Original investigation

Nondaily, Low-Rate Daily, and High-Rate Daily Smoking in Young Adults: A 17-Year Follow-Up

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Abstract

Introduction: While overall tobacco consumption is declining in many countries, patterns of low-frequency smoking—such as nondaily and low-rate daily smoking—appear to be increasing. We aimed firstly to describe differences in demographic, smoking- and quitting-related characteristics between nondaily and daily smokers in young adults; secondly, to determine the proportion of low-frequency smokers who transition to a higher rate of smoking by age 38 and factors associated with this.

Methods: We assessed a cohort of individuals born in Dunedin, New Zealand, in 1972–1973, at regular intervals from age 21 to age 38 years. Smokers were categorized as either nondaily, low-rate daily (ie, defined as five or less cigarettes per day) or high-rate daily smokers (six or more cigarettes per day). Descriptive statistics, linear and logistic regression were used.

Results: Nondaily smokers at age 21 tended to self-identify as nonsmokers. Both nondaily smokers and low-rate daily smokers reported higher readiness and confidence in quitting compared to high-rate daily smokers. Around 40% of the age 21 low-rate daily smokers reported smoking daily at age 38, compared to 13% of the nondaily smokers and 4% of the nonsmokers. Nondaily smoking at age 21 was associated with increased odds of being a daily smoker by age 38 (*OR*: 3.6; 95% *CI* = 1.7% to 7.8%) compared to nonsmokers.

Conclusions: Different patterns of smoking are associated with differences in readiness to quit and confidence in quitting ability. For a considerable proportion of smokers, low-frequency smoking in young adulthood develops into daily smoking by adulthood.

Implications: Low-frequency smoking, including nondaily smoking, in early adulthood is a significant risk factor for being a daily smoker in the long-term. Cessation interventions should be tailored to low-frequency smokers, taking into account differences between them and heavier smokers in terms of smoking motivation and quitting-related cognitions.

Introduction

While daily tobacco consumption is declining in many countries, the proportion of low-frequency smokers appears to be increasing.¹ In

the United States, in 2010 it was estimated that the prevalence of nondaily smokers was 36%.² This rise in nondaily smoking most likely reflects bans on workplace smoking and the ongoing denormalization of tobacco use in developed countries.¹ In addition to

nondaily smoking, low-rate daily smoking has also been identified as a relatively prevalent behavior. Shiffman³ was the first to distinguish the phenomenon of “chippers,” or smokers who consumed five or less cigarettes per day. Many chippers had been smoking for more than 20 years, and hence were not simply adolescents learning to smoke. Over time chippers did not escalate their smoking and few showed signs of nicotine dependence, challenging traditional ideas concerning nicotine addiction, whereby repeated use of tobacco leads to neuroadaptation and tolerance, which in turn cause withdrawal symptoms when nicotine levels drop, thus motivating continued use.⁴ Under this model, low-frequency smoking was viewed as a transitional developmental stage while an individual’s smoking was becoming established.⁴ Yet recent studies suggest that low-frequency smoking may be a distinct and sometimes long-term pattern of smoking in its own right.⁵ Genetic factors, at least in part, may moderate whether or not an individual progresses to heavier smoking over time.⁶ Evidence suggests that low-frequency smokers may differ from higher-rate daily smokers in demographic characteristics, psychological profile and degree of nicotine addiction.^{1,5} In comparison with heavier smokers, they tend to have higher socioeconomic status (SES); self-identify as nonsmokers^{1,7}; show fewer signs of nicotine dependence^{1,5}; and be more motivated to quit smoking.^{2,5,7}

There is a need for increased understanding of nondaily and low-rate daily smokers and their quitting beliefs and behavior, and in particular for longitudinal studies.⁵ Most existing longitudinal studies are short-term, with follow-up ranging from 6 months to 7 years.^{8–17} We identified only one long-term study, which was conducted over a period of 15 years.¹⁶ Furthermore, we are unaware of any New Zealand (NZ) studies of low-frequency smoking or nondaily smoking. Improving knowledge about the long-term risk of low-frequency smoking in early adulthood may help practitioners and policy-makers determine whether these smokers are a priority for tobacco control strategies. Furthermore, identifying factors associated with progression from low-frequency smoking to higher-frequency smoking may highlight opportunities for intervention. In this article, we examine data from a longitudinal study of the health, development and behavior of a NZ birth cohort. We firstly aim to describe the demographic and smoking-related characteristics of 21-year-old nondaily smokers and of low-rate daily smokers (who, as a combined group we refer to in this article as “low-frequency smokers”), and compare them with high-rate daily smokers. Secondly, we aim to determine the proportion of low-frequency smokers at age 21 who transition to a higher rate of smoking by age 38 years, and the factors associated with this progression.

Method

Participants

Study members belong to a cohort born in Dunedin, NZ, between April 1, 1972 and March 31, 1973 (The Dunedin Multidisciplinary Health and Development Study).¹⁸ The original sample comprised 1037 children (91% of all eligible births and 52% male) who participated in the first follow-up assessment at age 3. Assessments were conducted at 2-year intervals until age 15 years, then at ages 18, 21, 26, 32 and most recently at 38 years (2010–2012). The follow-up rates at the assessment phases used in this study have remained very high, with 96% follow-up of living Study members at ages 15 and 18 years, 97% at age 21 years, 96% at age 26, 96% at age 32, and 95% at age 38. Study members represent the full range of SES in the South Island of NZ. The majority, approximately 90%,

identified themselves as NZ European.¹⁹ Written informed consent was obtained at each assessment, and the Study received ethical approval from the Otago Ethics Committee.

Measures

Smoking Categories

At age 21 years, Study members were extensively interviewed about their smoking behaviors and associated perceptions of their smoking. Smoking categories at age 21 years were determined from the following four questions: “Do you usually smoke cigarettes every day?”; “How many cigarettes do you usually smoke in a day?”; “Do you usually smoke one or more cigarettes in a week?”; and “Have you smoked in the last 4 weeks?” On the basis of their answers, study participants were categorized as: (1) nonsmokers, who did not usually smoke one or more cigarettes in a week and had not smoked in the past 4 weeks; (2) nondaily smokers, who reported smoking weekly but not every day, and had smoked in the past 4 weeks; (3) low-rate daily smokers, who reported usually smoking five or fewer cigarettes per day; or (4) high-rate daily smokers, who usually smoked six or more cigarettes per day. These definitions are similar to those used previously in this literature.^{5,13} At ages 26, 32 and 38, the smoking questions differed slightly from those asked at age 21; nondaily smoking was not assessed. At these later assessments, Study members were asked “How many cigarettes per day do you now smoke on average?” Those who reported usually smoking one or more cigarette a day were categorized as daily smokers. To provide a more in-depth analysis of the long-term patterns of low-frequency smoking, the daily smokers at age 38 were categorized as either low-rate or high-rate daily smokers using the same definition as for age 21.

Smoking Progression From Age 21 to 38

A binary outcome was created to identify study members who had progressed from low-frequency smoking at age 21 to heavier smoking by age 38. Specifically, this included nondaily smokers who transitioned to either low-rate or high-rate daily smoking, and low-rate daily smokers who transitioned to high-rate daily smoking.

Other Smoking-Related Variables

The smoking behaviors assessed at age 21 years included: number of cigarettes smoked in past 4 weeks, time since last cigarette, and time until first cigarette after waking. Self-rated addiction to tobacco was assessed using a 5-point Likert scale (1 = *none*, 5 = *very high*); those who rated their addiction as a 4 or 5 were categorized as having “high” self-rated addiction. Study members indicated their main reason for smoking from five options: “addiction/craving,” “stimulation,” “relaxation/enjoyment,” “stress/tension,” and “friends/social.” They were asked to describe their smoking status from one of seven response options: “never smoked,” “nonsmoker but have tried smoking,” “nonsmoker but smoke occasionally,” “ex-smoker,” “occasional smoker,” “light smoker,” or “heavy smoker.” Participants selecting one of the first four options listed above were categorized as being a “self-reported” nonsmoker (ie, independent of their assigned smoking category).

Quitting Variables

Readiness to quit was based upon a 6-point “stages of change” rating from 1 = *no thought of quitting* to 6 = *quit more than 6 months ago*.²⁰ Perceived ease of quitting and confidence in ability to quit were assessed using 5-point Likert scales (1 = *very easy* to 5 = *very difficult*; 1 = *very low* to 5 = *very high*, respectively). Study members

were categorized as perceiving quitting to be “difficult” if they responded 4 or 5 to the former, and as having “low” confidence in their ability to quit if they responded 1 or 2 to the latter scale. Study members were asked: “Have you tried to quit since your 18th birthday?” If respondents had made a quit attempt, they were asked “what is the longest time you quit smoking for?” and “how long since that attempt?” These smoking measures were developed for the Dunedin Multidisciplinary Health and Development Study, and were based, where possible, on existing measures or measures developed and used at earlier phases of the study.

Other Variables

Study participants’ family SES during their childhood was assessed according to the highest parental occupation on a 6-point scale, based on the educational level and income associated with that occupation in the NZ census as previously reported.¹⁸ Weekly binge alcohol drinking at age 21 was assessed via self-report of annual frequency of consuming five or more drinks on a single occasion.²¹

Statistical Analyses

Associations of variables with smoking groups were assessed using the chi-squared test for independence for categorical variables and linear regression for continuous variables. The residuals of each linear regression model were assessed for evidence of heteroscedasticity and non-normality. If the model assumptions were not satisfied, bootstrap quantile (specifically median) regression was used. Post hoc individual pairwise comparisons were performed if the overall group Wald test was significant. Binary logistic regression was used to test the association between smoking group at 21 years of age and daily smoking at 38 years. A multiple binary logistic regression analysis was used to identify baseline factors associated with progression to heavier smoking between ages 21 and 38. The baseline factors examined were those we hypothesized to be most likely to be associated with progression, and those that would identify practical opportunities for intervention through health promotion initiatives. Specifically these were: sex, SES, perceived difficulty in quitting, low confidence in quitting, high-self rated addiction, currently taking action to quit (or reported having already quit), quit attempt since 18th birthday, “friends/social” the main reason for smoking, and weekly binge drinking. Stata version 13 (Statacorp, College Station, TX)²² was used for all statistical analyses and the two-sided significance level = 0.05 was specified for all statistical tests.

Results

Cross-Sectional Analyses

At 21 years of age, 54% of the Study members were nonsmokers ($n = 521/958$), 10% ($n = 98$) were nondaily smokers, 9% ($n = 82$) were low-rate daily smokers, and 27% ($n = 257$) were high-rate daily smokers. Nondaily smokers had smoked a median of eight cigarettes in the last 4 weeks, compared to 84 cigarettes for low-rate daily, and 420 for high-rate daily smokers. For nondaily smokers, the median number of hours since the last cigarette was 120, compared to 2 hours for low-rate daily and one for high-rate daily smokers. Low-rate daily smokers were awake a median 120 minutes before they smoked their first cigarette of the day whereas high-rate daily smokers waited a median of 30 minutes.

Some key smoking-related characteristics of the three smoking categories are presented in Table 1. Smoking categories were associated with each of these except sex. There was also no difference in

the number of months since the last quit attempt (data not shown in table). Nondaily smoking was associated with a higher SES compared to all other smoking categories. Nondaily, low-rate daily, and high-rate daily smokers all had an increased odds of regular binge drinking compared to nonsmokers.

Most (60%) nondaily smokers did not consider themselves to be smokers and more than half (58%) of the high-rate daily smokers self-identified as light smokers. In all three categories, a main reason for smoking was relaxation/enjoyment; this was the foremost reason cited among daily smokers, who were also more likely to cite habit and addiction as reasons for smoking, compared to nondaily smokers. Among nondaily smokers, the predominant reason given for their smoking was “friends/social.” As smoking frequency increased across categories, greater proportions within each smoking group self-reported a high level of addiction to tobacco; very few nondaily smokers (2%) reported a high level of addiction to tobacco. Those smoking with greater frequency were more likely to rate quitting as difficult, and report low confidence in being able to quit. Almost one-third of high-rate daily smokers reported low confidence in ability to quit, whereas three-quarters (76%) of nondaily smokers rated their confidence in ability to quit as “high” or “very high.” Around one-quarter of nondaily smokers and one-third of low-rate daily smokers were currently taking action to quit smoking, compared to 6% of high-rate daily smokers. Large proportions of each of the three smoking groups had made a quit attempt in the previous 3 years, with almost half of the nondaily smokers and almost three-quarters of the low-rate daily smokers having made an attempt. The median longest time that nondaily smokers had successfully quit for was 24 weeks (25th percentile = 12 weeks; 75th percentile = 56 weeks) compared to 8 weeks (25th percentile = 2 weeks; 75th percentile = 24 weeks) for low-rate daily smokers and 3 weeks (25th percentile = 1 week; 75th percentile = 8 weeks) for high-rate daily smokers.

Transitions in Smoking Category

As shown in Table 2, around one-third of the nondaily smokers at age 21 reported smoking daily at age 26, compared to only 5% of nonsmokers, and the vast majority of the daily smokers at age 21 reported smoking daily at age 26. In all smoking categories, the proportion of study members that reported smoking daily declined over time. Most nondaily smokers at age 21 were not daily smokers at age 38, though approximately 12.5% had progressed to some level of daily smoking. Table 3 provides a more detailed breakdown of smoking categories between age 21 and age 38. Around one-third of low-rate daily smokers at age 21 increased to high-rate daily smoking, and half of high-rate daily smokers remained at that level. There were significant overall group differences in the odds of daily smoking at age 38 ($P < .001$) with the odds increasing with increasing levels of smoking at 21 years of age. Nondaily smokers at 21 had almost four times the odds of being a daily smoker at age 38, compared to nonsmokers at age 21 (OR: 3.6; 95% CI = 1.7% to 7.8%). Of the predictors we examined in relation to smoking progression, both SES and weekly binge drinking were statistically significant. Study members with a lower SES were more likely to progress from low-frequency smoking at age 21 to a higher rate of smoking by age 38 (OR: 1.9; 95% CI = 1.3% to 2.9%) whereas weekly binge drinking at age 21 was associated with a decreased odds of smoking progression by age 38 (OR: 0.27; 95% CI = 0.11% to 0.66%). The median number of cigarettes smoked monthly by daily smokers at age 38 was similar to that at age 21: 98 cigarettes for low-rate daily and 420 for high-rate daily smokers at age 38.

Table 1. Characteristics of Nonsmokers, Nondaily, Low-Rate Daily, and High-Rate Daily Smokers at Age 21

Variable	Nonsmoker (<i>n</i> = 521)	Nondaily (<i>n</i> = 98)	Low-rate daily (<i>n</i> = 82)	High-rate daily (<i>n</i> = 257)	<i>P</i> value for group differences ^a
Demographics					
Male, %	53.2	49.0	37.8	52.1	.073
SES, <i>M</i> (<i>SD</i>)	3.1 (1.1)*	2.9 (1.1)*,**	3.3 (1.2)	3.5 (1.1)	<.001
Self-reported smoking status, %					
Nonsmoker	—	60.2*,**	0.0*	0.0	<.001
Occasional smoker	—	30.6	12.2	1.9	
Light smoker	—	9.2	82.9	57.6	
Heavy smoker	—	0.0	4.9	40.5	
Main reason for smoking, %					
Relaxation/enjoyment	—	29.5*,**	36.7	34.3	<.001
Habit	—	11.6	30.4	27.9	
Addiction/craving	—	4.2	17.7	29.9	
Friends/social	—	45.3	5.1	1.6	
Stress/tension	—	7.4	3.8	3.6	
Stimulation	—	2.1	6.3	2.8	
High self-rated addiction, %	—	2.2*,**	31.6*	74.1	<.001
Stages of thinking about quitting, %					
Quit more than 6 months ago	—	6.7*,**	0.0*	0.0	<.001
Taking action to quit	—	26.7	32.9	5.6	
Thinking about how to change	—	7.8	11.4	12.4	
Think I should quit but not ready	—	8.9	34.2	35.1	
Think I need to consider someday	—	20.0	15.2	33.1	
No thought of quitting	—	30.0	6.3	13.9	
Perceives quitting as difficult, %	—	19.4*,**	35.4*	68.1	<.001
Low confidence in ability to quit, %	—	7.1*	13.9*	29.1	<.001
Quit attempt since 18th birthday, %	—	45.6*,**	73.4*	58.6	<.01
Binge drinking weekly, %	31.6*	56.1	51.9	52.3	<.001

SES = socioeconomic status.

*For categorical variables, Fisher's Exact Test used if expected cell counts < 5.

*Indicates group is statistically significantly different from the high-rate daily smoking group (pairwise comparisons only made if the overall group Wald test was significant).

**Indicates that the nondaily smoking group is statistically significantly different from the low-rate daily group (pairwise comparisons only made if the overall group Wald test was significant).

Table 2. Proportion of the Age 21 Smoking Categories Subsequently Classified as Daily Smokers at Ages 26, 32, and 38 Years

		Daily smoking		
		Age 26	Age 32	Age 38
Age 21	Nonsmokers, % (95% CI)	4.8 (3.2, 7.1)	6.1 (4.3, 8.5)	3.8 (2.4, 5.8)
	Nondaily, % (95% CI)	32.3 (23.6, 42.4)	25.8 (17.9, 35.6)	12.5 (7.2, 20.9)
	Low-rate daily, % (95% CI)	81.7 (71.6, 88.8)	63.0 (51.7, 72.9)	40.5 (30.1, 51.9)
	High-rate daily, % (95% CI)	86.8 (82.0, 90.4)	74.2 (68.3, 79.3)	59.0 (52.7, 65.1)

CI = confidence interval.

Discussion

Nondaily and low-rate daily smokers made up 41% of the 437 smokers in our age 21 cohort. There were significant differences between the smoking groups in terms of smoking and quitting behaviors, psychological factors, patterns of smoking over time and long-term risk of becoming a daily smoker. Although few of the nondaily smokers

at age 21 reported being addicted to nicotine, they had a significantly increased risk of being a daily smoker 17 years later compared to the nonsmokers.

Consistent with previous research, the nondaily smokers had higher SES than daily smokers,^{11,17,23,24} most self-identified as a nonsmoker,¹ they were more likely than daily smokers to be motivated by social reasons rather than craving or addiction,^{11,25} and they had

Table 3. Smoking Categories at Age 38 by Smoking Categories at Age 21

		Age 38			
		Nonsmokers/ nondaily	Low-rate daily	High-rate daily	Total <i>n</i>
Age 21	Nonsmokers, % (95% CI)	96.2 (94.2, 97.6)	0.6 (0.2, 1.8)	3.2 (2.0, 5.1)	504
	Nondaily, % (95% CI)	87.5 (79.1, 92.8)	4.2 (1.5, 10.8)	8.3 (4.2, 16.0)	96
	Low-rate daily, % (95% CI)	59.5 (48.1, 69.9)	7.6 (3.4, 16.1)	32.9 (23.3, 44.2)	79
	High-rate daily, % (95% CI)	41.0 (34.9, 47.3)	7.4 (4.7, 11.4)	51.6 (45.3, 57.9)	244

CI = confidence interval.

a higher prevalence of weekly binge drinking.^{5,26} The low-rate daily smokers were of higher SES than high-rate daily smokers, which is also consistent with previous research.^{5,11,16,27} Reasons for smoking were generally similar for low-rate daily and high-rate daily smokers. As expected on the basis of existing evidence,⁵ as the level of smoking increased so did the tendency to report a high nicotine addiction, less time to first cigarette after waking and lower confidence in being able to quit.

Previous research suggests that the level of tobacco consumption is associated with quit intentions and success. Specifically, nondaily smokers have been found to be more likely to make and succeed at a quit attempt compared to daily smokers, whilst heavier daily smokers are less likely than low-rate daily smokers to make or succeed at a quit attempt.^{11,13,28} Whilst nondaily smokers are more likely to quit than daily smokers, their absolute rate of successful quitting appears to be low, with the vast majority failing to stay abstinent after a quit attempt.²⁹ Desire or intentions to quit also decrease as level of tobacco consumption increases.^{11,13,28,30} As a combined group, the low-frequency smokers in our cohort (ie, both the nondaily and low-rate daily smokers) appear to be more motivated to quit compared to the high-rate daily smokers; around 30% were currently taking action to quit smoking compared to only 6% of high-rate daily smokers. However, on the basis of previous research, fewer than expected nondaily smokers in our cohort reported either (1) having made a quit attempt in the past 3 years or (2) currently taking action to quit. In fact, almost a third of our nondaily smokers said they had no thought of quitting smoking. This contrasts markedly with results reported previously wherein only a small minority of nondaily smokers had no plans to quit.¹¹ A likely explanation for this is the different age distributions of the cohorts. In our cohort a considerable proportion of nondaily smokers at age 21 were content to continue this pattern of smoking. In other cohorts with wider (and overall older) age distributions, larger proportions of nondaily smokers appear to want to quit.^{11,13}

A study from Finland found that consistent light smokers represent only a very small proportion of the smoking population, with just 6% reporting a persistent pattern of low-rate smoking (defined as fewer than five cigarettes per day) throughout the 15-year study period.¹⁶ Comparisons of our results with this study are difficult due to differences in definitions of low-rate smoking, though our results suggest the proportion of long-term low-rate smokers might be higher than their estimate. Twelve percent of our baseline low-frequency smokers were low-rate daily smokers at follow-up. Yet, since we were unable to distinguish nondaily smokers and nonsmokers at follow-up this is highly likely to be an underestimate of the true proportion of consistent low-frequency smokers over the 17-year study period, since some baseline nondaily smokers may have maintained a pattern of nondaily smoking during that time.

We found that lower SES predicted progression from low-frequency smoking to a higher rate of smoking over the 17-year period; all other age 21 smoking- and quitting-related variables we tested were not statistically significant. This could reflect the fact that environmental factors (such as those associated with being of lower SES) are more influential on smoking in the long-term, compared to psychological variables such as motivation for smoking and confidence in quitting. Weekly binge drinking at age 21 was negatively associated with progression from low-frequency smoking at 21 to a higher rate of smoking by age 38. This could reflect a pattern whereby low-frequency smokers tend only to smoke while drinking alcohol, and as their drinking patterns change over time, they either quit by age 38 or remain as long-term low-frequency smokers. The significance of changes in drinking patterns for tobacco smoking among low-frequency smokers is a topic for future investigation.

These findings have important implications; until recently, the efforts of the tobacco control sector have been focused primarily on moderate to heavy daily smokers, and interventions and theories of addiction and quitting were also based on this pattern of smoking.³¹ Targeting efforts towards low-frequency patterns of smoking is important firstly, because of the argument that there is no safe level of smoking, given the evidence of health risks associated with exposure to secondhand smoke.^{32,33} Secondly, if the reported increase in low-frequency smoking is due to bans on workplace smoking and increasing denormalization of smoking, as some tobacco control experts believe, low-frequency patterns of tobacco smoking may become even more prevalent. An increase in the overall population of low-rate and nondaily smokers has been forecast in the United States and globally.³¹ Lastly, our study suggests that low-frequency smoking, including nondaily smoking, in early adulthood is a significant risk factor for being a daily smoker in the long-term.

In terms of tobacco control practice, light smokers may be an important group to target in cessation efforts, and the fact that they are more likely to make behavioral changes over time suggests they may be more amenable to tobacco control interventions. Screening for nicotine dependence may not identify this group, particularly nondaily smokers, and nicotine replacement therapy may not be the most appropriate approach given an apparent lack of dependence.³⁴ For mass media campaigns aimed at reducing demand for tobacco, a worthwhile approach may be to target messages specifically to low-frequency smokers, though without explicitly labeling the intended target group as “smokers.” An example of such an approach is the recent campaign launched by NZ’s Health Promotion Agency, “Stop before you start” (www.hpa.org.nz/stop-before-you-start). Lastly, the role of alcohol binge drinking in supporting smoking, particularly in the sub-group of nondaily smokers, has implications for tobacco control. Higher prevalence of binge drinking in early adulthood has

been associated with transitioning from nonsmoking to smoking,¹⁴ and calls have been made for interventions to disengage alcohol and tobacco use patterns.²⁶

A strength of this research is the low rate of attrition throughout the study, with over 90% of the original cohort participating in each assessment between 21 and 38 years old. We have been able to examine the stability of low-frequency smoking over a very long-term period, thus addressing a gap in the evidence, and were able to distinguish nondaily from low-rate daily smokers at baseline. Several limitations should be noted. First, we were unable to distinguish nondaily smokers from nonsmokers at follow-up, since Study members were only specifically asked whether they smoked daily at the age 38 assessment. Asking about nondaily smoking at age 38 would have been valuable, given that the prevalence of this behavior appears to be increasing.^{1,31} Second, study members who had not smoked in the past 4 weeks or smoked less than weekly were categorized as nonsmokers. This may have resulted in some occasional smokers being classified as nonsmokers. Third, NZ has had an active tobacco control programme over the past 40 years, with restrictions on tobacco advertising since 1990, and legislation prohibiting smoking in workplaces since 2004. Considering this, it is plausible that our estimates of the progression from nondaily to daily smoking over time may be conservative compared to countries with a less active tobacco control programme. Fourth, the prevalence and characteristics of low-frequency smokers in our sample may not be generalizable to the current population, given that the age 21 data were collected more than 20 years ago, in 1992–1993.

Smokers are a heterogeneous group, and light smokers in young adulthood are an important population group for tobacco control interventions. As a group they are more motivated to quit, and have higher confidence in being able to quit than high-rate smokers. Though many low-frequency smokers may identify as being a nonsmoker, they have a substantially higher risk of becoming daily smokers in the long-term, compared to nonsmokers.

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Declaration of Interests

None declared.

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References

- Schane RE, Glantz SA, Ling PM. Nondaily and social smoking: an increasingly prevalent pattern. *Arch Intern Med*. 2009;169(19):1742–1748. doi:10.1001/archinternmed.2009.315.
- Sacks R, Coady MH, Mbamalu IG, Johns M, Kansagra SM. Exploring the next frontier for tobacco control: nondaily smoking among New York City adults. *J Environ Public Health*. 2012;2012:1. doi:10.1155/2012/145861.
- Shiffman S. Tobacco “chippers”—individual differences in tobacco dependence. *Psychopharmacology*. 1989;97(4):539–547. doi:10.1007/BF00439561.
- Shiffman S. Light and intermittent smokers: background and perspective. *Nicotine Tob Res*. 2009;11(2):122–125. doi:10.1093/ntr/ntn020.
- Coggins CR, Murrelle EL, Carchman RA, Heidbreder C. Light and intermittent cigarette smokers: a review (1989–2009). *Psychopharmacology*. 2009;207(3):343–363. doi:10.1007/s00213-009-1675-4.
- Belsky DW, Moffitt TE, Baker TB, et al. Polygenic risk and the developmental progression to heavy, persistent smoking and nicotine dependence: evidence from a 4-decade longitudinal study. *JAMA Psychiatry*. 2013;70(5):534–542. doi:10.1001/jamapsychiatry.2013.736.
- Song A, Ling P. Social smoking among young adults: investigation of intentions and attempts to quit. *Am J Public Health*. 2011;101(7):1291–1296. doi:10.2105/AJPH.2010.300012.
- McDermott L, Dobson A, Owen N. Occasional tobacco use among young adult women: a longitudinal analysis of smoking transitions. *Tob Control*. 2007;16(4):248–254. doi:10.1136/tc.2006.018416.
- Kotz D, Fidler J, West R. Very low rate and light smokers: smoking patterns and cessation-related behaviour in England, 2006–11. *Addiction*. 2012;107(5):995–1002. doi:10.1111/j.1360-0443.2011.03739.x.
- Kvaavik E, Von Soest T, Pedersen W. Nondaily smoking: a population-based, longitudinal study of stability and predictors. *BMC Public Health*. 2014;14(1):123. doi:10.1186/1471-2458-14-123.
- Levy DE, Biener L, Rigotti NA. The natural history of light smokers: a population-based cohort study. *Nicotine Tob Res*. 2009;11(2):156–163. doi:10.1093/ntr/ntp011.
- Lindström M, Isacson SO. Long term and transitional intermittent smokers: a longitudinal study. *Tob Control*. 2002;11(1):61–67. doi:10.1136/tc.11.1.61.
- Swayampakala K, Thrasher J, Carpenter MJ, Shigematsu LM, Cupertio A, Berg CJ. Level of cigarette consumption and quit behavior in a population of low-intensity smokers: longitudinal results from the International Tobacco Control (ITC) survey in Mexico. *Addict Behav*. 2013;38(4):1958–1965. doi:10.1016/j.addbeh.2012.12.007.
- White HR, Bray BC, Fleming CB, Catalano R. Transitions into and out of light and intermittent smoking during emerging adulthood. *Nicotine Tob Res*. 2009;11(2):211–219. doi:10.1093/ntr/ntn017.
- Zhu SH, Sun J, Hawkins S, Pierce J, Cummins S. A population study of low-rate smokers: quitting history and instability over time. *Health Psychology*. 2003;22(3):245. doi:10.1037/0278-6133.22.3.245.
- Hukkinen M, Kaprio J, Broms U, Koskenvuo M, Korhonen T. Characteristics and consistency of light smoking: long-term follow-up among Finnish adults. *Nicotine Tob Res*. 2009;11(7):797–805. doi:10.1093/ntr/ntp065.
- Hassmiller KM, Warner KE, Mendez D, Levy DT, Romano E. Nondaily smokers: who are they? *Am J Public Health*. 2003;93(8):1321–1327. doi:10.2105/AJPH.93.8.1321.
- Hancox RJ, Milne BJ, Poulton R. Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study. *Lancet*. 2004;364(9430):257–262. doi:10.1016/S0140-6736(04)16675-0.
- Poulton R, Hancox R, Milne B, Baxter J, Scott K, Wilson N. The Dunedin Multidisciplinary Health and Development Study: are its findings consistent with the overall New Zealand population. *NZMJ*. 2006;119(1235):45–55. www.nzma.org.nz/journal/119-1235/2022. Accessed February 20, 2015.
- Biener L, Abrams D. The Contemplation Ladder: validation of a measure of readiness to consider smoking cessation. *Health Psychol*. 1991;10(5):360–365. doi:10.1037/0278-6133.10.5.360.
- Robertson L, McGee R, Hancox RJ. Smoking cessation and subsequent weight change. *Nicotine Tob Res*. 2014;16(6):867–871. doi:10.1093/ntr/ntt284.

22. *Stata Statistical Software: Release 13 [Program]*. College Station, TX: StataCorp LP; 2013.
23. Schane RE, Glantz SA, Ling PM. Social smoking: implications for public health, clinical practice, and intervention research. *Am J Prev Med*. 2009;37(2):124–131. doi:10.1016/j.amepre.2009.03.020.
24. Wortley PM, Husten CG, Trosclair A, Chrismon J, Pederson L. Nondaily smokers: a descriptive analysis. *Nicotine Tob Res*. 2003;5(5):755–759. doi:10.1080/1462220031000158753.
25. Shiffman S, Kassel JD, Paty J, Gnys M, Zettler-Segal M. Smoking typology profiles of chippers and regular smokers. *J Subst Use*. 1994;6(1):21–35. doi:10.1016/S0899-3289(94)90052-3.
26. Harrison EL, Desai RA, McKee SA. Nondaily smoking and alcohol use, hazardous drinking, and alcohol diagnoses among young adults: findings from the NESARC. *Alcohol Clin Exp Res*. 2008;32(12):2081–2087. doi:10.1111/j.1530-0277.2008.00796.x.
27. Hyland A, Rezaishiraz H, Bauer J, Giovino GA, Cummings M. Characteristics of low-level smokers. *Nicotine Tob Res*. 2005;7(3):461–468. doi:10.1080/14622200500125369.
28. Boulos DNK, Loffredo CA, El Setouhy M, Abdel-Aziz F, Israel E, Mohamed MK. Nondaily, light daily, and moderate-to-heavy cigarette smokers in a rural area of Egypt: a population-based survey. *Nicotine Tob Res*. 2009;11(2):134–138. doi:10.1093/ntr/ntp016.
29. Tindle H, Shiffman S. Smoking cessation behavior among intermittent smokers versus daily smokers. *Am J Public Health*. 2011;101(7):e1–3. doi:10.2105/AJPH.2011.300186.
30. Tong EK, Ong MK, Vittinghoff E, Perez-Stable EJ. Nondaily smokers should be asked and advised to quit. *Am J Prev Med*. 2006;30(1):23–30. doi:10.1016/j.amepre.2005.08.048.
31. Fagan P, Rigotti NA. Light and intermittent smoking: the road less traveled. *Nicotine Tob Res*. 2009;11(2):107–110. doi:10.1093/ntr/ntn015.
32. Neri M, Ugolini D, Bonassi S, et al. Children's exposure to environmental pollutants and biomarkers of genetic damage: II. Results of a comprehensive literature search and meta-analysis. *Mutat Res Rev Mutat Res*. 2006;612(1):14–39. doi:10.1016/j.mrrev.2005.04.003.
33. Boffetta P. Involuntary smoking and lung cancer. *Scand J Work Environ Health*. 2002;28(suppl 2):30–40. www.jstor.org/stable/40967253. Accessed February 20, 2015.
34. Schane RE, Ling PM, Glantz SA. Health effects of light and intermittent smoking: a review. *Circulation*. 2010;121(13):1518–1522. doi:10.1161/CIRCULATIONAHA.109.904235.