Journal of Internal Medicine 2004; **255**: 102–107

The influence of smoking and smokeless tobacco use on weight amongst men

B. RODU[1], B. STEGMAYR[2], S. NASIC[2], P. COLE[3] & K. ASPLUND[2]

From the [1]Department of Pathology, School of Medicine, University of Alabama at Birmingham, Birmingham, AL, USA; [2]Department of Medicine, University Hospital, Umeå, Sweden; and [3]Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, Birmingham, AL, USA

Abstract. Rodu B, Stegmayr B, Nasic S, Cole P, Asplund K (University of Alabama at Birmingham, Birmingham, AL, USA; University Hospital, Umeå Sweden; and School of Public Health, University of Alabama at Birmingham, Birmingham, AL, USA). The influence of smoking and smokeless tobacco use on weight amongst men. *J Intern Med* 2004; **255:** 102–107.

Objective. To explore the effect of tobacco use (smoking and smokeless tobacco) and cessation on body weight.

Design. Cross-sectional and prospective follow-up study.

Setting. Northern Sweden.

Subjects. A total of 2993 men aged 25–64 years who participated in the northern Sweden MONICA study in 1986, 1990 or 1994, 1650 of whom were followed up in 1999.

Main outcome measures. The prevalence of overweight [body mass index (BMI) ≥ 27] amongst tobacco users was compared with nonusers at entry into the study. The average annual percentage weight gain amongst men was also determined according to tobacco use both at entry and at follow-up, and the development of overweight amongst tobacco-use groups was reported using standardized incidence ratios.

Results. Smokers who quit tobacco during the follow-up period gained significantly more weight than smokers who switched to snus (annual gain 0.96% vs. 0.51%, $P < 0.05$). At entry, ex-smokers had higher prevalence of overweight than nonusers of tobacco [prevalence ratio (PR) = 1.24, 95% confidence interval (CI) = 1.10–1.40]. Snus users had slightly higher prevalence of overweight at entry (PR = 1.20, CI = 1.01–1.42). Snus users who quit gained more weight than nonusers (0.70% vs. 0.44%, $P < 0.05$) or those who continued to use snus (0.42%).

Conclusions. Cessation of tobacco, either cigarettes or snus, leads to significantly increased weight gain. However, snus use may play a role in lowering the weight gain following smoking cessation.

Keywords: overweight, smokeless tobacco, smoking, smoking cessation, snus.

Introduction

In developed countries, smoking and excess body weight are two of the most important risk factors for chronic diseases and premature death. Both of these factors have strong behavioural determinants, but neither has been controlled well by population-based approaches to behaviour change [1]. Although the prevalence of smoking has declined modestly in some countries over the past 30 years, the prevalence of overweight and obesity have risen steadily, and there is evidence that these two trends are partly related [2].

The population of Sweden is not immune to the problem of overweight and obesity [3], but patterns of smoking are somewhat different than those of other developed countries. Specifically, men in northern Sweden have remarkably low smoking prevalence and very high prevalence of smokeless tobacco use, mainly in the form of Swedish moist snuff or snus [4]. Furthermore, snus use appears to have played a prominent role in the high smoking cessation rate in this population [5]. Numerous studies have documented that cigarette smoking suppresses body weight, and that cessation is commonly followed by substantial weight gain.

However, very little is known about the influence of snus use on weight, or about the weight gain consequences of long-term snus use after smoking cessation. The purpose of this study was to investigate overweight and weight gain amongst men in northern Sweden, according to patterns of smoking, snus use and transitions between these forms of tobacco use.

Methods

This study used data from the northern Sweden component of the World Health Organization MONICA (Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases) study. Briefly, information was collected during four population-based surveys in 1986, 1990, 1994 and 1999. In addition, follow-up information on about 70% of participants from the first three surveys was collected in 1999, with durations of follow-up of 5, 9 and 13 years (1994, 1990 and 1986 cohorts, respectively) [5].

Subjects were randomly selected from population registers, stratified for age (25–64 years in the first two surveys and 25–74 years in the latter two surveys) and gender, in the two most northern counties of Sweden (Norrbotten and Västerbotten; target population 320 000 in 1999). Details of sampling and selection appear elsewhere [5–7]. Participants completed a questionnaire that was focused on cardiovascular disease risk factors. Weight and height measurements were completed and recorded by study personnel both at entry and at follow-up, and these procedures were subject to thorough MONICA quality control assessments [8]. As the primary focus of the present report is on the influence of smoking and snus use on weight gain, we limited the present analyses to men aged 25–64 years.

Responses to tobacco-related questions were used to designate three mutually exclusive categories of snus users: ex, current and never; and three identical categories of smokers. Current smokers are those who smoked at least one cigarette daily, ex-smokers are those who reported quitting >1 month prior to completing their survey and snus users were those who used snus each day. Ex-users of snus were those who had used snus in the past but who were not current users. In reporting follow-up tobacco use, the nine possible snus-use/smoking categories were consolidated into four: exclusive smokers, exclusive snus users, combined smokers/snus users and nonusers of tobacco.

In order to designate overweight persons in a manner that would be appropriate for this population, and for this study two definitions were considered. The first designated overweight subjects as those who had body mass index [BMI $\geq$ 25; (weight in kilograms/height in metres^2)]. Almost 60% of all subjects were overweight using this definition, which would have resulted in low specificity and obscured differences in the incidence and prevalence of overweight between tobacco-use groups. The second definition designated as overweight subjects with a BMI $\geq$ 27. Only 35% of subjects were overweight according to this definition, so BMI 27+ was used as the more discriminating and informative measure.

The prevalence of overweight at entry for all years combined was determined for groups of former or current tobacco users and for never users of tobacco (reference group), and the results were reported as prevalence ratios [95% confidence interval (CI)]. For ex-smokers we calculated overweight prevalence and prevalence ratios (PR) overall and according to the number of years elapsed since quitting.

For subjects who had follow-up information, weight measurements at entry and at follow-up were used to calculate their average annual percentage weight gain according to the following formula: (weight at follow-up − weight at entry) × 100/(weight at entry)/(years of follow-up). Results are reported according to tobacco status at entry and at follow-up.

After exclusion of subjects who were overweight at entry, we assessed the development of overweight during the follow-up period, according to tobacco use at entry and at follow-up, with never users of tobacco as the reference group. Using observed and expected numbers of overweight subjects, the results were reported as standardized incidence ratios (SIR).

Prevalence results were adjusted for age and entry year, as there was a secular trend of increasing body weight during the study period. Incidence results were adjusted for age and years of follow-up. All adjustments were made by the direct method.

This study was approved by institutional review boards at Umeå University and the University of Alabama at Birmingham.

Results

The MONICA study included 3030 men aged 25–64 years in the four entry years. Of these, 32 were excluded because of missing information on tobacco use, and five because of incomplete information on BMI, resulting in 2993 subjects in the prevalence part of the study. Of the 2296 men in the 1986, 1990 and 1994 entry cohorts who were eligible for follow-up, 1662 completed the survey in 1999 and 1650 had complete information on tobacco use and BMI. Information on follow-up characteristics of these subjects was described previously [5].

Table 1 shows the prevalence of overweight at entry amongst men according to tobacco-use category, adjusted for age and survey year. Overweight prevalence was 32% amongst never users of tobacco. The prevalence amongst smokers was lower (29%), and the PR was lower, although not significantly (PR = 0.87, CI = 0.73–1.03). Overweight prevalence was higher both amongst users of snus (PR = 1.20, CI = 1.01–1.42) and amongst combined users (PR = 1.25, CI = 1.03–1.63). Ex-smokers were more commonly overweight (PR = 1.24, CI = 1.10–1.40), and there was no difference between those using snus and ex-smokers who were tobacco-free. Table 2 shows the prevalence of overweight amongst ex-smokers according to the number of years elapsed since quitting smoking. In general, prevalence was higher in ex-smokers who had quit more recently (1–5 years) and lower amongst those who had been smoke-free for longer periods.

Table 1 Prevalence ratio of overweight amongst men aged 25–64 years according to mutually exclusive tobacco use at entry

Tobacco use	Overweight/ total	Prevalence	Prevalence ratio[a] (95% CI)
Never use	335/1047	32.0	1.00[b]
Current tobacco users			
Smokers	137/478	28.7	0.87 (0.73–1.03)
Exclusive snus users	96/295	32.5	1.20 (1.01–1.42)
Combined users	47/121	38.8	1.25 (1.03–1.63)
All ex-smokers	382/907	42.1	1.24 (1.10–1.40)
No current tobacco	249/589	42.3	1.23 (1.07–1.40)
Current snus	133/318	41.8	1.33 (1.14–1.55)
Ex-snus users	42/145	29.0	0.93 (0.71–1.21)

[a]Adjusted for age and entry year. [b]Reference group.

Table 2 Prevalence ratio of overweight amongst men ex-smokers aged 25–64 years at entry, according to current tobacco use and years since quitting

Tobacco use	Overweight/ total	Prevalence	Prevalence ratio[a] (95% CI)
Never use	335/1047	32.0	1.00[b]
Ex-smokers			
No current tobacco			
Quit 1–5 years	51/112	45.5	1.40 (1.11–1.75)
Quit 6–10 years	35/103	34.0	1.03 (0.77–1.38)
Quit >10 years	152/345	44.1	1.29 (1.10–1.50)
Current snus			
Quit 1–5 years	42/91	46.2	1.55 (1.23–1.93)
Quit 6–10 years	31/66	47.0	1.42 (1.08–1.88)
Quit >10 years	52/139	37.4	1.15 (0.91–1.45)

[a]Adjusted for age and entry year. [b]Reference group. Year of quitting was available for 856 of 907 ex-smokers.

Table 3 shows the average weight and BMI at entry for subjects according to tobacco use and also reports weight gain during the follow-up period according to tobacco use at follow-up. Weight gain is expressed as an annual percentage to accommodate for initial weight and the length of follow-up, and these values are adjusted to the age distribution of the reference group (never users of tobacco). This group had a mean weight of 80.5 kg and gained an average of 0.44% per year. Smokers had the lowest mean weight at entry (78.9 kg). Continuing smokers showed slightly lower weight gain (0.33%) and smokers who switched to snus had slightly higher weight gain (0.51%) than the reference group, but neither difference was statistically significant. However, smokers who quit tobacco experienced the highest annual gain of all groups (0.96%), which was significantly higher than both the reference group (0.44%) and those smokers who switched to snus (0.51%, $P < 0.05$). Snus users at entry had a mean weight of 81.1 kg, and weight gain amongst continuing users (0.42%) was the same as that of the reference group. However, snus users who quit tobacco showed higher annual gains than never users (0.70% vs. 0.44%, $P < 0.05$). Combined users who quit tobacco also showed elevated annual gains (0.86%), but this was based on small numbers. Weight gain amongst subjects who were ex-smokers and ex-users of snus at entry was 0.44 and 0.29%, respectively.

Table 4 shows the development of overweight during the follow-up period amongst men who were not overweight at entry, according to tobacco-use at

Table 3 Weight gain during follow-up amongst men aged 25–64 years

Tobacco status at entry [mean weight (kg) and BMI][a]	Weight gain[b] at follow-up amongst tobacco users (*n*)			
	Smoking	Snus	Combined use	No tobacco
Never user (80.5 and 25.8)	−0.12 (4)	0.24 (10)	–	0.44 (589)[c]
Current tobacco users				
Smoker (78.9 and 25.4)	0.33 (130)	0.51 (29)	0.63 (17)	0.96 (65)*
Snus user (81.3 and 26.2)	0.14 (6)	0.42 (233)	0.66 (10)	0.70 (63)*
Combined users (81.8 and 26.3)	−0.20 (4)	0.39 (29)	0.51 (26)	0.86 (8)
Ex-tobacco users				
Ex-smokers (82.8 and 26.3)	0.16 (15)	0.55 (26)	0.84 (1)	0.44 (313)
Ex-snus users (82.6 and 26.3)	0.84 (3)	0.79 (5)	–	0.29 (65)

*$P < 0.05$. [a]Adjusted to the age and entry year distribution of never users of tobacco. [b]Average annual percentage, based on weight at entry and adjusted to the age distribution of the reference group. [c]No adjustment was performed in cells with ≤6 observations.

Table 4 Standardized incidence ratios (SIR)[a] of development of overweight during follow-up amongst men aged 25–64 years according to tobacco use at entry and at follow-up

Tobacco status				
At entry	At follow-up	*n*	Observed/ expected	SIR (95% CI)
Never	No tobacco	411	78/–	–
Smoking	Smoking	93	15/16.99	88 (49–145)
	Snus	23	4/4.93	80 (22–205)
	No tobacco	53	22/11.09	198 (124–299)
Snus	Snus	152	35/29.13	120 (84–167)
	No tobacco	39	12/7.95	142 (78–264)
Ex-smokers	No tobacco	18	5/3.50	143 (46–333)
No smokers	No tobacco	21	7/4.33	162 (65–334)
Ex-smokers	No tobacco	189	35/37.27	94 (66–131)
Ex-snus	No tobacco	43	7/8.50	82 (33–169)

[a]Adjusted for age and years of follow-up.

entry and at follow-up. The results are reported as SIRs adjusted for age and years of follow-up. Compared with the reference group of never users of tobacco, smokers who continued or switched to snus had slightly lower SIRs for development of overweight during follow-up, but smokers who quit tobacco entirely had a significantly elevated SIR (SIR = 198, CI = 124–299). SIRs were elevated slightly amongst snus users who continued (SIR = 120, CI = 84–167) and amongst those who quit tobacco during follow-up (SIR = 142, CI = 78–264). Amongst the latter group there was little difference between those who had smoked previously (SIR = 143, CI = 46–333) and those who had never smoked (SIR = 162, CI = 65–334). The SIRs amongst ex-smokers and ex-users of snus at entry who remained tobacco-free during follow-up were 94 and 82, respectively.

Discussion

Smoking is widely recognized as the most important preventable cause of premature death in industrialized societies. But smoking is associated with the health-positive status of lower weight, and quitting smoking is associated with significant weight gain. In fact, smoking cessation was estimated to be responsible for about one quarter of the increase in prevalence of overweight amongst men in the USA during the 1980s [2]. Smokers in this study conformed with those of other Swedish and American studies in showing lower mean weight and/or BMI [1, 2, 8, 9] and lower prevalence of overweight [2, 9], and they gained weight over the follow-up period at the same rate as nontobacco users [1, 2]. In addition, this study confirmed findings from other studies that smokers who quit tobacco have higher mean weight/BMI [1, 2, 8, 10, 11] and have higher prevalence of overweight [1, 2]. We found that smokers who quit tobacco entirely had an average weight gain of 6.8 kg during the 9-year follow-up period. Recent studies have reported a range of weight gain amongst ex-smokers from 3 to 10 kg [1, 2, 12, 13], although direct comparisons between studies are difficult because of differences in population age and duration of follow-up. A substantial proportion of the weight gain and the tendency towards overweight occur shortly after cessation [2, 12], and the results suggest that the prevalence of overweight amongst ex-smokers declines towards

that of nonusers of tobacco with increasing duration of the postcessation period [2].

Nicotine replacement therapy with gum [14–18], patch [19–21] or nasal spray [22] is associated with a reduction in the initial weight gain related to smoking cessation. These studies are largely based on weight assessments during several weeks of temporary use of nicotine replacement medications in conventional cessation programmes, although there is evidence of weight suppression with gum use for 1 year [12]. This study provides evidence that weight gain is reduced amongst ex-smokers who use snus to maintain cessation. In this population snus use has played a prominent role in smoking cessation amongst men [4, 5]; perhaps this form of nicotine maintenance has played a role in lowering postcessation weight gain as well. In this study smokers who switched to snus during the follow-up period had significantly lower weight gain (0.51% per year and 3.6 kg over 9 years) than smokers who became tobacco-free (0.96% and 6.8 kg). In addition, overweight incidence was not elevated in either smokers who switched to snus or continuing snus users, but there was a trend towards increased SIRs in smokers and snus users who quit. However, the only group with significant overweight elevation in follow-up were smokers who quit tobacco. One of the results contradicted a weight suppressive effect of snus use in smoking cessation. At entry ex-smokers were more likely to be overweight (PR = 1.24, CI = 1.10–1.40), regardless of whether they were using snus or had quit tobacco entirely.

Snus users who had no smoking history had slightly higher prevalence of overweight at study entry, than never tobacco users. This was also seen amongst snus users in another large population survey from Sweden [9], although two other Swedish studies did not find any significant differences in mean BMI between snus users and nonusers of tobacco [10, 11]. In this study, snus users had only a slightly higher mean weight than nonusers of tobacco at entry (81.3 and 80.5 kg, respectively), and those who continued to use the product had a weight gain of 0.42% per year on average (for a total of 3.1 kg over the 9-year follow-up period), which was similar to the reference group, nonusers of tobacco (0.44% and 3.2 kg). In contrast, significantly higher weight gain was recorded in snus users who were tobacco-free at follow-up (0.70% and 5.1 kg), another indication of weight gain associated with nicotine abstinence.

The major strengths of this study are the homogeneity of the population, the standardized data collection in MONICA surveys, and the accurate and consistent definitions of tobacco use. Recall bias was not a factor as all weight measurements were recorded by study personnel, and these were subject to thorough MONICA quality control procedures [8]. A limitation of the study is that a change in tobacco status could have occurred at any time during follow-up. Thus, the annual percentage weight gain data, which is based on the entire follow-up period, underestimates the rate of increase immediately after tobacco cessation or change.

In summary, the health benefits of quitting smoking are considerable but may be partially negated by the weight gain following cessation, depending on the magnitude of the gain [1]. In addition, sustained smoking cessation in some individuals may be seriously jeopardized by the cosmetic impact of weight gain [1], so its control is important from both perspectives. This study suggests that primary snus use does not have major implications for weight gain, and furthermore that smokers who switch to snus may avoid some of the excess weight gain conventionally associated with smoking cessation. Results from previous studies show that snus use has served as a very effective and permanent nicotine substitute for smoking cessation amongst men in northern Sweden [4, 5]. Thus, snus use may have the dual effects of enhancing smoking cessation and minimizing the consequential effect of weight gain.

Conflict of interest statement

None of the authors has any financial or other personal conflict of interest with regard to any of the sponsors.

The sponsors had no scientific input or other influence in regard to this project, including design, analysis, interpretation or preparation of the manuscript.

Acknowledgements

Dr Rodu is supported in part by an unrestricted gift from the US Smokeless Tobacco Company to the Tobacco Research Fund of the University of

Alabama at Birmingham. Dr Stegmayr is supported by a grant from the Swedish Medical Research Council (Project K2000-27Gx-13574). This study was also supported by grants from the Swedish Research Council, the Research Council for Social Sciences, the Heart and Chest Fund, King Gustaf V's and Queen Victoria's Foundation, Västerbotten and Norrbotten County Councils and the Swedish Public Health Institute.

References

1 Williamson DF, Madans J, Anda RF, Kleinman JC, Giovino GA, Byers T. Smoking cessation and severity of weight gain in a national cohort. *New Engl J Med* 1991; **324:** 739–45.
2 Flegal KM, Troiano RP, Pamuk ER, Kuczmarski RJ, Campbell SM. The influence of smoking cessation on the prevalence of overweight in the United States. *New Engl J Med* 1995; **333:** 1165–70.
3 Lissner L, Johansson SE, Qvist J, Rossner S, Wolk A. Social mapping of the obesity epidemic in Sweden. *Int J Obes Relat Metab Disord* 2000; **24:** 801–5.
4 Rodu B, Stegmayr B, Nasic S, Asplund K. Impact of smokeless tobacco use on smoking in northern Sweden. *J Intern Med* 2002; **252:** 398–404.
5 Rodu B, Stegmayr B, Nasic S, Cole P, Asplund K. Evolving patterns of tobacco use in northern Sweden. *J Intern Med* 2003; **253:** 660–5.
6 Asplund K, Huhtasaari F, Lundberg V, Stegmayr B, Wester PO. Trends in cardiovascular risk factors in the northern Sweden MONICA study: who are the winners? *Cardiovasc Risk Factors* 1993; **3:** 215.
7 Persson M, Carlberg B, Mjörndal T, Asplund K, Bohlin J, Lindholm L. 1999 WHO/ISH guidelines applied to a 1999 MONICA sample from northern Sweden. *J Hypertens* 2002; **20:** 29–35.
8 Molarius A, Seidell JC, Kuulasmaa K, Dobson AJ, Sans S. Smoking and relative body weight: an international perspective from the WHO MONICA project. *J Epidemiol Community Health* 1997; **51:** 252–60.
9 Bolinder GM, Ahlborg BO, Lindell JH. Use of smokeless tobacco: blood pressure elevation and other health hazards found in a large-scale population survey. *J Intern Med* 1992; **232:** 327–34.
10 Eliasson M, Asplund K, Evrin P, Lundblad D. Relationship of cigarette smoking and snuff dipping to plasma fibrinogen, fibrinolytic variables and serum insulin. The northern Sweden MONICA study. *Atherosclerosis* 1995; **113:** 41–53.
11 Wallenfeldt K, Hulthe J, Bokemark L, Wikstrand J, Fagerberg B. Carotid and femoral atherosclerosis, cardiovascular risk factors and C-reactive protein in relation to smokeless tobacco use or smoking in 58 year old men. *J Intern Med* 2001; **250:** 492–501.
12 O'Hara P, Connett JE, Lee WW, Nides M, Murray R, Wise R. Early and late weight gain following smoking cessation in the lung health study. *Am J Epidemiol* 1998; **148:** 821–30.
13 Daughton DM, Fortmann SP, Glover ED *et al.* The smoking cessation efficacy of varying doses of nicotine patch delivery systems 4 to 5 years post-quit day. *Prev Med* 1999; **28:** 113–8.
14 Emont SL, Cummings KM. Weight gain following smoking cessation: a possible role for nicotine replacement in weight management. *Addict Behav* 1987; **12:** 151–5.
15 Gross J, Stitzer ML, Maldonado J. Nicotine replacement: effects of postcessation weight gain. *J Consult Clin Psych* 1989; **57:** 87–92.
16 Leischow SJ, Sachs DP, Bostrom AG, Hansen MD. Effects of differing nicotine-replacement doses on weight gain after smoking cessation. *Arch Fam Med* 1992; **1:** 233–7.
17 Doherty K, Militello FS, Kinnunen T, Garvey AJ. Nicotine gum dose and weight gain after smoking cessation. *J Consult Clin Psych* 1996; **64:** 799–807.
18 Nordstrom BL, Kinnunen T, Utman CH, Garvey AJ. Long-term effects of nicotine gum on weight gain after smoking cessation. *Nicotine Tob Res* 1999; **1:** 259–68.
19 Hughes JR, Hatsukami DK. Effects of three doses of transdermal nicotine on post-cessation eating, hunger and weight. *J Subst Abuse* 1997; **9:** 151–9.
20 Dale LC, Schroeder DR, Wolter TD, Croghan IT, Hurt RD, Offord KP. Weight change after smoking cessation using variable doses of transdermal nicotine replacement. *J Gen Intern Med* 1998; **13:** 9–15.
21 Jorenby DE, Hatsukami DK, Smith SS *et al.* Characterization of tobacco withdrawal symptoms: transdermal nicotine reduces hunger and weight gain. *Psychopharmacol* 1996; **128:** 130–8.
22 Sutherland G, Stapleton JA, Russell MA *et al.* Randomised controlled trial of nasal nicotine spray in smoking cessation. *Lancet* 1992; **340:** 324–9.

Correspondence: Brad Rodu, SDB 81, University of Alabama at Birmingham, Birmingham, AL 35294-0007, USA (fax: +1 205 975 5200; e-mail: rodu@uab.edu).