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The smoking epidemic in Switzerland – an empirical examination of the theory of diffusion of innovations

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Summary

Objectives: Cultural and sex differences in smoking rates among countries indicate different phases of the smoking epidemic. Their background is summarized in a four-stage model based on the Rogers Theory of Diffusion of Innovations. First, to test predictions of the Rogers theory and, second, to test whether, according to the theory, today's innovative process is smoking cessation, predicted by higher rates of cessation among the more highly educated and among men of all educational levels.

Methods: Data covered respondents older than 24 years from two Swiss Health Surveys (1997 and 2002). Logistic regression models were on lifetime smoking versus never-smoking, and on former smoking versus current smoking.

Results: Declining smoking rates in both sexes over time, measured by birth cohorts, indicate that the epidemic has peaked, but women of all educational levels and men of lower education still show high prevalence rates. The gap between higher-educated and lower-educated individuals is widening.

Conclusion: Smoking prevalence is expected to decline further, particularly among women and little educated men. The incidence of tobacco-related diseases in women is predicted to exceed that of men, owing to their lower cessation rates.

Keywords: Switzerland – Smoking epidemic – Tobacco – Sex differences – Education.

The World Health Report 2002 gave an estimation of 4.9 million tobacco-related deaths (8.8% of all deaths) for the year 2000. Projections by Peto et al. (1994) indicated even about 10 million annually by the years 2020 to 2030. The course of smoking prevalence varies across countries, however, as well as in men and women and socio-economic groups within countries. Whereas smoking prevalence is increasing in most developing countries, in established market economies it is decreasing, mainly in men (Corrao et al. 2000; WHO 1997). In some northern European countries, for example, women smoke as much as men; in southern Europe men smokers still outnumber women (Mackay & Eriksen 2002; Jha & Chaloupka 1999). Smoking cessation is more likely to increase among high socio-economic groups than among those of lower status (Barbeau et al. 2004). One theory that accords with those differential trends is the "Theory of Diffusion of Innovations" (Rogers 2003; Rogers & Shoemaker 1971). The present study has tested some of the key assumptions of this theory with regard to smoking in Switzerland.

The predictions deriving from the Rogers theory have been used to explain findings on the diffusion of smoking and formulated into a second theory, on the "smoking epidemic" (Graham 1996; Peto et al. 1994). According to the Rogers theory, innovative behaviour, such as smoking at the beginning of the 20th century, follows certain processes. First adopters of innovation are individuals or societies with advantages in education, higher socio-economic status (SES), and upward social mobility (Rogers 2003). The new behaviour spreads within these individuals or societies until it begins to be taken up by less advantaged socio-economic classes.

Theorists of the smoking epidemic divide the distribution of smoking in a society into four stages (Graham 1996; Peto et al. 1994). Whereas the original theory of Rogers referred to socio-economic groups, the four-stage model of the smoking epidemic additionally relates to sex differences (see Fig. 1), with a delay of the process in women. It postulates a comparable delay for low SES groups of both sexes compared with high SES groups. Graham (1996) found an interval of 10 to 20 years between men's adoption of smoking and that of women. The theory assumes that the course of the smoking epidemic in women is similar to that in men, but not that women will

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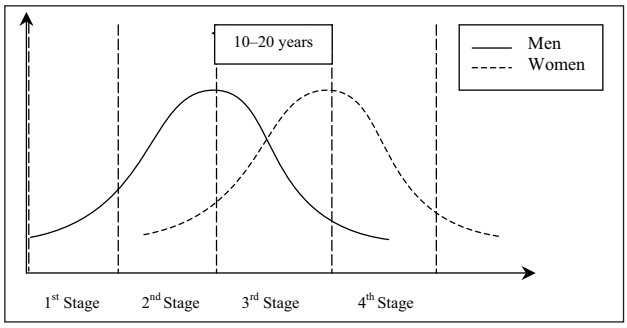

Figure 1 Highly simplified diagram of the four-stage-model of the smoking epidemic within a society. Switzerland, 2002

reach the same smoking prevalence; this is depicted in the highly simplified version of Figure 1.

The four stages of the smoking epidemic can be summarized as follows. In stage 1, smoking is exclusive to men of higher SES. In stage 2, it becomes common among all men. Male prevalence attains its highest rates and becomes more or less similar at all SES levels. Women show a comparable but delayed process: those of high SES become smokers at stage 2. In stage 3, prevalence among men decreases, as many, especially of higher SES, stop or reduce smoking, or less often initiate it. At the same time, prevalence among women in general remains high. At the end of stage 3, it begins to decrease too, first in higher SES groups. In the fourth and last stage of the epidemic the percentages of smokers of both sexes decrease further.

Not only uptake of smoking follows the assumptions of the Rogers theory but also non-smoking, for two reasons: a) smoking is no longer innovative, resulting in lower smoking initiation and thus lower lifetime prevalence, and b) smoking cessation becomes an innovative behaviour, resulting in higher rates of smoking cessation. Of course, other factors also, such as growing knowledge of the harmful effects of smoking or the increasing effectiveness of smoking prevention (WHO 2003), can lower incidence and prevalence or increase cessation.

Numerous studies have dealt with the assumptions of the theory of smoking epidemic (Brenner 1993; Fiore 1992; Pierce 1989; Stronks et al. 1997; Santos & Barros 2004; Mackay & Amos 2003; Fernandez et al. 2003; Bondy & Ialomiteanu 1997). Most have been carried out in established market economies and have shown the epidemic to be directed toward its end – prevalence in women is approaching that of men, as women's rates are increasing or men's decreasing. In developing countries, however, smoking rates are increasing, mainly among the lower SES groups (Jha & Chaloupka 1999), indicating the earlier stages of the process. Many studies in established market economies have found differences in prevalence across SES groups (Regidor et al. 2001; Helmert et al. 2001): People of lower SES are more likely to be smokers and less successful in cessation attempts (Barbeau et al. 2004). Individuals with higher formal education tend more often than others to stop smoking (Fernandez et al. 2001; Rose et al. 1996; Wagenknecht et al. 1990; Wray et al. 1998). Nevertheless, even established market economies show differences in smoking. For Europe, a north-south gradient has been observed for both sexes, pointing to more advanced stages of the process in the north than in the south (Cavelaars et al. 2000; Mackay & Eriksen 2002; Graham 1996). Smokers in northern Europe tend to be of lower SES and in southern parts higher. Similarly, men and women differ less in smoking prevalence in northern than in southern Europe. One explanation is unequal progress in the emancipation of women in different countries (Mackay & Eriksen 2002).

For Switzerland, the theory has been tested in a francophone region only (Geneva area), by Curtin and colleagues (1997). Their findings confirmed many of the assumptions of the Rogers theory, this area being at later stages of the smoking epidemic. So far, there has been no study on the smoking epidemic in the Swiss population. At the end of the 1990s Switzerland counted about 1.95 million smokers of between 15 and 74 years (SFA 1999), or one third of the population in this age range. Though smoking declined slightly from its highest rates, in the mid-1970s, the rates stabilized at a high level in the mid-1990s, especially among women (Gmel 1995). The consequence was a reduction of differences in prevalence between men and women, a closing of the gender gap, related to a) decreased prevalence in men, and b) non-decreasing rates in women, and eventually the diffusion of smoking from higher to lower social classes. Other countries have reported the same effects (Rose et al. 1996).

The study described here had two aims:

First, to test the following hypotheses, derived from the theory of diffusion of innovations:

- Lifetime smoking takes a curvilinear, inversely U-shaped course across time among men and women and all SES levels. This follows directly from the theory (Rogers 2003; Graham 1996; Peto et al. 1994), as presented in Figure 1.
- The curves of lifetime smoking prevalence rates across time for different SES levels and both sexes intersect, indicating different stages of the process among these four subgroups; higher SES groups and men are at more advanced stages of the process.
- Smoking cessation is more pronounced in higher SES levels and in younger than in older cohorts, indicating that smoking cessation is becoming the innovative behaviour in Switzerland.

Second, to determine the current stage of the process.
This should permit better allocation of health care resources. It could determine, for instance, whether smoking-related diseases are likely to decrease in general, or whether prevalence among women will increase. It could also permit a better tailoring of preventive action – for example, by focusing prevention on socio-economically less advantaged individuals or on women.

Method

Samples
Analysis is based mainly on the third Swiss Health Survey (SHS), conducted during 2002, which was a representative telephone survey with a response rate of 63.9% (random sample stratified by cantons). For an indication of effects of age, cohort and period, data from the 1997 SHS were also used (see below). Analysis was weighted throughout. The Swiss Federal Statistical Office, which conducted the surveys in Switzerland, provided weights to balance the sampling design and reflect the Swiss population.
To keep the culture factor constant, only respondents of Swiss nationality were examined. Also, only individuals older than 24 years were considered (total $n_{(all\ above\ 24)}$=15 816 (6 978 men, 8 838 women)). Usually, smoking begins at about 16 years; nearly all ever-smokers begin prior to 18 (USDHHS 1994; Jha & Chaloupka 1999). The first reason for excluding under-25s was to reduce the effect on rates of lifetime smoking. The second reason was the higher probability of an uncompleted education of younger respondents. Also, as they are more likely to live still in the parental home, their SES is probably comparable to that of their parents.
Seven missing cases on the dependent variables were excluded from the analysis. Also, individuals whose educational level was unknown were not considered (n = 264). The sample size was thus reduced (total $n_{(all\ above\ 24)}$=15 547 (6 897 men, 8 650 women)). The analysis concerns either lifetime smokers compared with never-smokers or former compared with current smokers as dependent variables in logistic regressions. The latter group consisted of lifetime smokers only.
In addition, to test the stability of the models and to identify possible age or period effects, data of the 1997 SHS were used. Both surveys used the same questions to measure smoking. The 1997 SHS sample was slightly smaller (total $n_{(all\ above\ 24)}$=9 799 (4 224 men, 5 575 women)).

Instruments and variables

Independent variables
Independent variables related to the smoking epidemic are:
– Sex (men coded 1, women 0)
– Socio-economic status, which was measured as educational level. Education, rather than income or occupation, is the central indicator; it varies less across time in relation to individuals than occupation, for example, which may change more often (Gottfredson & Deary 2004). Education is the indicator with the highest influence on a person's occupational status, income and general lifestyle (Siegrist 1995). Bisig and Gmel (2004) have shown that, in relation to health behaviour and use of health care, the use of a complex, multi-faceted SES indicator results in largely the same conclusions as those of formal education as single indicator. The variable "formal education" was constructed by the Swiss Federal Statistical Office and has four categories: 0 (missing information or obligatory school not completed); 1 (compulsory school); 2 (secondary school diploma/apprenticeship/full-time trade school); and 3 (university degree/higher professional education). For the current analysis, individuals on whom there was no information about educational status were excluded. Education as a variable was dichotomized into university degree/higher professional education coded as 1 and other education (categories 1 and 2 of the initial education variable) as 0.
– Historical time: Because only cross-sectional surveys of 1997 and 2002 could be used, effects of historical time are approximated by effects in different age groups. Testing the assumptions of the smoking epidemic with cross-sectional surveys of a limited period of time (here five years) is restricted to a certain period, namely that represented by age groups. Some of the described processes of the smoking epidemic (e. g. the beginning of the epidemic among highly educated men) probably took place at the end of the 19th century (Graham 1996). This survey, therefore, could not comprise all four stages of the epidemic, the time frame being limited to that of living persons.

Dependent variables
To test the hypotheses of the smoking epidemic, lifetime smokers were compared with never-smokers. Two questions were used to construct these indicators of tobacco use. The first, "Do you smoke, even rarely?", differentiates current smokers from non-smokers. Among non-smokers, former smokers were identified by the question: "Have you ever smoked regularly for more than six months?". Lifetime smok-

ing (i. e. former and current smokers) was used instead of current consumption, because it should – at least theoretically – be less affected by age. Smoking cessation, partly because of ill-health consequent to smoking, commonly increases with age (USDHHS 1989) and thus estimates of current smoking are likely to reflect effects of aging and confound effects of historical time. To test prediction of the theory as regards smoking cessation, former smokers were contrasted with current smokers.

A general problem in a single cross-sectional survey is the confounding of age, cohort, and period (Fienberg & Mason 1978; Robertson & Boyle 1998). For an indication of possible confounding effects of age and period, the 1997 SHS was used. If historical time, measured on the basis of birth cohorts, is the crucial factor, the course of smoking should be the same in all birth cohorts and both surveys. If age or period influences smoking, the prevalence curves compared at constant birth cohorts should be significantly different. Significant differences indicate age effects, as respondents of the same birth cohort were five years older in the 2002 SHS than in that of 1997. Differences, however, may also indicate changes occurring over time (period), because of, for example, increased prevention efforts between 1997 and 2002.

Hypothesis testing and statistical analysis

Hypothesis 1: Associations between second-order polynomials of age and lifetime smoking were used to test for curvilinear development over time in each sex/SES group. This is tested by logistic regressions that use lifetime smoking as the dependent variable. Independent variables are age as the linear term and age as a quadratic term. Analysis was performed separately for both sexes and in both educational groups.

Hypothesis 2: The aim was to test predictions from the four-stage-model of the smoking epidemic as regards lifetime smoking. Tests were broken down into two steps. In the first, intersections of the course of smoking in the two educational groups were analysed. A significant interaction of education and age indicates different phases of the smoking trends among status groups. Analyses were stratified by sex. The second step was to test for delayed processes among women compared with men.

Here, a significant interaction between sex and age indicates that the sexes differ in smoking trends. The analyses were stratified by educational status. Visual inspection of curves plotting log odds versus age separately for men and women tell whether trends for men precede those for women.

Hypothesis 3: The aim was to test predictions of the theory as regards smoking cessation. Logistic regression analysis using former versus current smoking as the dependent variable follows the course of the analysis outlined in hypothesis 2. Again the hypothesis is broken down into two steps. First, interactions of education and age are tested separately for both sexes, and second, interactions between sex and age are tested separately for both educational groups.

Statistical analysis was performed with SPSS 11.5 (SPSS Inc. 2002). Logistic regressions with interactions of age and education and of age and sex were calculated to test the main hypotheses of the theory**.** Models using both surveys tested with logistic regressions for the interaction of age (as proxy for historical time) and survey year to reveal possible effects of age and period. The significance of interactions is crucial for testing predictions from the theory of diffusion of innovations. Owing to the postulated curvilinear relationships with age, tests have two degrees of freedom, related to the linear and quadratic terms used to model historical time. Thus, the concern is not with the significance of each of the components but, rather, with the interaction as a whole. Both terms, therefore, were conjointly tested as a block (Kleinbaum 1994) by means of log-likelihood-ratio tests of the model with interactions against the model without interactions (Bühl & Zöffel 2000). The degrees of freedom for this chi-square test equal the difference between the number of parameters in the two models.

Results

Table 1 shows the prevalence of lifetime smoking and cessation of smoking in six 10-years age groups, separately for both sexes and educational levels.

Hypothesis 1: Among men and women and in both educational groups lifetime prevalence of smoking was inversely U-shaped – the youngest and the oldest ages have lower smoking prevalence than middle-age groups.

Tests for these U-shaped curves (i. e. significant negative quadratic effects of age) were significant for men (higher education: $B_{age\ quadratic}$ = -0.94, p<0.01; other education: $B_{age\ quadratic}$= -0.69, p<0.01), and women (higher education: $B_{age\ quadratic}$ = -1.10, p<0.01; other education: $B_{age\ quadratic}$ = -1.29, p<0.01). All the B values were multiplied by 1 000 for easier presentation.

Hypothesis 2: The first part of the analysis (Tab. 2) tests differences between the SES groups in the course of lifetime smoking. Among men the interaction of age and educational class has a significant influence on smoking (χ^2 = 6.03, df = 2, p<0.05), whereas women show no such significant interaction (χ^2 = 4.17, df = 2, n.s.). The curves tend to follow the general theory with a delayed process among lower educated, and lower smoking risks in younger cohorts. Similarly, the course of the smoking epidemic in women is delayed by 20 to 30 years compared with that for men (Fig. 2).

Table 1 Prevalence of lifetime use and smoking cessation (only smokers) by sex, formal education, and age; unweighted total n. Switzerland, 2002

			Age in years						
Lifetime smoking			**25–34**	**35–44**	**45–54**	**55–64**	**65–74**	**75 +**	**total**
Men	**higher education**	n	338	553	364	311	241	136	1943
		%	51.6	51.2	63.2	69.9	69.7	53.4	58.7
	other education	n	787	1149	877	896	724	521	4954
		%	57.1	59.8	71.4	68.6	63.9	61.0	63.9
Women	**higher education**	n	189	248	200	122	56	28	843
		%	41.7	46.5	56.0	39.3	36.8	38.1	46.2
	other education	n	1139	1560	1337	1521	1263	987	7808
		%	43.5	54.3	52.2	42.2	28.3	19.0	41.5
Smoking cessation: only smokers									
Men	**higher education**	n	163	286	219	210	170	79	1127
		%	31.4	37.6	45.1	54.7	68.4	66.7	46.9
	other education	n	449	696	632	616	466	319	3178
		%	20.1	29.6	43.4	53.0	60.1	76.5	43.5
Women	**higher education**	n	82	121	121	54	20	11	409
		%	39.7	48.8	51.5	40.0	42.9	50.0	46.5
	other education	n	515	849	744	667	380	203	3358
		%	30.4	36.3	44.4	51.1	56.9	73.1	44.1

Table 2 Logistic regression of lifetime smoking use on age (linear and quadratic) and education (dichotomous), sex specific (see Fig. 2). Switzerland, 2002

	B	**S.E.**	**p**	**log-likelihood-ratio test (χ^2-change) for interaction**	
			Men (n=6 897)		
Age (linear)	0.08	0.01	0.00		
Age (quadratic)	-0.69 [b]	0.12 [b]	0.00		
Education (higher)[a]	-1.27	0.63	0.05		
Age (linear) * Education	0.04	0.03	0.17	6.03	p<0.05
Age (quadratic) * Education	-0.26 [b]	0.24 [b]	0.28		
Constant	-1.47	0.32	0.00		
			Women (n=8 650)		
Age (linear)	0.11	0.01	0.00		
Age (quadratic)	-1.29 [b]	0.11 [b]	0.00		
Education (higher)[a]	-0.19	0.96	0.84		
Age (linear) * Education	-0.01	0.04	0.89	4.17	n.s.
Age (quadratic) * Education	0.19 [b]	0.40 [b]	0.64		
Constant	-2.36	0.30	0.00		

Remarks: [a] Reference: Compulsory school/secondary school diploma/apprenticeship/full-time trade school.
[b] Multiplied by 1000 for easier presentation.

The statistical test for this delay shown in women (namely the interaction between age, as historical time, and sex) attained significance in both socio-economic groups (higher education: $\chi^2 = 10.68$, df = 2, $p<0.01$; other education: $\chi^2 = 156.79$, df = 2, $p<0.001$; Tab. 3).

The following formulas were used to calculate logit estimates on the basis of estimates of B in logistic regression (see Tab. 2):

Higher education:

$$\text{logit} = B_{\text{age linear}}*\text{age} + B_{\text{age quadratic}}*\text{age}^2 + B_{\text{education}} + B_{\text{edu*age linear}}*\text{age} + B_{\text{edu*age quadratic}}*\text{age}^2 + B_{\text{constant}}$$

Other education:

$$\text{logit} = B_{\text{age linear}}*\text{age} + B_{\text{age quadratic}}*\text{age}^2 + B_{\text{constant}}$$

	B	S.E.	p	log-likelihood-ratio test (χ^2-change) for interaction	
			Higher education (n= 2 786)		
Age (linear)	0.11	0.04	0.01		
Age (quadratic)	-1.10 [b]	0.39 [b]	0.00		
Sex (male)[a]	-0.17	1.07	0.87		
Age (linear) * Sex	0.01	0.04	0.88	10.68	p <0.01
Age (quadratic) * Sex	0.16 [b]	0.44 [b]	0.72		
Constant	-2.56	0.92	0.01		
			Other education (n =1 2 761)		
Age (linear)	0.11	0.01	0.00		
Age (quadratic)	-1.29 [b]	0.11 [b]	0.00		
Sex (male)[a]	0.90	0.43	0.04		
Age (linear) * Sex	-0.03	0.02	0.05	156.79	p <0.001
Age (quadratic) * Sex	0.60 [b]	0.16 [b]	0.00		
Constant	-2.36	0.30	0.00		

Table 3 Logistic regression of lifetime smoking use on age (linear and quadratic) and sex, for both educational groups separately. Switzerland, 2002

Remarks: [a] Reference: Women.
[b] Multiplied by 1000 for easier presentation.

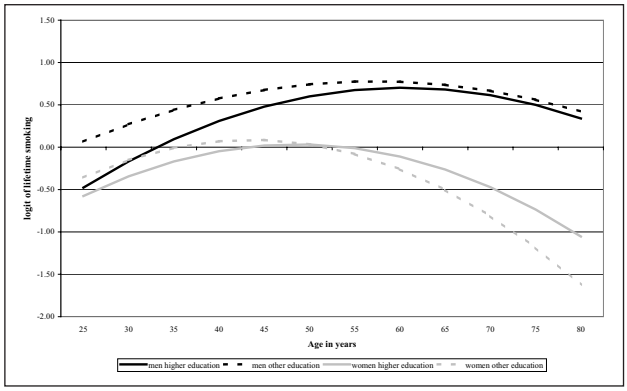

Figure 2 Effects of interaction of age and education on lifetime smoking, sex-specific (see Table 2). Switzerland, 2002

Remark: Effects of interaction of age and education on lifetime smoking did not attain significance among women.

Hypothesis 3: As regards the postulated differences among the socio-economic groups in smoking cessation, women show a significant interaction between age and education in former smoking (χ^2 = 8.55, df = 2, p<0.05). Though not significantly so (χ^2 = 3.82, df = 2, n.s.; see Tab. 4), also among men younger cohorts of highly educated men tend to show higher cessation rates than those of other education levels (Fig. 3). Thus, for both sexes "smoking cessation" has become an innovative behaviour and is more likely to be taken up by higher educated groups.

As Table 5 shows, the interaction between age and sex attains significance in both educational groups (higher education: χ^2 = 10.16, df = 2, p<0.01; other education: χ^2 = 17.65, df = 2, p<0.001), indicating that more men than women, and men earlier than women, adopt smoking cessation as an innovative behaviour.

Cohort effects: Stability of results (comparison 1997–2002)

Women in neither educational group show significant interaction between survey year and birth cohort in respect of lifetime smoking (other education χ^2 = 5.73, df = 2, n.s.; higher education χ^2 = 0.82, df = 2, p = n.s.); this indicates no particular effect of age or period. In both educational groups, however, a significant interaction of age and cohort is found for men (higher education: χ^2 = 6.08, df = 2, p<0.05; other education: χ^2 = 10.19, df = 2, p<0.01). The significant results are presented in Fig. 4, which shows that differences between surveys apply mainly to higher-educated men.

Discussion

The study found evidence for the curvilinear course of lifetime smoking over age in both sexes and both educational groups. The curves are stable over cohorts in both surveys, which shows that age and lifetime smoking can be used to model the smoking epidemic in cross-sectional surveys. Age or period effects were found mainly for higher educated men. The epidemic has passed its peak in Switzerland. In both men and women, prevalence has begun to decrease and can be expected to decrease further in coming years. Whereas in men, however, smoking rates had already begun to decrease 30 to 40 years ago, this has occurred more recently in women, con-

	B	S.E.	p	log-likelihood-ratio test (χ^2-change) for interaction	
			Men (n = 3 767)		
Age (linear)	0.08	0.02	0.00		
Age (quadratic)	-0.26 [b]	0.17 [b]	0.11		
Education (higher)[a]	1.07	0.94	0.26		
Age (linear) * Education	-0.02	0.04	0.52	3.82	n.s.
Age (quadratic) * Education	0.13 [b]	0.35 [b]	0.71		
Constant	-3.41	0.47	0.00		
			Women (n = 4 305)		
Age (linear)	0.01	0.02	0.67		
Age (quadratic)	0.24 [b]	0.18 [b]	0.19		
Education (higher)[a]	-0.65	1.51	0.67		
Age (linear) * Education	0.06	0.06	0.31	8.55	p<0.05
Age (quadratic) * Education	-0.90 [b]	0.63 [b]	0.15		
Constant	-1.26	0.48	0.01		

Table 4 Logistic regression of former smoking use on age (linear and quadratic) and education (dichotomous), sex-specific (see Fig. 3). Switzerland, 2002

Remarks: [a] Reference: Compulsory school/secondary school diploma/apprenticeship/full-time trade school.
[b] Multiplied by 1000 for easier presentation.

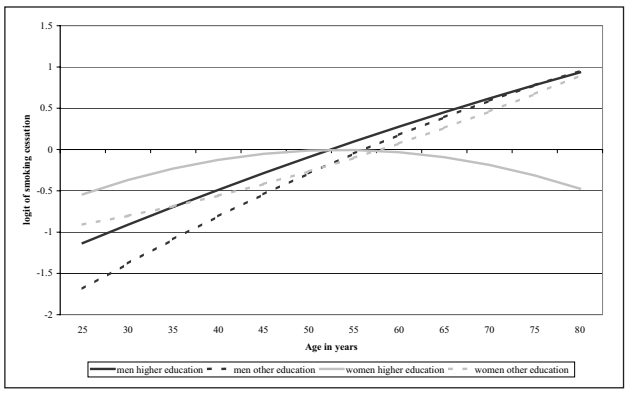

Figure 3 Effects of interaction of age and education on former smoking, sex-specific (see Table 4)

Remark: Effects of interaction of age and education on former smoking did not attain significance among men.

firming the prediction of the four-stage-model of the smoking epidemic. All models testing for sex differences were significant. Similarly confirmed, though significantly only for men, is the differential process among education groups. In accordance with the theory, the decrease in smoking rates among men was steeper in the higher education group, pointing again to a later stage of the general process. In women, older cohorts of higher educated groups have higher smoking rates; this is reversed among younger birth cohorts, indicating an earlier beginning of the process of non-smoking in the higher educated group. Similarly, with decreasing age the gap between higher and lower educated groups in smoking cessation is apparently widening. As the theory predicts, the innovation "smoking cessation" appears more likely to be adopted among the higher educated. It should be noted that, in contrast to the findings for men, smoking cessation rates are not shown to have increased in higher educated women in older age groups; this may simply be due to small sample sizes of highly educated smoking women in these age groups.

One limitation of the present study is that findings are based mainly on one cross-sectional study. Thus, cohort and age effects may be confounded in the sense that older cohorts appear to be more often smokers simply because they had more time to initiate this behaviour. The focus on lifetime prevalence and age groups of 25 years and older should, at least partly, account for this effect. It is rare to commence smoking beyond this age (Jha & Chaloupka 1999). In addition, the comparison of the two surveys shows the same trends for cohorts, though individuals of the same cohort were older in the 2002 than in the 1997 Survey. Finally, in accordance with the theory, smoking prevalence decreased at older ages, at younger ages in women than in men, and for "other education" compared with higher education. The findings show also that the "smoking epidemic" or the Rogers theory cannot be regarded as being deterministic or indicating a sole cause: smoking is also affected by short-term changes or by characteristics of the survey year, such as the slightly increasing prevalence among higher educated men in younger age groups.

In addition to the effect discussed above, several studies have shown higher mortality among older, especially male, smokers (Noale et al. 2005; Fried et al. 1998). The observed

Table 5 Logistic regression of former smoking use on age (linear and quadratic) and sex, for both educational groups separately. Switzerland, 2002

	B	S.E.	p	log-likelihood-ratio test (χ^2-change) for interaction	
Higher education (n = 1 536)					
Age (linear)	0.07	0.06	0.23		
Age (quadratic)	-0.67 [b]	0.60 [b]	0.27		
Sex (male)[a]	-0.44	1.64	0.79		
Age (linear) * Sex	-0.02	0.07	0.78	10.16	p <0.01
Age (quadratic) * Sex	0.53 [b]	0.68 [b]	0.43		
Constant	-1.90	1.43	0.18		
Other education (n = 6 536)					
Age (linear)	0.01	0.02	0.67		
Age (quadratic)	0.24 [b]	0.18 [b]	0.19		
Sex (male)[a]	-2.15	0.67	0.00		
Age (linear) * Sex	0.07	0.03	0.01	17.65	p <0.001
Age (quadratic) * Sex	-0.50 [b]	0.25 [b]	0.04		
Constant	-1.26	0.48	0.01		

Remarks: [a] Reference: Compulsory school/secondary school diploma/apprenticeship/full-time trade school.
[b] Multiplied by 1000 for easier presentation.

relation between lifetime prevalence of smoking and age may, therefore, not only be related to the processes of the smoking epidemic but also to a higher "selection" of non-smokers into older age groups. This would mean that the observed results are due not only to birth cohort, but also to higher exposure of older smokers to smoking-related disease and therefore higher smoking-related mortality. Similarly, individuals with a higher level of education are more likely than those with lower levels to cease smoking (Fernandez et al. 2001; Rose et al. 1996; Wagenknecht et al. 1990; Wray et al. 1998) and therefore are likely to have a lower risk of mortality. Though "mortality selection" may partly explain decreasing smoking prevalence at older ages, it cannot explain the decreasing prevalence at younger ages or the widening of the gap between lower and higher formal education, which is in line with assumptions of the Rogers theory.

Another limitation is that, because of the restricted age range in a survey, not all stages of a process that began at the end of the 19th century can be observed. Thus, particularly for men, the presented data reflect only the coming end of the epidemic, showing that smoking prevalence is declining; this is true for both educational groups, though steeper – as the theory predicts – among higher-educated men. As to women, however, the end of the process is not yet in sight, because the upturn phase of smoking set in later among them. For older women the risk of being a lifetime smoker was greater among those with higher formal education. Until the 1950s the smoking risks of less educated women increased continuously, whereas women with higher formal education were stabilized in their smoking risk. Since the mid-1950s the risk curve of less educated women has been higher than that of women with higher formal education. The risk of lifetime smoking for the latter decreased during the following years, whereas that of less educated women increased until the 1970s and then also decreased. These results are comparable to those of the study of Curtin et al. (1997) on women in Geneva. A possible reason for this is that after the Second World War women entered the workforce in increasing numbers and a false emancipation as regards smoking took place (Graham 1996).

Currently, according to the study findings, the less educated respondents of both sexes are at highest risk of lifetime smoking; this can be explained by the theory of a process directed towards its end, which favours, first, higher educational groups as regards non-smoking. The gap between men and women is closing for both higher and lower educational groups, which the theory can again explain by an earlier onset of the downturn of the curve on the part of men. It can be predicted that rates among men and women will become more similar, though probably at a lower level. A Swiss study (HBSC) among 15-year-olds has already shown that females have slightly higher smoking rates than males (Godeau et al. 2004). The United States Surgeon General (2002) has stated that reducing and preventing smoking is one of the highest contemporary priorities for women's health. Given the results of the study presented here, the same applies to Switzerland. The steeper decline in smoking rates among men highlights

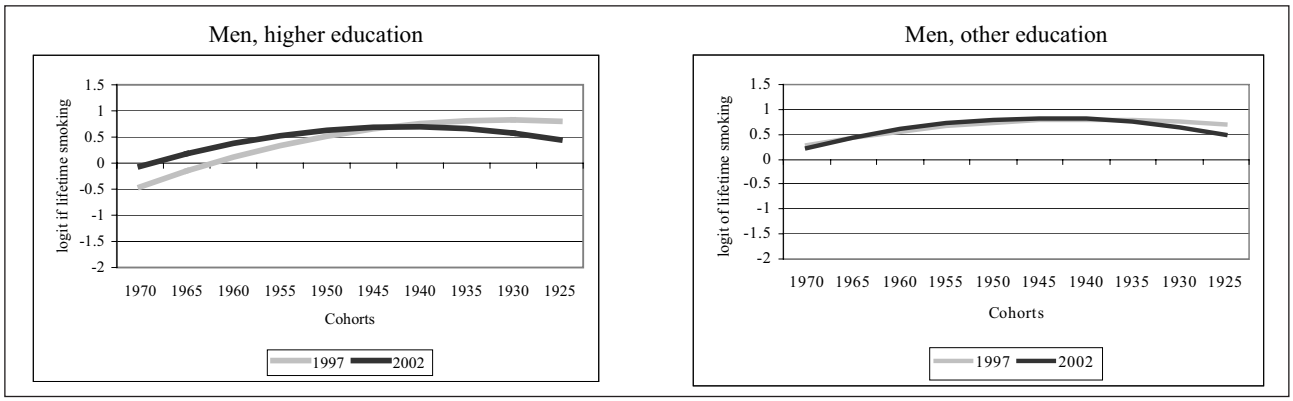

Figure 4 Effects of interaction of cohort and period on lifetime smoking among men, Switzerland, 2002

the need for preventive efforts directed more strongly at women.

Secondary prevention includes support to smoking cessation. Again in accordance with the theory, individuals with a higher level of education are more likely than those with lower levels to cease smoking (Fernandez et al. 2001; Rose et al. 1996; Wagenknecht et al. 1990; Wray et al. 1998). The analysis of potential age and cohort effects, however, when comparing results from the 2002 and the 1997 Surveys, tends to show that the decrease in smoking prevalence, particularly among younger, higher-educated men, slowed down between 1997 and 2002. This may point to the possible need to increase preventive efforts in Switzerland among young people, in order to speed up again the process of the smoking epidemic, which is now one of declining use. At present it is hotly debated in Switzerland whether the advertisement of tobacco products should be restricted, or perhaps the sale of cigarettes to minors by cigarette machines be prevented – for example, by permitting credit card payment only. Given the higher rates in less-educated individuals, however, such structural measures might best be accompanied by preventive efforts targeted at individuals with low levels of education and at women in general.

There is a time lag between beginning smoking and the onset of smoking-related diseases (Bray et al. 2004). Higher smoking rates in certain groups of the population will thus be reflected in higher rates of lung cancer (Bray et al. 2004) and other smoking-related diseases after a certain interval. Mackenbach et al. (2004) have found lower risks of lung cancer for Switzerland among less educated men in older age groups and less educated women in all age groups. Given the results presented here, this should change in the coming years. At present, less-educated individuals are at higher smoking risk, and this can be expected to result in higher risks of lung cancer and of other diseases in the future. Health care planning should take these developments into account. According to the present findings, it may be predicted that among men smoking-related diseases will decrease. Female smoking-related diseases may not yet have peaked, however, given the lag between smoking rates and disease rates. Health care planning should be prepared for such a shift in sex rates in patients entering hospitals or using the health care system in general.

Zusammenfassung

Die Epidemie des Rauchens in der Schweiz – eine empirische Überprüfung der Theorie zur Verbreitung von Innovation

Fragestellung: Zunächst wurden einzelne Aspekte der Theorie „Diffusion of Innovations" von Rogers, zusammengefasst in einem Vier-Stufen-Modell, getestet. Weiterhin wurde überprüft, ob die Aufgabe des Rauchens den Annahmen der Theorie folgt und ebenfalls als innovatives Verhalten verstanden werden kann. Dies würde mit höheren Aufgaberaten unter Personen mit einer formal höheren Bildung und unter Männern im Allgemeinen einhergehen.

Methode: Die Daten stammen aus zwei Wellen der Schweizerischen Gesundheitsbefragung (1997 und 2002). Die Analysen wurden auf die über-24-Jährigen begrenzt und basieren auf logistischen Regressionsmodellen mit Lebenszeitkonsum von Tabak und der Aufgabe des Tabakkonsums als abhängiger Variablen.

Ergebnisse: Die Raucherraten sanken in den letzten Jahren bei beiden Geschlechtern. Somit scheint der Höhepunkt der Epidemie insgesamt bereits überschritten. Zwei Gruppen, Frauen insgesamt und Männer mit einer geringeren formalen Bildung zeigen noch hohe Raucherprävalenzen. Die Kluft bei den Raucherraten zwischen den höheren Bildungsgruppen und weniger Gebildeten weitet sich aus.

Schlussfolgerungen: Es wird erwartet, dass sich die Raucherraten weiterhin verringern, dies besonders unter Frauen und bei Männern mit geringer formaler Bildung. Die Autoren gehen davon aus, dass die Inzidenz von tabakbedingten Erkrankungen unter Frauen zukünftig die der Männer übersteigen wird, da erstere in der Entwicklung zu Rauchstopps geringere Raten aufweisen als Männer.

Résumé

Consommation de tabac en Suisse – la théorie de la diffusion de l'innovation à l'épreuve

Objectifs: Premièrement, vérifier la théorie de la diffusion de l'innovation de Rogers, qui repose sur un modèle en quatre phases. Deuxièmement, tester si le processus innovateur actuel est celui de l'arrêt du tabac, prédit par des taux d'arrêt plus élevés parmi les personnes avec un niveau élevé d'éducation et chez les hommes.

Méthodes: : Les données ont été recueillies dans le cadre de l'Enquête suisse sur la santé (1997 et 2002) auprès de personnes de plus de 24 ans. Les analyses portent sur la consommation de tabac au cours de l'existence (au moins une fois vs. jamais, et ex-fumeurs vs fumeurs actuels).

Résultats: Les taux de consommation de tabac reculent chez les hommes et les femmes, indiquant que le pic de l'épidémie est passé. Dans la phase actuelle, en ce qui concerne l'arrêt du tabac, les hommes avec un niveau d'éducation bas et les femmes sont en retard par rapport aux hommes au niveau de formation élevé. Le fossé se creuse entre les personnes au niveau de formation élevé et celles au niveau de formation bas.

Conclusion: La prévalence de la consommation de tabac devrait continuer de baisser, en particulier chez les femmes et parmi les hommes de bas niveau de formation. Toutefois, comme le taux de consommation de tabac ne décline chez les femmes que depuis quelques années, l'incidence des maladies liées au tabac chez celles-ci devrait dépasser celle observée chez les hommes.

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