Original Investigation

Cigarette Smoking Reduction and Changes in Nicotine Dependence

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Abstract

Introduction: The relationship of nicotine dependence (ND) to smoking behavior and cessation has been well characterized. However, little is known about the association between smoking reduction (SR) and ND.

Methods: We retrospectively evaluated the lifetime prevalence and extent of SR and whether ND as assessed by a modified Fagerström Test for Nicotine Dependence (FTND) score without cigarettes per day (CPD) and time-to-first cigarette changed with reductions in CPD. As part of the Collaborative Study of the Genetics of Nicotine Dependence (COGEND), 47,777 individuals from 2 mid-Western metropolitan areas were identified for a community-based telephone screening, yielding 6,955 current daily smokers ages 25–44 years (European-American, *n* = 5,135 and Black, *n* = 1,820). The FTND was administered to measure current ND and peak ND in respondents whose current daily CPD is lower than their reported lifetime peak.

Results: About 44% (*n* = 3,077) of the sample reported reducing their smoking from their lifetime peak, with a mean reduction of 14.4 CPD (*SD* = 8.9) or a 54.0% reduction compared with peak smoking. Controlling for peak smoking and years smoked, the magnitude of SR was associated with declines in ND excluding the direct contribution of CPD.

Conclusions: Self-reported SR was associated with reduced levels of ND. The impact of this reduction on smoking cessation and health risks and smoking cessation requires further study, particularly given the retrospective nature of the present dataset.

Introduction

Nicotine dependence (ND) has been shown to predict quit attempts and smoking cessation (Piper, McCarthy, & Baker, 2006). In contrast to smoking cessation, less is known about the association between smoking reduction (SR) and ND. Given the broader relationship of ND to smoking behavior and cessation, establishing if any relationship exists between ND and SR is warranted. However, only two reports have described the association of ND with SR (Etter, Laszlo, Zellweger, Perrot, & Perneger, 2002; Joseph, Bliss, Zhao, & Lando, 2005), using the Fagerström Test for Nicotine Dependence (FTND) in research samples (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). In both studies, SR was associated with lower FTND scores; however, since the total FTND score includes cigarettes per day (CPD), apparent differences in ND may simply reflect lower scores from smoking fewer cigarettes (Etter et al., 2002; Joseph et al., 2005). To meaningfully examine the relationship between SR and ND, non-CPD elements of ND must be the focus of analysis, acknowledging that all such elements will be to varying extents correlated with CPD.

In order to extend the limited literature on SR and ND, to date restricted to a few small research samples, we analyzed a community-based sample of 6,955 current smokers recruited through a telephone screening survey for a genetic study on nicotine dependence (COGEND; Bierut et al., 2007; Saccone et al., 2007). The dataset captured information on past smoking through retrospection; the design was cross-sectional and not longitudinal and prospective. We had two primary goals in this report using data based on restrospection. First, we sought to characterize CPD reduction in a community-based sample, reporting descriptive data on the extent and frequency of SR. Second, we evaluated the relationship between the magnitude of reported SR and changes in ND as assessed by (a) a modified total FTND score that excludes the contribution of CPD and (2) time-to-first cigarette (TTFC).

Methods

Sample

Participants were recruited via random sampling through a community-based telephone screening of 47,777 individuals at two sites (Detroit, MI and St. Louis, MO) to identify case and control subjects eligible to participate in the COGEND study from February 2003 through August 2005 (Bierut et al., 2007; Saccone et al., 2007). Individuals aged 25–44 years, who spoke

English and were mentally competent, were eligible for participation in the telephone screening. The Detroit site (greater metropolitan areas including Macomb, Oakland, and Wayne counties) drew from an Health Maintenance Organization (HMO) with a membership list of more than 400,000. A total of 35,530 HMO members meeting age criteria were sampled for screening; 29,887 were eligible for screening (or assumed to be eligible for the purposes of calculating the response rate because they could not be contacted); 1,818 refused participation; and 15,326 completed screening for a response rate of 51.3%. The St. Louis site (St. Louis City, St. Louis County, and St. Charles County) drew from the state driver's license registry. A total of 78,072 driver's license holders meeting age criteria were sampled for screening; 42,813 were eligible for screening (or assumed to be eligible for the purposes of calculating the response rate because they could not be contacted); 1,973 refused participation; and 28,658 completed screening for a response rate of 66.9%

Due to a small number of respondents in the other reported racial categories, only European-American (n = 28,902) and Black (n = 11,642) respondents were eligible for inclusion in analyses. Of the 40,544 Black and European-American respondents, 6,955 were eligible for analysis as they were current smokers, Black (n = 1,820), and European-American (n = 5,135). A total of 55 respondents were Hispanic (Black, n = 18 and European-American, n = 39).

Procedures and Measurement

Respondents were administered a structured telephone interview that captured information on demographic characteristics and smoking history. The FTND was administered to measure (a) current level of ND (full sample) and (b) level of ND when smoking the most (only reducers prior to reduction). Current smoking was defined as having smoked at least one cigarette in the 30 days prior to the interview among respondents who had smoked at least 100 cigarettes in their lifetime. Smoking level was treated as a categorical variable with five levels: (a) 1–5 CPD, (b) 6–10 CPD, (c) 11–15 CPD, (d) 16–20 CPD, and (e) ≥ 21 CPD.

Reducer Versus Nonreducer

The sample of current smokers was classified as (a) reducers and (b) nonreducers. Respondents were classified as reducers if their current level of smoking was five or more cigarettes fewer than their lifetime peak CPD. The 5 CPD minimum reduction criterion was employed to minimize the effects of measurement error and the misclassification of nonreducers as reducers (e.g., Garcia, Fernandez, Schiaffino, Peris, & Borras, 2005; Godtfredsen, Prescott, Osler, & Vestbo, 2001; Hughes, Cummings, & Hyland, 1999). Those respondents whose current smoking was historically their highest or those who noted reductions of 1–4 CPD from lifetime peak were classified as nonreducers.

Non-CPD Indexes of ND

We calculated a modified FTND excluding FTND Item 4 (i.e., CPD), FTND without CPD (range = 0–7 points). In addition, we also examined FTND Item 1 (i.e., TTFC) in minutes as opposed to the usual ordinal scale (i.e., 0–5, 6–30, 31–60, and more than 60 min) and used this as a second non-CPD index (range = 0–720 min [12 hr]).

Analyses

All analyses were conducted using the Statistical Analysis System, Version 9.1.3 (SAS Institute Inc., 2010). Values of $p < .05$ were considered statistically significant. Type I error rate in all post-hoc comparisons was controlled Dunnett–Hsu adjustments. Multivariate linear regression analyses were employed to evaluate the relationship between non-CPD indexes of ND and SR, controlling for subject characteristics.

Results

Smoking Nonreducers Versus Reducers

Sample Characteristics

Mean and frequency differences between nonreducers and reducers as well as unadjusted odds ratios with 95% CI are shown in Table 1.

Prevalence and Distribution of Reduction

Of the 6,955 respondents in the analysis sample, 44.2% (n = 3,077) reduced their smoking from a lifetime peak by five or more cigarettes. The remaining 55.8% (n = 3,878) of the sample were nonreducers, with 51.5% (n = 3,579) reporting no reduction and 4.3% (n = 299) reporting a reduction of 1–4 CPD from lifetime peak (henceforth, nonreducers are treated as a single group). Table 2 presents the percentages of reducing smokers at their current CPD level as a function of their peak smoking level category among the 6,955 current smokers. Since each CPD category includes a range of 5 CPD and SR was defined as 5 or more CPD, no respondents reduced and remained in their peak CPD stratum, except for those in the ≥21 CPD category. The final column in Table 2 presents percentages of nonreducers; since these respondents have always smoked at this level, current and peak smoking rates are the same.

Mean reductions in CPD by peak smoking level and percentage reducing by 50% or more are presented at the bottom of Table 2. In reducers, before reduction, respondents smoked an average of 27.6 CPD (SD = 13.6). Absolute reduction in CPD increased with peak smoking level, $F(3, 3073) = 432.91$, $p < .0001$, with a mean SR of 14.4 CPD (SD = 8.9) or 54% reduction compared with peak smoking. More than half (66.6%) of reducers reduced from their peak smoking by 50% or more, $\chi^2(3) = 258.36$, $p < .0001$. By definition, those smoking 6–10 CPD at peak all achieved substantial reductions since a 5 or more CPD reduction was required to be classified as a reducer.

Association Between Amount of SR and Changes in ND

Change scores were computed such that (a) current FTND without CPD or (b) TTFC was subtracted from respective values of these indexes at peak smoking level. The relationship between the magnitude of SR and the two foregoing indexes on ND were evaluated in multivariate linear regression models.

Larger positive estimated values of change in FTND without CPD reflect greater apparent decreases in ND. Controlling for peak CPD, years smoked, and other variables (see Table 1),

Table 1. Sample Characteristics: Smoking Nonreducers versus Reducers

	Nonreducers	Reducers	OR (95% CI)[a]
	n = 3,878	n = 3,077	Unadjusted
Age in years (M, SD)	36.1 (5.6)	35.9 (5.5)	0.99 (0.98, 1.00)
Sex (%)			
Male[b]	54.4	56.8	–
Female	45.6	43.2	0.91 (0.83, 1.00)
Race (%)			
Black[b]	67.6	51.6‡	–
European-American	32.4	48.4	1.96 (1.75, 2.19)‡
Marital status (%)			
Married[b]	53.6	58.4‡	–
Never married/other	46.4	41.6	0.82 (0.75, 0.91)‡
Education (years, %)			
≤12[b]	45.9	37.6‡	–
13–15	31.7	34.1	1.31 (1.18, 1.47)‡
≥16	22.4	28.3	1.54 (1.37, 1.74)‡
Employment status (%)			
Full time[b]	82.6	82.0	–
Part time	8.4	9.8	1.17 (0.99, 1.39)
Other	9.0	8.2	0.91 (0.77, 1.08)
Years smoked (M, SD)	17.9 (7.2)	18.8 (6.6)‡	1.02 (1.01, 1.02)‡
Current CPD (M, SD)	15.7 (10.3)	13.2 (8.9)‡	0.97 (0.97, 0.98)‡
Current CPD (%)			
1–5[b]	17.9	24.7‡	–
6–10	22.1	25.8	0.85 (0.74, 0.98)*
11–15	14.7	16.1	0.79 (0.68, 0.93)*
16–20	29.4	22.5	0.55 (0.48, 0.64)‡
≥21	15.9	10.9	0.50 (0.42, 0.59)‡
Current FTND (M, SD)	3.5 (2.6)	3.0 (2.5)‡	0.92 (0.91, 0.94)‡
TTFC (%)			
≤30 min[b]	51.8	59.8‡	–
>30 min	48.2	40.2	0.72 (0.66, 0.79)‡

Note. CPD = cigarettes per day; FTND = Fagerström Test for Nicotine Dependence; TTFC = time-to-first cigarette.

[a]Modeling the likelihood of being a reducer.

[b]Reference group.

*$p < .05$; †$p < .01$; ‡$p < .0001$.

the magnitude of SR was strongly associated with reduction in the FTND without CPD score, $F_{(4, 2988)} = 30.3$, $p < .0001$. All SR levels were different from the 1–5 CPD reduction reference category ($ps < .01$). About one third of those (32.6%) reducing by 5 or more CPD showed no change in FTND without CPD.

Larger negative estimated values of change in TTFC reflect greater increases in time before smoking the first cigarette after awakening, suggesting less ND. Controlling for peak CPD and years smoked, the magnitude of SR was strongly associated with increased TTFC, $F_{(4, 2948)} = 71.7$, $p < .0001$. All SR levels were different from the 1–5 CPD reduction reference category ($ps < .0001$). With respect to TTFC without CPD, 37.5% showed no change despite reducing by 5 or more CPD.

Discussion

Summary

In an analysis of a community-based sample of current daily smokers, we observed that SR was common (i.e., 44% of current smokers had reduced) and that among reducers, a majority of all reducing smokers (67%) achieved at least a 50% reduction from peak smoking. Non-CPD elements of FTND declined with SR. Increasing magnitude of SR was associated with decreased ND indexes excluding the contribution of CPD. These findings must be placed in the context of some major limitations, particularly the retrospective nature of the design and the lack of information on the duration of and time since last peak smoking.

Frequency and Magnitude of SR

In our community-based sample, 44% of smokers reduced their CPD by 5 or more CPD. This finding is consistent with a growing literature showing that smokers often reduce daily CPD, with rates of reducing smoking ranging from 8% to 64% (Broms, Korhonen, & Kaprio, 2008; Falba, Jofre-Bonet, Busch, Duchovny, & Sindelar, 2004; Farkas, 1999; Garcia et al., 2005; Godtfredsen et al., 2001; Hughes et al., 1999; Hyland et al., 2005; McDermott, Dobson, & Owen, 2008; Meyer, Rumpf, Schumann, Hapke, & John, 2003). Of greater practical interest is not mere reduction but the quantity of reduction. Substantial reductions of 50% or more (Broms et al., 2008; Falba et al., 2004; Farkas, 1999; Hughes & Carpenter, 2006; Hyland et al., 2005) have been shown to be associated with smoking cessation. Among reducers in our sample, 67% of daily smokers reduced CPD by 50% or more. Other reports have noted somewhat lower rates of substantial reduction, for example, 8%–52% (Broms et al., 2008; Falba et al., 2004; Farkas, 1999; Hughes et al., 1999; Hyland et al., 2005; McDermott et al., 2008). In the existing literature, the duration during which reduction was maintained ranges from 2 to 6 years. In our study, the duration of reduction maintenance, that is, the length of time the current decreased CPD has lasted, was not assessed, and the potentially shorter durations of reduction in some of the smokers in our sample preclude a direct comparison with the previous studies.

Association Between SR and Changes in ND

Controlling for potential confounders, quantity of SR was strongly associated with decreased FTND without CPD score and with increased TTFC in minutes. The practical or clinical implications of this finding remain to be determined. Given the broader relationship of ND to smoking cessation, it is possible that ND can be a mediating variable between SR and smoking cessation. However, it should be acknowledged that decreasing ND might lead to decreasing smoking. We do not know if SR caused decreased ND or visa versa. Prospective studies are warranted to evaluate this hypothesis and to determine the causal connections between ND, SR, and cessation. In the only prospective study to repeatedly measure FTND in reducing smokers, Etter et al. (2002) found that reducing smokers using either nicotine replacement therapy (NRT) or placebo NRT had significantly lower FTND scores than a no-treatment group after six months of attempted reduction. Within-subject comparisons between baseline and follow-up timepoints were not reported, and these would have been most informative. Investigators with

Table 2. Distribution of Current CPD in Reducers and Nonreducers

Current CPD	Peak CPD					
	1–5, % (n)	6–10	11–15	16–20	≥21	Nonreducer[a]
1–5	–[b]	4.7 (327)	1.8 (128)	2.9 (203)	1.5 (102)	10.0 (694)
6–10		–[b]	2.3 (163)	6.4 (446)	2.7 (186)	12.3 (856)
11–15			–[b]	2.8 (194)	4.3 (302)	8.2 (572)
16-20				–[b]	9.9 (691)	16.4 (1139)
≥21					4.8 (335)	8.9 (617)
Mean CPD reduction (*SD*)	–	6.6 (1.5)	8.0 (2.9)	11.1 (3.9)	18.9 (9.9)	–
≥50% reduction	–	100%	59.8%	74.1%	57.0%	–

Note. Percentages and numbers of reducing smokers (as part of the total sample of 6,955: 44.2% reducers [$n = 3,077$], 55.8% [$n = 3,878$] nonreducers) at their current CPD level as a function of peak smoking level (i.e., 1–5, 6–10, 11–15, 16–20, and ≥21 CPD) are shown. CPD = cigarettes per day.

[a]Peak CPD is the same as current CPD for nonreducers since they never reduced.

[b]Given the definition of smoking reduction of being 5 or more CPD, no respondents reduced and remained in the peak CPD stratum except for the ≥21 CPD category.

prospective data amenable to evaluation of the hypotheses evaluated in this paper are encouraged to verify and extend the present findings (e.g., Etter et al., 2002).

Limitations

The current findings are limited on several counts. First, a significant weakness of this report is that data on smoking rates and reduction are based on retrospective self-report, which are vulnerable bias due to response sets and mnemonic fallibility. Objective measurement of cigarette consumption or nicotine exposure as well as collateral ratings would have strengthened this study's findings. However, recent work by Brigham et al. (2008, 2010) has shown that smokers can indeed reliably recall amounts of consumption and even FTND items after substantial delays (Hudmon, Pomerleau, Brigham, Javitz, & Swan, 2005). Second, the interval between peak smoking and current smoking level was not assessed. This prevented evaluation of the duration and stability of reduction (e.g., respondents may have smoked at peak for days to years). Third, we did not assess nicotine withdrawal complaints, and this would have been an informative process that did not simply re-reference consumption. Fourth, we focused on European-American and Black smokers ages 25–44 years. More generally, the sample comprised those willing to complete the survey and may differ substantially from refusers or those who could not be contacted.

Conclusions

In summary, the current report has several significant findings, acknowledging the retrospective nature of the study design. First, it appears that ND can be modified in smokers who have not quit. Second, we have made a partial test of the hypothesis that one mechanism through which reducing smoking leads to smoking cessation is through reducing ND. Reductions in daily smoking appear to be common and sometimes involve substantial reductions in daily tobacco consumption. Reduction in CPD is associated with reductions in ND. The impact of significant reductions in cigarettes and ND on health risks and cessation trajectory is worthy of further research using prospective and experimental research designs.

Declaration of Interests

Dr. LJB is listed as an inventor on a patent (US 20070258898) covering the use of certain SNPs in determining the diagnosis, prognosis, and treatment of addiction. Dr. LJB has acted as a consultant for Pfizer, Inc. in 2008. All authors declare that they have no conflicts of interest.

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