those for males. However, unlike males, female FDO smokers do not differ from female NDO smokers in any of the seven smoking situations.

Low percentages of male FDO and NDO smokers (6-7%) agreed with the statement “smoking helps me control my weight.” A slightly higher percentage of male daily smokers (13%) endorsed smoking for weight control. There was no difference between FDO and NDO smokers ($p = .76$), but both groups were significantly lower than daily smokers (p 's < .05). For women, the pattern of results was similar. Female FDO and NDO smokers had lower rates than daily smokers, 8-10% vs. 23%. Again, female FDO and NDO smokers were the same ($p = .76$), and both were lower than daily smokers (p 's < .01).

On “smoking helps me control my stress level,” the data pattern was similar to weight control, but percentages were higher across the board. Among men, about half of both the FDO and NDO groups (56.2% and 45.3%, respectively) endorsed stress control, while nearly three quarters of daily smokers did so. FDO and NDO smokers did not differ ($p = .07$) from one another, but did differ from daily smokers (p 's < .01). The percentages were similar for women, with 82.7% of daily smokers endorsing stress control compared to 59.3% of FDO smokers and 48.8% of NDO smokers. Again, FDO and NDO smokers were the same ($p = .15$), and both were significantly lower than daily smokers (p 's < .01).

Social network and social smoking

Table 4 shows percentages of smokers who reported that all or most people in their social networks smoked. For men and women, there were no differences among NDO, FDO, and daily smokers regarding co-workers and party companions. However, NDO and FDO smokers

were less likely to report that all or most of their close friends or close relatives smoked. There was no significant difference between NDO and FDO smokers.

When presented with the statement “I only smoke when other people are smoking,” 41.4% of NDO smokers endorsed it (not shown in tables), significantly higher than daily smokers (13.5%, $p < 0.01$), but not significantly different from FDO smokers (34.7%, $p = .49$). NDOs and FDOs were also not significantly different in reporting that they usually get cigarettes from others (40.3% vs. 32.1%, $p = .07$), but both were significantly higher than daily smokers (4.3%, p 's < 0.01).

Study 2: Discussion

The Study 2 results indicate that in terms of smoking situations, FDO smokers were more similar to NDO smokers than they were to daily smokers, their former smoking category, and this pattern was true for both men and women. This pattern is interesting given that on average, FDO smokers were daily smokers about 22 months prior to the survey.

These similarities in smoking situations between FDO and NDO smokers are evident despite differences in smoking measures. FDO smokers tended to smoke more days per month than did NDO smokers. On their smoking days, FDOs tended to consume slightly more cigarettes. But despite these differences, FDOs and NDOs were essentially the same regarding situations in which they frequently smoke.

The results of the present study agree with previous research showing that many occasional smokers are former daily smokers and that the transition from daily to occasional smoking happens frequently at the population level (Etter, 2004; Henrikus et al., 1996; Zhu et al., 2003). For example, a longitudinal study of California smokers found that about a third of people who reported only occasional smoking at follow-up had been smoking daily at baseline 20 months earlier. The present study found that on average, these FDOs were smoking daily 22 months before the survey. They might have gradually cut out some of their smoking days, or they might have quit entirely and then relapsed to smoking fewer days than before their quit attempt

(Zhu et al., 2003). However it happened, the result was a shift from daily smoking to smoking only 13 days a month.

A key question is which smoking situations do FDO smokers cut out when they become occasional smokers. Using these categorizations of social/episodic situations vs. routine/solitary situations, the following model could help explain how former-daily smokers cut down from daily smoking to occasional smoking, based on this study's results. If we assume that FDO smokers used to smoke frequently in different situations, like daily smokers, then the data in Table 3 suggests that FDO smokers appeared to reduce their smoking roughly 20-30% across all smoking situations presented in the table. For daily smokers, the likelihood of frequent smoking in routine/solitary situations (e.g., "while working/studying" or "at home/apartment") is lower than in social/episodic situations (e.g., "while socializing with friends" or "at parties"), and it may decrease even more when daily smokers become FDOs. It may become so low that if a day involves only routine activities, then FDO smokers will not smoke on that day. Thus, if we assume that an average smoker has more routine days than social event days and that the probability of smoking is likely reduced equally across situations, former-daily smokers probably first cut down on smoking on more routine/solitary days rather than on social/episodic days.

However FDO smokers reduced their number of smoking days, Table 3 suggests that FDO smokers behave more like NDO smokers in the seven smoking situations studied, once they have made the transition. These results are consistent with a previous study of lifetime tobacco chippers (like NDOs) and converted tobacco chippers (like FDOs) who had previously smoked more heavily (Shiffman et al., 1994; Shiffman, Kassel, Paty, Gnys, & Zettler-Segal, 1994). Even though converted chippers had higher lifetime cigarette consumption, they did not differ from lifetime chippers on current number of smoking days per week, serum cotinine levels, exhaled carbon monoxide levels, withdrawal symptoms, and time to first cigarette of the day (Shiffman et al., 1994). In another study, converted and lifetime chippers were the same on smoking motive factors (Hajek et al., 1995). Taken together, these studies suggest that smoking history has a

negligible influence after heavier smokers transition to smoking fewer cigarettes and maintain the low level of smoking for an extended time.

Another behavior, in which FDO smokers were more like NDO smokers and less like daily smokers, was their way of obtaining cigarettes. A significant proportion reported that they usually got their cigarettes from other people rather than bought their own packs. This would mean that if they experience an urge to smoke in some situations, they might not always have cigarettes readily available (Zhu et al., 2007). The lack of availability would help to keep their smoking frequency low. It is not clear, however, whether these FDO smokers developed their habit of getting cigarettes from other people before or after transitioning to occasional smoking.

Another factor making it easier for FDO smokers to maintain their lower smoking frequency may be that FDO smokers have fewer close friends and relatives who smoke than did daily smokers (Table 4). They are more similar to NDO smokers in that regard, a finding that did not support the study hypothesis. Having fewer friends and relatives who smoke means FDOs may encounter fewer and less consistent smoking cues in their social networks, and they will have fewer social sources to get cigarettes when they want to smoke. This difference in social network may or may not be pre-existing; FDOs' friends and relatives could have never smoked, formerly smoked, or quit smoking when FDO smokers transitioned from daily to occasional smoking. Whatever the situation, it is likely FDO smokers and their family and friends influenced each other (Christakis & Fowler, 2007; Christakis & Fowler, 2008). The social networks could be a determining factor in daily smokers' transition to, and also their maintenance of, occasional smoking.

Study 2, in part, is published in *Nicotine & Tobacco Research*, 2009. Nguyen, Quyen B.; Zhu, Shu-Hong. The dissertation author was the primary investigator and the primary author of this paper.

Study 3: Introduction

Study 3 is a follow-up to Studies 1 and 2. It was designed to survey a wider age range of FDO smokers from the community to supplement the young adult data from the 2002 California Tobacco Survey. More importantly, it involved detailed telephone interviews with FDO smokers about their smoking situations, cigarette carrying, and transition from daily to occasional smoking. NDO smokers were included as a reference group. There were three research questions.

The first was how did FDO smokers transition from daily smoking to occasional smoking? Zhu et al. presented a model of how smokers change their consumption (Zhu et al., 2003). One possibility is that regular smokers gradually cut down their cigarette consumption to low-rate smoking and then to occasional smoking. Another is that regular or low-rate smokers quit smoking and then relapse to occasional smoking. In the present study, FDO smokers were asked about their transition to occasional smoking to determine if they gradually cut down or quit smoking.

The second objective of the present study was to further examine the model about which smoking days FDO smokers forgo. On average, FDO smokers reduced their smoking from every day to about half the days in a month (Gilpin et al., 1997) (Study 2). Based on the Study 2 results, it seems that when FDO smokers transition, they forgo smoking on routine or solitary days first rather than on social episodic days. The questionnaire on smoking situations used in the present study differed from those in Study 2; the situations were modeled on ecological momentary assessment studies of tobacco chippers (Shiffman & Paty, 2006), although they can also be roughly categorized as solitary/routine and social/episodic.

Another interest of the present study was whether FDO smokers usually carry cigarettes with them. In Study 2, about a third of occasional smokers obtained their cigarettes from other people rather than purchased them. However, the study did not explore whether FDO smokers typically carry cigarettes with them. If occasional smokers do experience a smoking urge in certain situations, they might not always have cigarettes readily available, thus helping keep their smoking frequency low (Zhu et al., 2007).

Study 3: Methods

Recruitment and study procedure

Study 3 consisted of telephone interviews with occasional smokers recruited through online research advertisements on sandiego.craigslist.org and sandiego.backpage.com from November 2007 to May 2009. Interested individuals were screened online or over the telephone to determine eligibility. To be eligible, individuals needed to be at least 18 years old, have smoked at least 100 cigarettes, have smoked for at least three years, and smoke cigarettes non-daily.

Screening questionnaire

In the online or telephone screening survey, respondents were asked if they have ever smoked at least 100 cigarettes in their entire life. Current smoking status was assessed with a question about whether they smoke every day, some days, or not at all. Two items dealt with cigarette consumption: number of days smoked in the past 30 and average number of cigarettes on smoking days. To assess daily smoking history, there was a question about whether respondents have smoked every day for at least six months. Respondents were also asked how long they have smoked as well as their background, including age, ethnicity, and sex.

Interview questionnaire

The telephone interview included questions about occasional smokers' likelihood of smoking in different situations. The situations were modeled after those used in ecological momentary assessment (EMA) studies of tobacco chippers and daily smokers (Shiffman et al., 2002; Shiffman, Paty, Gwaltney, & Dang, 2004; Shiffman & Paty, 2006). In these EMA studies, smokers entered information about each smoking episode into a handheld device, and they were randomly assessed during the day for nonsmoking episodes (Shiffman et al., 2004).

The present study's interview approach differs from the EMA approach. First, smokers were asked how likely they are to smoke in each of the following locations: "home," "work," "other

people's homes," "bar or restaurant," and "car." They were then asked about the likelihood of smoking while doing certain activities: "working," "socializing," "relaxing," "waiting," "eating food," "drinking coffee," and "drinking alcohol." Last, they were asked about smoking in social environments: "while alone," "with other people who are smoking," and "with other people who are not smoking." The response options for all of these situations were "very likely," "likely," "somewhat likely," and "not at all likely." To assess cigarette-carrying habits, smokers were asked, "Do you usually carry cigarettes with you?"

Paralleling items from the California Tobacco Survey Young Adult Supplement (UCSD-San Diego Data Services (UCSD-SSDS), 2008), a set of questions dealt with the proportion of smokers among the respondents' a) close relatives, b) close friends, and if applicable, c) co-workers. Response options were "all of them smoke," "most of them smoke," "most of them do not smoke," and "none of them smoke."

Some interview questions were specific to former-daily smokers. The interviewer probed when FDO smokers last smoked daily and how long they had been smoking occasionally. In addition, the interviewer assessed how smokers transitioned from daily smoking to occasional smoking, whether by gradually reducing their consumption or quitting and then relapsing to occasional smoking.

Analyses

For the smoking situations, responses were categorized as "very likely" vs. "likely," "somewhat likely," or "not at all likely." "Very likely" was used as the point of comparison. This categorization is similar to Study 2, which used the highest option "frequently."

Like Study 2, smoking situations were categorized as social/episodic or solitary/routine. Among the activities, "socializing" and "drinking alcohol" were considered more social/episodic, while "waiting" and "working" were more solitary/routine. The other activities could be either solitary or social: "eating food," "relaxing," and "drinking coffee." For the social environment items, "alone" was categorized as solitary/routine; "with other people who are smoking" and "with

other people who are not smoking” were considered social/episodic. It was not clear how to classify some locations. “Bar/restaurant” and “other people’s homes” are probably social/episodic while “car” and “home” could be solitary/routine, but “work” could fit either category.

For the social network analyses, responses were categorized as all or most smoke vs. most do not smoke or none smoke. This approach is consistent with the one used in Study 2.

FDO and NDO smokers were compared on each smoking location, activity, social environment, and social network variable. Between-group differences were tested in logistic regression with age and ethnicity as covariates and the smoking situation or social-network variable as the predictor of former-daily smoking among occasional smokers. This approach is similar to the one used in Study 2. Age was categorized as 18-24, 25-44, 45-64, and 65 and up. Ethnicity was grouped into two categories, White and non-White, because of the small sample sizes for the non-White races/ethnicities.

Study 3: Results

Sample

316 individuals completed the screening survey over the telephone or online. 208 (66%) were eligible and contacted by email or telephone for the interview. The interviewed sample consisted of 152 occasional smokers (65% conversion rate): 58 never daily and 94 former daily. At the time of screening, 27 of the interviewed smokers who answered “no” to former-daily smoking in the screening survey were actually former-daily smokers, based on the more detailed telephone interview. On the other hand, five former-daily smokers identified at screening had actually never smoked daily for at least six months. For the analyses, these smokers were reclassified accordingly.

Table 5 shows the demographics and smoking characteristics of the study sample. Overall, the average age of the interviewed occasional smokers was 32 (last column). About half of the total sample was White. Occasional smokers smoked an average of 12 of the past 30 days

and three cigarettes on smoking days. Overall, they had smoked for an average of almost 11 years.

For male occasional smokers (first and second columns), FDO smokers were generally similar to NDO smokers. However, FDO smokers tended to be older and smoked for longer. The same pattern was observed for female occasional smokers, with FDO-NDO differences on age and years smoked. As a group, former-daily smokers reported last smoking daily an average of six years before the survey.

Smoking situations

Table 6 presents the percentage of smokers who reported being very likely to smoke in given smoking situations, grouped by sex. The smoking situations were grouped by category: location, activity, and social environment. In the table, the situations are presented by the order asked in the telephone interview.

First, the results for the entire sample are discussed (last column). For locations, few occasional smokers (7%) reported being very likely to smoke at “other people’s homes.” A higher percentage endorsed smoking at “work” (17%) or in the “car” (15%) as very likely. Even higher percentages of occasional smokers said they were very likely to smoke at “home” (30%) or at a “bar or restaurant” (34%).

Among activities, the one that received the highest endorsement by occasional smokers was while “drinking alcohol” (47%). “Socializing” (29%) was the next highest. By contrast, lower percentages of occasional smokers (7-13%) reported being very likely to smoke while “eating food,” “waiting,” “working,” “relaxing,” or “drinking coffee.”

With social environments, a low percentage of occasional smokers (<1%) reported being very likely to smoke when “other people are not smoking.” A higher percentage (16%) endorsed being very likely to smoke “alone.” Almost half (45%) said they are very likely to smoke with “other people who are smoking.”

The first and second sets of columns in Table 6 show the NDO and FDO percentages for males and females. The results for male smokers are discussed first (first set of columns). Compared to NDO smokers, male FDO smokers had similar percentages on all the smoking situations except two. First, a higher percentage of male FDO smokers endorsed smoking while “drinking alcohol” than male NDO smokers did, 51% vs. 14%, $p < .01$ after adjusting for age and ethnicity. Second, more male FDO smokers than NDO smokers reported being very likely to smoke when “other people were smoking,” 42% vs. 17%, $p = .01$, adjusting for age and ethnicity.

Among female occasional smokers (second set of columns), again FDO and NDO smokers had similar percentages on all the situations. There was a nearly significant trend for more female FDO smokers to smoke at their homes compared to female NDO smokers, 37% vs. 12%, $p = .06$.

Social network smoking

Table 7 displays the percentages of NDO and FDO smokers who reported that all or most of a social network category smoked. Results for men are in the first set of columns and for women in the second set of columns. The last column shows the results for the total sample, discussed first. Among currently employed occasional smokers ($n = 99$), 18% responded that all or most of their coworkers smoke. Almost a third of occasional smokers said all or most of their close friends also smoke. A low percentage (13%) reported that all or most close relatives smoke.

For men, FDO and NDO smokers did not differ on the percentage reporting all or most co-workers smoke, after adjusting for age and ethnicity ($p = .18$). For both FDO and NDO, about a third indicated that all or most close friends smoke, and the percentages were not significantly different ($p = .28$). Low percentages (<13%) of FDO and NDO reported that all or most close relatives smoke, and FDO and NDO did not significantly differ ($p = .20$).

For women, FDO and NDO smokers had similar percentages that reported all or most co-workers smoke ($p = .92$) and all or most close friends smoke ($p = .55$). However, for close

relatives, a lower percentage of female FDO smokers indicated that all or most smoke compared to NDO smokers: 27% and 9%, respectively, $p = .02$.

Carrying cigarettes

A majority of occasional smokers (72.8%) reported they did not usually carry cigarettes with them (missing $n = 1$). Among men, FDO smokers did not differ from NDO smokers on not carrying cigarettes, 56.3% and 70.8% respectively, $p = .22$ adjusting for age and ethnicity. Women FDO smokers were also similar to NDO smokers on their cigarette-carrying behavior, 84.4% and 82.4% respectively, $p = .74$ adjusting for age and ethnicity.

Transition to occasional smoking

Former-daily occasional smokers ($n = 84$) were asked how they transitioned from daily smoking to occasional smoking. Data were missing for ten FDO smokers. A majority of former-daily smokers (64.3%) reported quitting first and then relapsing to occasional smoking instead of gradually cutting down their consumption. On average, these former-daily smokers had been smoking occasionally for 3.9 years (standard deviation = 4.9, $n = 73$).

Study 3: Discussion

The findings from Study 3 complement those of Study 2. FDO smokers were generally the same as NDO smokers on smoking situations. The two exceptions were that male FDO smokers were more likely to smoke while drinking alcohol or with other smokers than were male NDO smokers. Like Study 2, the Study 3 results generally held for both men and women. The FDO-NDO similarity on smoking situations is interesting given slightly higher cigarette consumption, longer smoking history, and previous daily smoking for FDOs. These interviewed FDO smokers were long-term occasional smokers; on average, FDO smokers last reported smoking daily six years before the survey and had been smoking occasionally for an average of nearly four years.

In Study 2, a model was proposed to help explain how FDO smokers cut their smoking from every day to about half the days out of a month. In Study 2, it appeared that FDO smokers first cut out smoking on solitary/routine days rather than on social/episodic days. The results from the present study generally support this model. Specifically, a substantial percentage of FDO smokers reported being very likely to smoke in the more social/episodic situations: at a “bar/restaurant,” “socializing,” “drinking alcohol,” and with “other people smoking.” However, for situations considered more routine or solitary, such as in a “car” or when “working,” lower percentages of FDO smokers were very likely to smoke.

A majority of FDO smokers in the present study reported that all or most of their social network members do not smoke. The low smoking proportion in the network probably helps FDO smokers remain low-frequency smokers. They are not as likely to encounter smoking cues in their environment nor are they likely to have easy sources for cigarettes. One issue is whether their social network changed as they transitioned from daily smoking to occasional smoking. In other words, as observed in a longitudinal social-network study (Christakis & Fowler, 2008), was there a relationship between family, friends, and co-workers quitting smoking and FDO smokers quitting or cutting down? Or was the low proportion of smokers in the social network a preexisting, protective factor for FDO smokers?

One possible protective factor is not carrying cigarettes, which in the present study, most FDO smokers did not typically do. This finding confirms a hypothesized strategy for low-frequency smoking (Zhu et al., 2007). Not having cigarettes readily available would make it less likely for FDO smokers to smoke. Alternatively, since FDO smokers smoke at a low level, they may not need to carry cigarettes with them or buy packs of cigarettes. When they were regular daily smokers, at least some FDO smokers had probably carried their cigarettes with them and had also bought their own cigarettes.

In the present study, most former-daily smokers transitioned from daily smoking to occasional smoking by quitting first and then relapsing to occasional smoking, instead of

gradually cutting down their cigarette consumption. This provides an answer to the question about how occasional smokers, or low-rate smokers, get to where they are (Zhu et al., 2003).

General Discussion

Summary

Across the three studies, the recurring theme is FDO smokers are similar to NDO smokers on current smoking behaviors. Like NDO smokers, most FDO smokers had made a quit attempt in the previous year, in contrast to daily smokers (Study 1). FDO smokers' motivations to smoke were similar to NDO smokers', with greater overall likelihood of smoking in social or episodic situations (i.e., socializing with friends or going out) rather than solitary or routine situations (i.e., working or driving) (Studies 2 and 3). Similar to NDO smokers, a low proportion of FDO smokers reported having all or most relatives or close friends who smoke (Studies 2 and 3), in contrast to daily smokers (Study 2). Also like NDO smokers, a majority of FDO smokers reported not usually carrying cigarettes with them (Study 3), and many obtained cigarettes from other people rather than bought them (Study 2).

The similarities between FDO and NDO smokers on current smoking aspects are remarkable considering their different smoking histories and cigarette consumption. On average, FDO smokers had started smoking at a younger age (Study 2) and had been smoking for a longer period than NDO smokers (Studies 2 and 3). On cigarette consumption, FDO smokers tended to smoke on more days out of the month and more cigarettes on the days they did smoke (Study 2).

Quit attempts

Across the survey years, FDO and NDO smokers had similarly high rates of recent quit attempts in the previous year; all were above 74%. Both occasional-smoking groups had higher past-year quit attempts than daily smokers. These results are consistent with previous research showing that FDO and NDO smokers were similar in having quit for at least a year cumulatively (Gilpin et al., 1997), expectations about reducing their smoking in the future (Gilpin & Pierce, 2002), and readiness to quit smoking (Gilpin et al., 1997; Gilpin & Pierce, 2002). The present

study focused on recent quitting behavior, which together with cigarette consumption, has been shown to be a better predictor of smoking cessation than readiness to quit alone (Abrams et al., 2000).

Most FDO smokers wanted to quit smoking, based on their high past-year quit attempt rates. This suggests that FDO smokers were not content with their low-frequency smoking but wanted to quit smoking completely. Pertinent to FDO smoking, smoking reduction is predictive of future smoking cessation (Hughes & Carpenter, 2006). One study illustrates this: In a seven-year study of young adult women, daily smokers who reduced to occasional smoking at year 4 were more likely to quit by year 7 of the study than daily smokers who did not reduce their smoking (McDermott et al., 2008). Likewise in another longitudinal study, for moderate to heavy daily smokers who cut down to smoking fewer than 15 cigarettes per day, their chance of quitting smoking increased (Farkas, 1999). Another study showed that for the smokers who were not successful in remaining abstinent, cigarette consumption stayed lower for some time after the quit attempt (Knoke, Anderson, & Burns, 2006).

The high quit attempt rates observed for both FDO and NDO smokers could contribute to occasional smokers' less stable smoking status over time, as seen in previous longitudinal studies (McCarthy, Zhou, & Hser, 2001; McDermott, Dobson, & Owen, 2007; Zhu et al., 2003). For example, in a three-year study of polydrug users (McCarthy et al., 2001), the probability of occasional smokers to remain occasional from year to year was .16, much lower than nonsmokers (.77) and daily smokers (.82) (McCarthy et al., 2001). In a study of young women (McDermott et al., 2007), only 12% of baseline occasional smokers were still occasional smokers at year 4 and at year 7.

Proportion of FDO smoking

Based on the results of the current study, FDO and NDO smokers together make up a substantial proportion of established smokers, ranging from 24-30% for men and women for different survey years. These estimates are consistent with previous studies, showing that

occasional smokers represent as much as 30% of the smoking population (Burns et al., 2003; Centers for Disease Control and Prevention (CDC), 2008; Evans et al., 1992; Gilpin & Pierce, 2002; Hassmiller et al., 2003; Tong et al., 2006; Trinidad et al., 2009; Wortley et al., 2003; Zhu et al., 2003).

In the present study, although FDO and NDO smokers have consistently high quit attempt rates compared to daily smokers, the proportions of smokers who are FDO and NDO generally increased though not significantly from 1996 to 2005. To provide some context for FDO and NDO smoking proportions, additional analyses were conducted to estimate smoking prevalence. The overall smoking prevalence decreased from 20.9% to 17.5% for men and from 14.5% to 11.0% for women. The changes are primarily due to a decrease in daily smoking prevalence: from 15.1% to 12.3% for men and from 10.9% to 8.1% for women. There was no significant change in prevalence of occasional smoking for men (5.8% to 5.2%) though there was a nearly significant decrease for women (3.6% to 2.9%). Taken together, these trends in smoking proportions and smoking prevalence suggest that some of these occasional smokers are being replenished by daily smokers who convert to occasional smoking. This present study's finding differs from a previous U.S. population survey, which indicated that the proportion of occasional smokers among all smokers remained stable at 18-19% from 1993 to 2004 (Centers for Disease Control and Prevention (CDC), 2005). However, the previous study did not adjust for changes in demographics over the years as in the present study.

Tobacco control programs may have contributed to a decrease in smoking prevalence (Farrelly, Pechacek, Thomas, & Nelson, 2008) as well as daily smokers' cigarette consumption (Al-Delaimy et al., 2007; Burns et al., 2003; Gilpin & Pierce, 2002). In fact, states with stronger tobacco control programs tend to have higher prevalence of light daily smoking and occasional smoking (Shiffman, 2009). In addition, home and workplace smoking bans as well as strength of the state tobacco control program were associated with low-rate daily smoking among young adult smokers (Pierce et al., 2009). Also, with increased costs of cigarettes, occasional smokers decrease their cigarette consumption (Tauras, 2004). With respect to FDO smokers, tobacco

control efforts could encourage cessation or smoking reduction in regular, daily smokers, leading to more FDO smokers. On the other hand, tobacco control could discourage new smokers from escalating their use, possibly leading to more NDO smokers.

The proportion of current smokers who are light and occasional smokers is expected to increase: Rates of occasional smoking are relatively high among non-White ethnicities (Evans et al., 1992; Hassmiller et al., 2003; Wortley et al., 2003; Zhu et al., 2007), and a prediction is that in 40 years about half of the population in the U.S. will be non-White (Fagan & Rigotti, 2009). Given high quit rates among occasional smokers, having more smokers who smoke occasionally could increase population-level quitting (Zhu et al., 2003) and could lead to fewer smokers over time.

Smoking situations

For both sexes, FDO and NDO smokers had similar percentages reporting frequent or very likely smoking in different situations (Studies 2 and 3). The exceptions were for male FDO smokers to be more likely to smoke at parties (Study 2), during work or school breaks (Study 2), drinking alcohol (Study 3), and with other people smoking (Study 3) than were NDO smokers. The two occasional-smoking groups were less likely than daily smokers to endorse frequently smoking across seven different situations (Study 2).

In contrast to daily smokers, FDO and NDO smokers seem to limit their smoking to certain situations, those more social or episodic. This pattern of results has been noted in a previous study, in which a predictor of occasional smokers continuing to smoke was the number of smoking situations (Kenford et al., 2005). Specifically, compared to occasional smokers who restricted their smoking to just parties, occasional smokers who smoked in more situations - such as at home, while by themselves, or when spending quiet time with friends in addition to parties - had a higher probability of remaining smokers at a four-year follow-up, (Kenford et al., 2005). Using the present study's classification of types of situations, it seems that expanding smoking to include more routine or solitary situations, such as while alone, is linked to continued smoking.

Whereas limiting smoking to only social or episodic situations (i.e., parties) is predictive of discontinued smoking.

In the present set of studies, the most commonly endorsed smoking situations involved drinking alcohol or socializing. These results are similar to those from an ecological momentary assessment study, which showed that overall, occasional smokers smoked 19% of their cigarettes with alcohol and 29% with other people (Shiffman et al., 2009). These drinking and social situations fit the ideas of the indulgent smoker who smokes for pleasure and also of the psychosocial smoker who smokes for social reasons (Russell, 1971). The results also correspond with the type of occasional smoker who is likely to smoke while drinking alcohol or socializing, but also concentrates their cigarette smoking in short periods and on two days out of the week, usually the weekend (Shiffman et al., 2009).

The connection between drinking alcohol and smoking cigarettes has been demonstrated in controlled laboratory studies of tobacco chippers, and these findings likely apply to FDO smokers and NDO smokers. In one study, there was a dose-response relationship between the amount of alcohol and the strength of the craving (Epstein, Sher, Young, & King, 2007). Specifically, for lighter-smoking tobacco chippers (2-19 cigarettes a week), the low dose of alcohol (2-3 drinks) had an effect on the urge to smoke while no effect was observed for the heavier-smoking tobacco chippers (20 or more cigarettes a week) (Epstein et al., 2007). In another study (Sayette & Kirchner, 2007), after drinking alcohol, tobacco chippers reported increased smoking urges even before the actual smoking cue exposure. During the smoking cue exposure, smoking urges increased even more compared to smokers in the placebo alcohol condition (Sayette & Kirchner, 2007). Thus, smoking is independently related to drinking alcohol, regardless of social situation.

Aside from alcohol, another popular smoking situation was smoking while socializing, and this is consistent with previous studies (Shiffman & Paty, 2006; Shiffman et al., 2009). Despite the strong association between smoking and drinking, occasional smokers cannot be dismissed as merely social smokers. In the present set of studies, a majority of FDO smokers (65%) and

NDO smokers (59%) were not social smokers, defined as smoking only when other people are smoking in Study 2. In addition, about 16% of occasional smokers in Study 3 reported being very likely to smoke while alone. Similarly, in previous research, social smokers made up a small percentage (15%) of a sample of occasional smokers (Shiffman et al., 2009).

Being primarily a social smoker (i.e., with friends) appears to be protect against progressing to higher levels of smoking (Levy, Biener, & Rigotti, 2009), perhaps due to less frequent contact with social situations (Moran, Wechsler, & Rigotti, 2004). In other words, because social smoking occasions are probably episodic and not routine for most people, they help limit smoking and could prevent increased tobacco consumption.

Smoking in the social network

A factor in FDO and NDO smokers' low-frequency smoking is their social network, as indicated by Studies 2 and 3. These results for FDO and NDO smokers match those from a prior study of non-daily social smokers and other non-daily smokers, in which a majority of relatives and friends were not smokers (Gilpin et al., 2005). Previous research shows that having nonsmoking friends in the social network is a protective factor. For example, among tobacco chippers including occasional smokers, those with mostly nonsmoking friends were less likely to escalate their smoking during a four-year period (Levy et al., 2009). In addition, a social network effect has been demonstrated in a longitudinal study, with quitting behaviors spreading through the social network (Christakis & Fowler, 2008). Possible mechanisms for social influence could involve social norms about the desirability of smoking as well as network behaviors like telling or requesting individuals not to smoke or to quit altogether (Christakis & Fowler, 2008). This social network effect has been shown with other health-related behaviors, including obesity and alcohol consumption (Christakis & Fowler, 2007; Rosenquist, Murabito, Fowler, & Christakis, 2010).

Self-regulation theory

Of the theories reviewed in the conceptual framework of the general introduction, self-regulation theory seems to be best for understanding FDO smokers as well as NDO smokers. In self-regulation theory, even though smokers' natural tendency may be to smoke cigarettes in certain situations, they can override this tendency (Baumeister et al., 1994). The present study investigated two self-regulation strategies: source of cigarettes and cigarette-carrying behavior.

Cigarette source. In the first self-regulation strategy, since FDO smokers and NDO smokers smoke at a low rate, they may not need to buy their own packs of cigarettes and instead may opt to get cigarettes from other people. Study 2 supports this idea: Almost a third of young adult FDO smokers and 40% of NDO smokers obtained cigarettes from other people rather than bought their own. This finding fits with previous studies of youth occasional smokers (Jones, Sharp, Husten, & Crossett, 2002; Katzman et al., 2007; Robinson, Dalton, & Nicholson, 2006). Instead of buying their own cigarettes, FDO and NDO smokers could rely on bumming or borrowing cigarettes from other people like smoking friends or coworkers. Bumming cigarettes works well if they primarily smoke with other smokers in social situations, as is the case for occasional smokers who reported smoking only when other people smoke or who were very likely to smoke while socializing. Not buying cigarettes could be a conscious strategy for FDO and NDO smokers to limit their consumption. If FDO and NDO smokers have cigarettes readily available, they may be more likely to smoke them.

Cigarette carrying. The second self-regulation strategy is whether FDO and NDO smokers usually carry cigarettes with them. The results of the present study were that for both sexes, a majority of FDO and NDO smokers did not carry cigarettes with them. These results confirm the hypothesis for low-frequency smokers (Zhu et al., 2007). Since FDO and NDO smokers smoke at such a low rate and do not smoke every day, they may not need to carry a pack of cigarettes with them all the time. On the other hand, not carrying cigarettes may be a conscious decision to help FDO and NDO smokers maintain their low level of smoking, as supported by anecdotes from smokers in Study 3. Either way, the habit of not carrying cigarettes

makes cigarettes less available when FDO and NDO smokers do experience an urge to smoke (Zhu et al., 2007).

As daily smokers, at least some FDO smokers bought and carried around their cigarettes. One issue is when they stopped buying and carrying cigarettes. For those who had quit smoking first, they probably stopped doing either before they quit. The issue becomes more interesting for FDO smokers who had gradually cut down their cigarette consumption. They may have stopped carrying cigarettes or buying cigarettes as a self-regulation strategy to further lower their cigarette consumption and to maintain low-frequency smoking.

The present study addresses only two of many possible self-regulation strategies. Other smoking-reduction strategies for occasional smokers included general ones like “reduce number of cigarettes” (75.0%) or “try to limit amount of smoking” (61.5%), as well as more specific ones like “set a daily limit” (55.8%) (Okuyemi et al., 2002). Similarly, in qualitative interviews (Johnson, Kalaw, Lovato, Baillie, & Chambers, 2004), adolescent smokers were probed about their methods to control their smoking, and these included monitoring the number of cigarettes they smoked, restricting their smoking to certain times or places (e.g., not at school or home), not smoking unnecessarily (e.g., out of boredom or one cigarette after another), smoking only part of a cigarette, and delaying a cigarette.

Converted and native chippers

The present series of studies indicate that once daily smokers reduce their smoking to a low level (i.e., FDO smokers), they are actually similar to lifetime occasional smokers (i.e., NDO smokers) on current smoking behaviors. This finding matches those from two studies about converted tobacco chippers and native tobacco chippers (Hajek et al., 1995; Shiffman et al., 1994), analogous to FDO and NDO smokers respectively. Although on average converted chippers had higher lifetime cigarette consumption than native chippers, they were similar on biochemical and addiction measures, including serum cotinine level, exhaled carbon monoxide, time to first cigarette of the day, reported withdrawal symptoms, and self-reported addiction level

(Shiffman et al., 1994). Converted and native chippers were also similar on smoking situations and smoking motivations (Hajek et al., 1995). They also did not differ on smoking among their social network, specifically friends, relatives, and partners/spouses (Hajek et al., 1995).

FDO smoking history and transition

Former-daily occasional smokers could be placed on different trajectories. For example, some reduced their cigarette consumption perhaps out of concern about the effects of smoking or as preparation to quit smoking, while others are continuing as long-term low-rate smokers (Husten, 2009; Levy et al., 2009). Of course, some others could be on their way back to more heavy smoking (Levy et al., 2009). Illustrating this instability in smoking status, among FDO smokers, 39% were occasional smokers two years prior while 11% were former smokers and 36% daily smokers (Gilpin et al., 1997).

A model was previously presented depicting how smokers could modify their cigarette consumption levels (Zhu et al., 2003). For former-daily occasional smokers, one pathway is when a regular daily smoker (> 5 cigarettes per day) or low-rate daily smoker (≤ 5 cigarettes per day) cuts down their consumption to occasional smoking. Another pathway is when a regular daily smoker or low-rate daily smoker quits and then relapses to occasional smoking. Illustrating this, in a longitudinal study, 21% of low-rate daily smokers had cut down to smoking occasionally at a four-year follow-up (Levy et al., 2009). Another longitudinal study showed that two years prior, 29% of occasional smokers were regular daily smokers while 2% were low-rate daily smokers (Zhu et al., 2003). Of course, in between the two-year time points, these FDO smokers may have been in and out of different smoking categories.

Although relapsed smokers may be expected to increase their consumption to their former smoking levels, FDO smokers can, in fact, be long-term occasional smokers. In Study 3, on average, these FDO smokers last smoked daily about six years prior to the survey and were smoking occasionally for about four years.

To get a better sense of FDO smokers' history in the present series of studies, additional analyses were conducted with the 2005 CTS data. A year before the survey, 65% of FDO smokers were smoking occasionally while 35% were smoking daily. Among FDO smokers who had been smoking daily a year prior to the survey, the average number of cigarettes smoked per day was 16. Analyzed another way, 54% of FDO smokers who had been daily smokers a year prior were low-rate daily smokers (five or fewer CPD) while 46% were regular daily smokers (more than five CPD). About three-fourths of FDO smokers reported smoking more cigarettes than their levels at the time of the survey. The peak cigarette consumption for FDO smokers was an average of 18, nearly a pack a day. At their peak smoking levels, most FDO smokers were regular smokers (92%), not low-rate smokers (8%). These results suggest that not all FDO smokers were low-rate smokers, but had transitioned from higher daily smoking levels.

The present study's results indicate that more FDO smokers had taken the route of quitting and then relapsing to occasional smoking rather than the route of gradually cutting down to occasional smoking. It may be that former-daily smokers control their smoking by quitting first, allowing them to break the association between situations and their smoking. After having quit for a period of time, smokers could be selective about which situations to smoke in, perhaps to keep their smoking level low.

A model of transition was proposed to explain which smoking days former-daily smokers cut out or pick up again when switching from daily smoking to occasional smoking. In the present studies, FDO smokers reduced their smoking to the point where they smoke less than half the days in a given month. If FDO smokers gradually cut down consumption from smoking daily to non-daily, they first forgo smoking on days that involve routine/solitary situations (i.e., at home) when no other smokers are present. If they transition from daily to occasional through the quit-and-relapse route, they restrict their smoking mostly to days that involve social/episodic situations (i.e., at parties). A longitudinal study could track how daily smokers make the transition to occasional smoking and test the proposed model of transition.

Limitations

Study 1 has a few limitations. One is that the data are cross-sectional rather than longitudinal. Respondents' smoking status was not tracked at multiple time points, which would provide a better idea of how the two pathways (FDO and NDO) to occasional smoking operate over time. Another limitation is the dependence on self-report data from a population survey. In addition, the survey questions were limited with respect to providing much detail about FDO and NDO smokers.

For Study 2, a limitation is the use of cross-sectional data instead of longitudinal data. Another is reliance on smokers' recall, instead of tracking their smoking situations in real time (Shiffman & Paty, 2006). Also, the survey did not ask how often smokers are in those seven situations. For the proposed model of transition, an assumption was that the average smoker has more routine/solitary days than days with social/episodic events. In addition, this supplemental survey includes only 18-29-year-olds, which limits the generalizability of the results to other age groups (Biener & Albers, 2004; Moran et al., 2004). Due to a design effect, this study may be underpowered, resulting in bigger confidence intervals.

There are also a few limitations to Study 3. Since most of the sample was White or female, the study results may not apply to other segments of the population. Also, the recruitment approach was through internet-based advertisements, which reach a limited selection of the population, thus presenting another sampling bias. Unlike the previous EMA studies (Shiffman & Paty, 2006), affect was not included in the list of smoking situations, which would provide useful information about this aspect of occasional smokers' smoking motivation. Daily smokers were not included as a reference group for the occasional smokers, as in Studies 1 and 2.

Future directions

The present series of studies helped to answer some questions about FDO smokers. However, there are still some questions that future studies can address.

Building on the previous cluster analysis of occasional smokers (Shiffman et al., 2009), one study could be conducted with FDO smokers and NDO smokers. Based on the interviewed smokers' stories in Study 3, there seems to be considerable heterogeneity in smoking situations and patterns. Cluster analyses could be conducted on smoking situations or on smokers' reasons for smoking.

Ecological momentary assessment could be used to better understand when and where FDO smokers smoke (Shiffman et al., 2002; Shiffman et al., 2004; Shiffman & Paty, 2006; Shiffman et al., 2009). It allows for a precise analysis of the immediate antecedents to FDO as well as NDO smoking, including urge to smoke, affect, location, activities, and social environment (Shiffman et al., 2004; Shiffman & Paty, 2006; Shiffman et al., 2009). A previous study focused on occasional smokers, but it did not separate FDO smokers from NDO smokers (Shiffman et al., 2009).

The ideal study design for examining FDO smoking is longitudinal, population-based, and uses the EMA method. This type of study would help answer several unresolved questions, particularly for FDO smokers. For FDO smokers who used to carry cigarettes with them, when did they stop carrying them? Was it before or after they became occasional smokers? Similarly, if FDO smokers used to buy their own packs of cigarettes, when did they stop? How exactly did daily smokers cut down on their smoking? Did they really cut out the solitary or routine situations first rather than the social or episodic ones, as proposed in the present model? Did smokers' social networks also change when they switched to occasional smoking?

Conclusion

Former-daily occasional smokers are an interesting though relatively understudied subgroup of smokers. Their previous daily consumption is consistent with classic withdrawal-based addiction theory, but their current occasional smoking pattern poses difficulties for withdrawal-based addiction theory. NDO smokers also present a challenge to withdrawal-based addiction theory; they never escalated their smoking or developed tolerance to nicotine. The

findings from the present study indicate that despite coming from a different pathway to occasional smoking, FDO smokers are similar to NDO smokers on current smoking behaviors and aspects, namely smoking situations, source of cigarettes, cigarette carrying, and recent quit attempts. On the other hand, FDO smokers are considerably different from their previous smoking category, daily smokers, on these current smoking behaviors and aspects. Thus, it appears that previous daily smoking history has little influence on FDO smokers' current smoking behaviors.

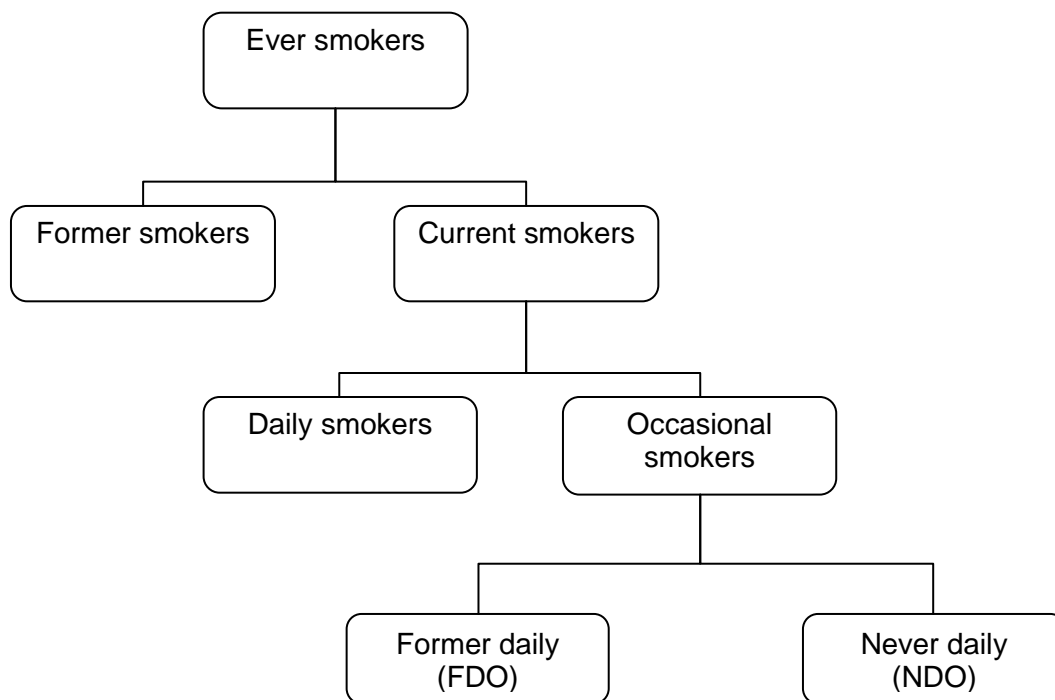


Figure 1. Categorization of smokers

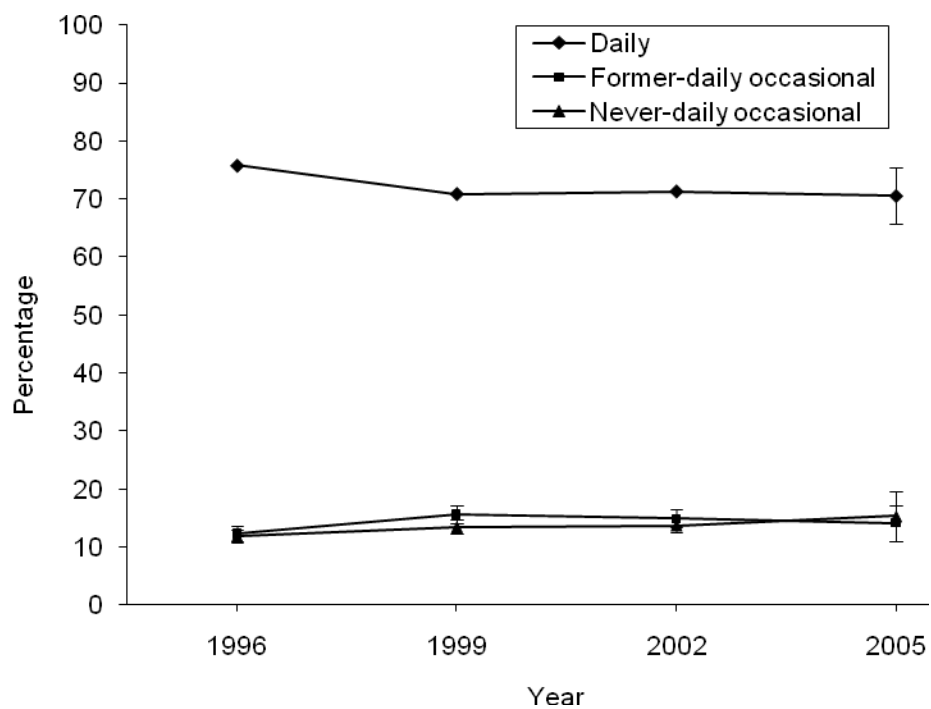


Figure 2. Standardized weighted proportions of NDO, FDO, and daily smokers among male established smokers across years. Error bars represent 95% confidence intervals.

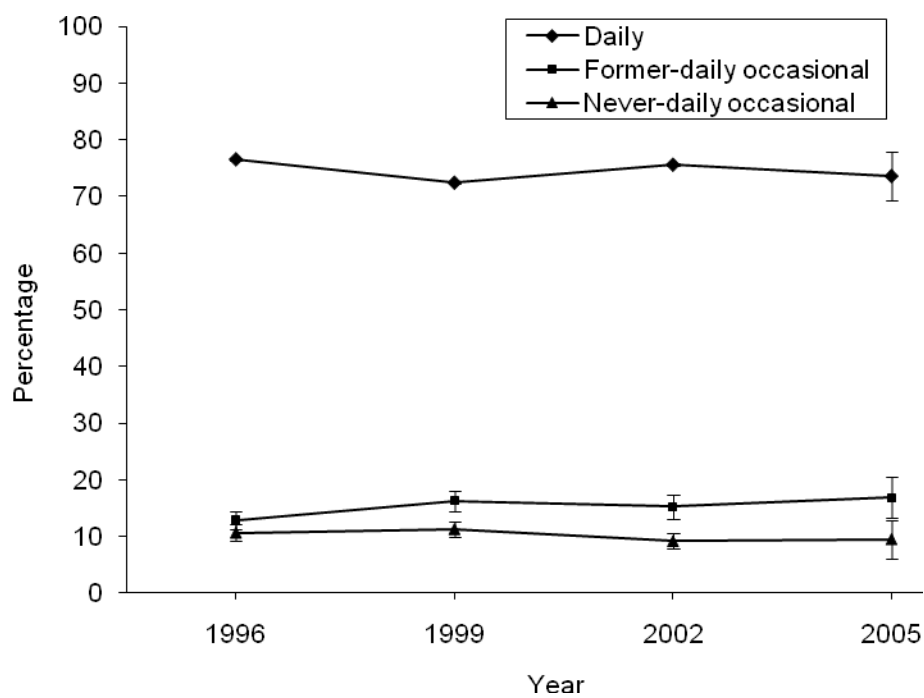


Figure 3. Standardized weighted proportions of NDO, FDO, and daily smokers among female established smokers across years. Error bars represent 95% confidence intervals.

Table 1
Weighted percentage of smokers who made a quit attempt in the previous year

Smoker category	1996		1999		2002		2005	
	Men %,95%CI (n = 4297)	Women %,95%CI (n = 4182)	Men %,95%CI (n = 2906)	Women %,95%CI (n = 2602)	Men %,95%CI (n = 2777)	Women %,95%CI (n = 2559)	Men %,95%CI (n = 1831)	Women %,95%CI (n = 1995)
Never-daily occasional	74.4 ^A 69.7, 78.5	75.5 ^A 67.4, 82.1	80.0 ^A 73.9, 84.9	82.2 ^A 72.1, 89.1	78.8 ^A 72.2, 84.1	76.4 ^A 68.8, 82.6	78.2 ^A 67.2, 86.3	79.8 ^A 61.5, 90.7
Former-daily occasional	79.9 ^A 75.1, 83.9	80.1 ^A 76.1, 83.5	83.5 ^A 79.2, 87.0	80.5 ^A 75.0, 85.0	89.6 ^B 85.5, 92.7	86.4 ^B 81.7, 90.0	80.3 ^A 69.9, 87.7	87.4 ^A 79.4, 92.6
Daily	45.8 ^B 44.0, 47.6	44.0 ^B 42.0, 46.0	52.9 ^B 50.2, 55.6	49.0 ^B 46.5, 51.5	50.8 ^C 48.6, 52.9	47.4 ^C 44.5, 50.3	51.0 ^B 43.2, 58.6	45.7 ^B 40.6, 50.9

Note. Differing superscripts within columns indicate significant differences between smoking groups at the $p < .05$ level, adjusted by age, educational level, and ethnicity.

Table 2
Demographics and smoking characteristics of young adult smokers

	Never-daily occasional (%) (n = 298)	Former-daily occasional (%) (n = 294)	Daily (%) (n = 959)
Sex			
Male	70.7 ^A	61.7 ^{BC}	66.2 ^{AC}
Age			
18-24	57.7	57.0	61.8
25-29	42.3	43.0	38.2
Education level			
Less than high school	24.6	17.7	22.4
High school graduate	19.8	24.5	34.9
Some college	34.6	36.7	33.4
College graduate	21.1 ^A	21.2 ^A	9.3 ^B
Ethnicity			
Non-Hispanic White	32.9	48.6	54.1
Hispanic	52.5 ^A	35.6 ^B	24.2 ^C
African American	1.7	4.1	5.4
Asian American/Pacific Islander	8.9	9.0	10.6
Other	4.1	2.7	5.8
Age smoked first whole cigarette, mean	15.4 ^A	14.8 ^B	14.5 ^B
Number of years smoked, mean	8.3 ^A	8.9 ^B	8.9 ^B
Number of days smoked in past 30 days, mean	10.3 ^A	12.9 ^B	
Number of cigarettes on smoking days, mean	3.1 ^A	4.1 ^B	12.6
Number of months since smoked daily, mean		21.6	

Note. All estimates are population-weighted. Different superscript letters indicate significant difference at the $p < .05$ level, adjusted for sex, age, ethnicity, and educational level, where appropriate.

Table 3

Weighted percentage of young adult smokers who report frequently smoking in specific situations

	Male		
	Never-daily occasional (% (95% CI))	Former-daily occasional (% (95% CI))	Daily (% (95% CI))
	(n = 186)	(n = 157)	(n = 540)
While socializing with friends	27.9 (20.9, 36.1) ^A	42.7 (35.0, 50.8) ^A	72.5 (67.1, 77.4) ^B
At parties	35.7 (28.5, 43.8) ^A	52.6 (44.4, 60.7) ^B	77.5 (72.2, 82.0) ^C
At clubs/bars	34.4 (26.5, 43.4) ^A	45.4 (36.5, 54.6) ^A	60.2 (54.0, 66.1) ^B
Driving in your car	12.5 (7.9, 19.0) ^A	19.7 (13.2, 28.2) ^A	57.7 (51.9, 63.2) ^B
While working/studying	7.4 (3.9, 13.7) ^A	12.7 (7.4, 20.8) ^A	34.4 (29.8, 39.3) ^B
In your home or apartment	10.2 (5.2, 19.3) ^A	11.2 (6.7, 18.1) ^A	43.3 (37.7, 49.2) ^B
When taking a break at work or school	8.5 (5.0, 14.1) ^A	26.4 (18.5, 36.2) ^B	73.8 (69.2, 78.0) ^C
	Female		
	Never-daily occasional (% (95% CI))	Former-daily occasional (% (95% CI))	Daily (% (95% CI))
	(n = 109)	(n = 132)	(n = 412)
While socializing with friends	41.0 (29.6, 53.3) ^A	51.4 (41.2, 61.5) ^A	80.0 (75.3, 84.1) ^B
At parties	51.2 (39.2, 63.2) ^A	60.4 (50.6, 69.5) ^A	85.5 (81.2, 89.0) ^B
At clubs/bars	54.8 (43.7, 65.4) ^A	54.5 (44.6, 64.1) ^A	72.5 (67.3, 77.2) ^B
Driving in your car	16.2 (9.2, 27.0) ^A	21.9 (14.3, 32.2) ^A	64.1 (57.7, 70.0) ^B
While working/studying	3.5 (1.0, 11.6) ^A	3.2 (1.4, 7.2) ^A	24.5 (20.2, 29.4) ^B
In your home or apartment	7.0 (2.5, 17.9) ^A	9.5 (5.5, 16.0) ^A	40.1 (34.2, 46.4) ^B
When taking a break at work or school	12.2 (6.3, 22.4) ^A	11.7 (7.4, 18.0) ^A	69.8 (63.5, 75.5) ^B

Note. Different superscript letters indicate significant difference at the $p < .05$ level, adjusted for age, ethnicity, and education.

If smokers answered “not applicable” to any of the situations, the answer was treated as missing, and proportions were calculated based on the rest of the answers. The rates of answering “not applicable” for the seven situations are: Socializing with friends 1.6%, At parties 3.9%, At clubs/bars 11.6%, While driving in your car 4.9%, While working/studying 3.8%, At home/apartment 2.7%, and When taking a break 2.9%.

Table 4
 Weighted percentage of young adult smokers who report all or most of a social-network category smokes

	Male		
	Never-daily occasional (% (95% CI)) (n = 188)	Former-daily occasional (% (95% CI)) (n = 160)	Daily (% (95% CI)) (n = 545)
People party with	60.3 (50.9, 68.9)	67.3 (58.6, 75.0)	68.5 (63.8, 72.8)
Co-workers (if applicable)	34.7 (27.5, 42.8)	39.2 (30.8, 48.3)	43.5 (38.7, 48.5)
Close friends	48.2 (41.1, 55.4) ^A	50.6 (41.8, 59.3) ^A	65.2 (59.6, 70.4) ^B
Close relatives	21.1 (14.9, 29.0) ^A	21.0 (14.6, 29.3) ^A	38.3 (34.3, 42.6) ^B
	Female		
	Never-daily occasional (% (95% CI)) (n = 110)	Former-daily occasional (% (95% CI)) (n = 134)	Daily (% (95% CI)) (n = 414)
People party with	54.9 (42.7, 66.6)	59.1 (50.0, 67.6)	69.0 (62.7, 74.6)
Co-workers (if applicable)	20.5 (12.6, 31.5)	21.7 (13.9, 32.2)	32.5 (27.4, 38.1)
Close friends	44.8 (34.3, 55.7) ^A	44.6 (36.4, 53.0) ^A	65.7 (59.4, 71.4) ^B
Close relatives	22.4 (13.9, 34.2) ^A	16.1 (10.6, 23.7) ^A	44.1 (38.4, 50.0) ^B

Note. Different superscript letters indicate significant difference at the $p < .05$ level, adjusted for age, ethnicity, and education.

Table 5
Demographics and smoking characteristics of interview sample

	Male		Female		TOTAL
	Never- daily occasional % (n = 24)	Former- daily occasional % (n = 48)	Never- daily occasional % (n = 34)	Former- daily occasional % (n = 46)	
Age, mean (standard deviation) ^{A B}	28.8 (9.9)	35.8(11.9)	27.8 (8.4)	32.5(10.8)	31.9(10.9)
White	41.7	50.0	73.5	58.7	56.6
Number of days smoked in the last 30 days, mean (standard deviation)	13.5 (4.9)	14.1 (5.5)	10.9 (6.9)	10.7 (7.2)	12.3 (6.4)
Number of cigarettes on smoking days, mean (standard deviation)	3.8 (2.6)	3.4 (2.3)	2.6 (1.5)	3.2 (2.1)	3.2 (2.2)
Number of years smoked, mean (standard deviation) ^{A B}	5.9 (3.7)	13.1 (8.6)	8.1 (5.6)	13.1 (8.9)	10.8 (8.0)
Number of years since smoked daily, mean (standard deviation)		5.7 (5.5)		6.3 (7.0)	6.0 (6.3)

Note. ^A means male NDO and FDO differ and ^B means female NDO and FDO differ at the $p < .05$ level, adjusted by age and ethnicity.

Table 6
Percentage of interviewed smokers who report very likely smoking in specific situations

Smoking situation	Men		Women		TOTAL
	Never-daily occasional	Former-daily occasional	Never-daily occasional	Former-daily occasional	
	% (n = 24)	% (n = 48)	% (n = 34)	% (n = 46)	
Location					
Home	33.3	33.3	11.8	37.0	29.6
Work	5.9	15.6	21.4	19.4	16.8
Other people's homes	8.3	10.6	8.8	2.2	7.3
Bar or restaurant	20.8	31.1	41.2	37.0	33.6
Car	12.5	12.5	23.5	13.0	15.1
Activity					
Working	8.7	17.0	8.8	8.9	11.4
Socializing	20.8	29.8	32.4	30.4	29.1
Relaxing	8.3	18.8	2.9	13.0	11.8
Waiting	4.2	12.5	9.1	13.0	10.6
Eating food	0.0	12.5	0.0	8.9	6.6
Drinking coffee	4.2	19.5	11.8	12.2	12.9
Drinking alcohol ^A	13.6	51.2	54.5	53.7	46.7
Social environment					
Alone	8.3	27.1	5.9	15.2	15.8
With other people who are smoking ^A	16.7	41.7	52.9	57.8	45.0
With other people who are not smoking	0.0	0.0	2.9	0.0	0.7

Note. ^A means male NDO and FDO differ at the $p < .05$ level, adjusted by age and ethnicity.

Table 7

Percentage of interviewed smokers who report all or most of a social-network category smokes

	Men		Women		TOTAL
	Never-daily occasional (<i>n</i> = 24)	Former-daily occasional (<i>n</i> = 48)	Never-daily occasional (<i>n</i> = 34)	Former-daily occasional (<i>n</i> = 46)	
Co-workers (if applicable)	6.3	24.1	20.0	17.9	18.3
Close friends	29.2	33.4	32.4	19.6	28.3
Close relatives ^B	4.2	12.7	26.5	8.7	13.2

Note: ^B means female NDO and FDO differ at the $p < .05$ level, adjusted by age and ethnicity. Only currently employed smokers were asked about the proportion of smokers among their co-workers, $n = 45$ for men and $n = 53$ for women.

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