



# Changes in active and passive smoking in the European Community Respiratory Health Survey

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**ABSTRACT:** The aim of the present investigation was to study changes and determinants for changes in active and passive smoking.

The present study included 9,053 adults from 14 countries that participated in the European Community Respiratory Health Survey II. The mean follow-up period was 8.8 yrs. Change in the prevalence of active and passive smoking was expressed as absolute net change (95% confidence interval) standardised to a 10-yr period. Determinants of change were analysed and the results expressed as adjusted hazard risk ratio (HRR) or odds ratio (OR).

The prevalence of active smoking declined by 5.9% (5.1–6.8) and exposure to passive smoking in nonsmokers declined by 18.4% (16.8–20.0). Subjects with a lower educational level (HRR: 0.73 (0.54–0.98) and subjects living with a smoker (HRR: 0.45 (0.34–0.59)) or with workplace smoking (HRR: 0.69 (0.50–0.95)) were less likely to quit. Low socio-economic groups were more likely to become exposed (OR: 2.21 (1.61–3.03)) and less likely to cease being exposed to passive smoking (OR: 0.48 (0.37–0.61)).

In conclusion, the quitting rate was lower and the risk of exposure to passive smoking higher among subjects with lower socio-economic status. Exposure to other peoples smoking decreased quitting rates and increased the risk of starting to smoke.

**KEYWORDS:** Epidemiology, passive smoking, smoking, socio-economic status

Tobacco is the world's biggest preventable killer and with 1.3 billion current smokers it is estimated that 450 million tobacco deaths will occur over the next 50 yrs unless current use changes dramatically [1]. It has also become evident that smoking is not only a problem for smokers, but also for those around them with mounting evidence of the harmful effect of passive smoking [2–4]. In the UK alone, passive smoking at home and in the workplaces has been estimated to cause deaths of >10,000 persons each year [4].

In the European Community Respiratory Health Survey (ECRHS) I, which included young adults (aged 20–44 yrs) from 16 countries, 37% were active smokers [5] and 39% of the never-smokers were exposed to passive smoking [6]. The ECRHS I was conducted in 1990–1994 and since then measures to reduce active and passive smoking have been introduced in many countries [7–9]. There are indications that these measures, to some

extent, have been successful with declining prevalence of daily smoking in several countries [10–12] and a decrease in exposure to passive smoking in English children during the 1990s [13]. Results from smoking cessation studies show a lower success rate in participants from lower socio-economic groups [14, 15]. Having a smoking spouse [15, 16], a higher level of nicotine dependency, or higher tobacco consumption are other factors related to a lower quitting rate [15, 17].

The ECRHS II [18] was a follow-up study of the subjects that were investigated in the ECRHS I. This study provided a unique opportunity to study determinants of changes for active and passive smoking in population cohorts from a large number of different countries.

## METHODS

The design of the ECRHS I and ECRHS II have been published in detail [18, 19]. Each participant was sent a brief questionnaire (stage 1) and from

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those who responded, a random sample was selected to undergo a more detailed clinical examination (stage 2).

In the ECRHS II, subjects who had participated in stage 2 of the ECRHS I were invited to participate in the follow-up.

This analysis included data from 29 centres in the ECRHS II (table 1). The target population was 15,468 subjects with smoking data in stage 2 of the ECRHS I, of these 9,053 (58.6%) supplied data on smoking in the ECRHS II. The follow-up time was  $8.8 \pm 1.2$  yrs (mean  $\pm$  SD).

**TABLE 1** Prevalence of current and passive smoking in the European Community Respiratory Health Survey (ECRHS) I and II

Country and centre	Current smoking			Passive smoking in nonsmokers			Follow-up
	n	ECRHS I %	ECRHS II %	n	ECRHS I %	ECRHS II %	
<b>Iceland</b>							
Reykjavik	457	38.5	28.4	257	48.4	24.5	8.9 $\pm$ 0.3
<b>Norway</b>							
Bergen	595	41.8	37.1	315	34.1	15.2	9.5 $\pm$ 0.2
<b>Sweden</b>							
Göteborg	497	34.2	23.9	294	43.9	9.9	9.1 $\pm$ 0.4
Umeå	421	22.1	16.6	315	19.4	8.6	8.5 $\pm$ 0.4
Uppsala	511	23.7	13.7	366	22.4	6.0	8.6 $\pm$ 0.4
<b>Estonia</b>							
Tartu	241	30.7	43.9	127	37.8	27.6	5.2 $\pm$ 0.4
<b>The Netherlands</b>							
Geleen	138	33.3	26.1	88	67.0	38.6	10.3 $\pm$ 0.3
<b>Belgium</b>							
Antwerp South	337	24.6	20.5	228	54.8	32.0	9.8 $\pm$ 0.4
Antwerp City	298	33.2	31.5	178	51.7	33.2	9.1 $\pm$ 0.4
<b>Germany</b>							
Hamburg	303	38.6	32.0	169	49.7	27.2	9.3 $\pm$ 0.6
Erfurt	286	38.1	37.4	141	39.7	27.0	9.2 $\pm$ 0.3
<b>Switzerland</b>							
Basel	447	33.8	30.4	268	23.9	16.8	10.3 $\pm$ 0.4
<b>France</b>							
Bordeaux	163	38.0	30.1	92	47.8	26.1	9.2 $\pm$ 0.5
Grenoble	384	30.5	23.4	244	36.1	25.0	9.1 $\pm$ 0.4
Montpellier	202	23.8	18.3	130	37.7	18.5	9.2 $\pm$ 0.7
Paris	433	34.9	32.8	246	44.7	36.2	8.2 $\pm$ 0.9
<b>UK</b>							
Cardiff	209	27.8	23.0	147	42.9	25.8	10.6 $\pm$ 0.2
Ipswich	296	24.3	19.6	199	38.2	24.6	8.5 $\pm$ 0.5
Nonwich	257	20.2	17.5	190	38.4	16.8	9.0 $\pm$ 0.5
<b>Italy</b>							
Pavia	192	38.0	30.7	106	67.0	51.9	8.5 $\pm$ 0.7
Turin	123	25.2	22.8	85	55.3	27.1	8.4 $\pm$ 0.4
Verona	204	33.3	33.3	121	41.3	21.5	8.7 $\pm$ 0.6
<b>Spain</b>							
Barcelona	271	45.8	38.8	129	65.1	45.0	8.9 $\pm$ 0.7
Galdakao	358	49.4	39.9	172	74.4	48.3	8.6 $\pm$ 0.4
Albacete	308	52.3	46.8	133	60.9	42.1	8.7 $\pm$ 0.8
Oveido	240	57.5	44.6	97	57.7	55.7	8.4 $\pm$ 0.7
Huevía	204	52.9	46.1	83	67.5	65.1	8.4 $\pm$ 0.7
<b>Australia</b>							
Melbourne	482	23.0	20.5	351	19.7	10.8	7.0 $\pm$ 0.5
<b>USA</b>							
Portland	196	15.3	12.2	158	17.1	10.8	7.7 $\pm$ 0.4
<b>All subjects</b>	9053	33.9	28.7	5429	40.6	24.0	8.8 $\pm$ 1.2

Data are presented as mean  $\pm$  SD, unless otherwise stated.

### Smoking

Information on smoking history was collected by an administered questionnaire at each occasion. Those who answered "yes" to the lead question ("Have you ever smoked for as long as one year?") were asked "Do you smoke now, as of one month ago?" Subjects that were current smokers in the ECRHS I but not in the ECRHS II were defined as quitters. Subjects that were never-smokers in the ECRHS I but smokers in the ECRHS II were defined as starters. Questions on age when starting and quitting were used to determine when the change in smoking habits occurred during the study period. Information on the number of cigarettes, cigarillos, cigars and the amount of pipe tobacco consumed was collected in both surveys. Based on this information the quantity of smoking in the ECRHS I was assessed. The quantity was expressed as the average daily number of cigarettes, where cigarillos were assumed equivalent to three cigarettes and cigars to five, and pipe tobacco was converted to equivalence by weight [20].

### Passive smoking

Passive smoking was assessed using different items from the questionnaire. The participants were asked whether they had regularly (most days or nights) been exposed to tobacco smoke in the last 12 months. Participants answering affirmatively to this question were classified as being passive smokers and then asked the number of other persons in the household who regularly smoked. Participants with at least one other active smoker in the household were classified as living with a smoker. Participants were also asked whether other people smoked regularly in the room where they worked and those who answered affirmatively were classified as being exposed to workplace smoking. Passive smoking was only assessed in subjects that were nonsmokers in both surveys, except when analysing the association between change in smoking status and living or working with smokers.

### Socio-economic status

Socio-economic status was defined using information on the subject's occupation that was provided during the ECRHS I according to the UK social classification [21]. Using this classification the subjects were divided into: 1) professional and semi-professionals; 2) skilled nonmanual workers; 3) manual workers; and 4) undefined. A low educational level was defined as having completed full-time education before the age of 16 yrs [22].

### Age groups

Based on the quartile distribution of the age in the ECRHS I, the subjects were divided into the following age groups: 20–<28; 28–<34; 34–<40; and 40–48 yrs.

### Body mass index

Height and weight were measured in the majority of centres, self-reported in a few, prior to lung function measurement in the ECRHS I. The body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in metres. BMI was analysed as a categorical variable divided into underweight (<20 kg), normal weight (20–<25 kg), overweight (25–<30 kg) and obese ( $\geq 30$  kg).

### Ethics approval

Local ethics committees at each centre approved the study protocols.

### Statistics

Absolute change in smoking status per year of follow-up was estimated using population averaged generalised estimating equations for a binomial outcome with identity link. Participants were identified as the clustering factor and length of follow-up as an independent variable. Results were expressed as net change per 10 yrs of follow-up. The Wald test was used to examine differences in change of prevalence by sex and age group.

Kaplan-Meyer and Cox regression was used to analyse determinants for change in smoking status and logistic regression for change in passive smoking status. The results were expressed as adjusted hazard risk ratio (HRR) and odds ratio, respectively, with a 95% confidence interval (CI). Age, sex, socio-economic status, centre and length of follow-up were used as independent variables in all models. Living with a smoker and workplace smoking were used as determinants for all analyses of change in active smoking status and the quantity of smoking in the ECRHS I in all analyses of determinants for quitting. Analyses of sex interactions were performed and, when a significant interaction was found, the logistic regression was performed for males and females separately. Estimates by centre or country were examined for heterogeneity and combined using random effects meta-analysis.

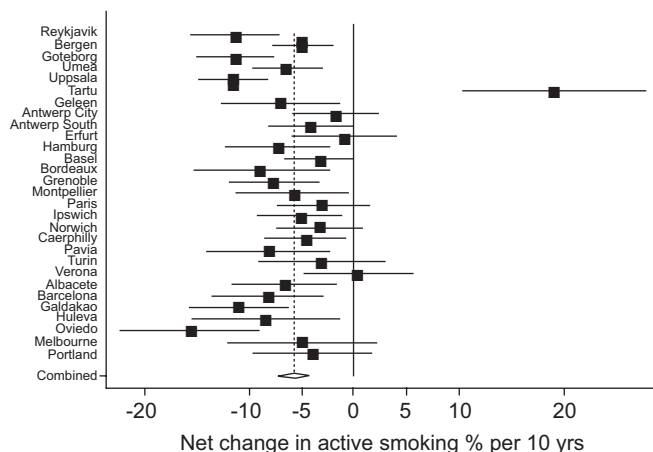
### RESULTS

The present study included 9,053 subjects (4,313 males and 4,740 females), whose mean age at ECRHS I was  $34.1 \pm 7.1$  (range 20–48) yrs. The participants in the ECRHS II were slightly older ( $34.1 \pm 7.1$  versus  $33.0 \pm 7.2$ ) and less often smokers (33.9 versus 41.3%) or manual workers (36.5 versus 41.9%;  $p < 0.0001$ ) than subjects that only participated in the ECRHS I. Among the nonsmokers in the ECRHS I, the participants in the ECRHS II were exposed less often to passive smoking than the nonparticipants (40.6 versus 43.5%;  $p = 0.006$ ).

### Change in prevalence of smoking

The overall prevalence of smoking had decreased by 5.9% (5.1–6.8) when expressed as absolute change (95% CI) per 10 yrs of follow-up (table 1). There was a significant heterogeneity between the centres ( $p < 0.0001$ ) with a significantly decreased prevalence in 18 of the centres and a significant increase in one centre (Tartu, Estonia; fig. 1). Since the current smokers in the ECRHS I were under-represented in the ECRHS II, an adjusted estimate of change in smoking was made assuming that all the nonparticipants' smoking habits were unchanged. With this adjustment the overall decrease in the prevalence of current smoking was 3.4% (2.8–3.9) per 10 yrs of follow-up.

Males had a significantly higher decline in the prevalence of current smoking than females and the decrease in the prevalence of smoking was significantly lower in the youngest age group than in the oldest age group (table 2). Differences in quit rates by sex and age were not significantly different between centres.



**FIGURE 1.** Net change in the prevalence of current smoking with 95% confidence interval (CI) in each centre. The area of each square is proportional to the reciprocal of the variance of the estimate for the centre. The diamond has the width of its 95% CI. - - - -: combined random effects estimate.

**TABLE 2** Prevalence of smoking in European Community Respiratory Health Survey I and change in smoking during the study period

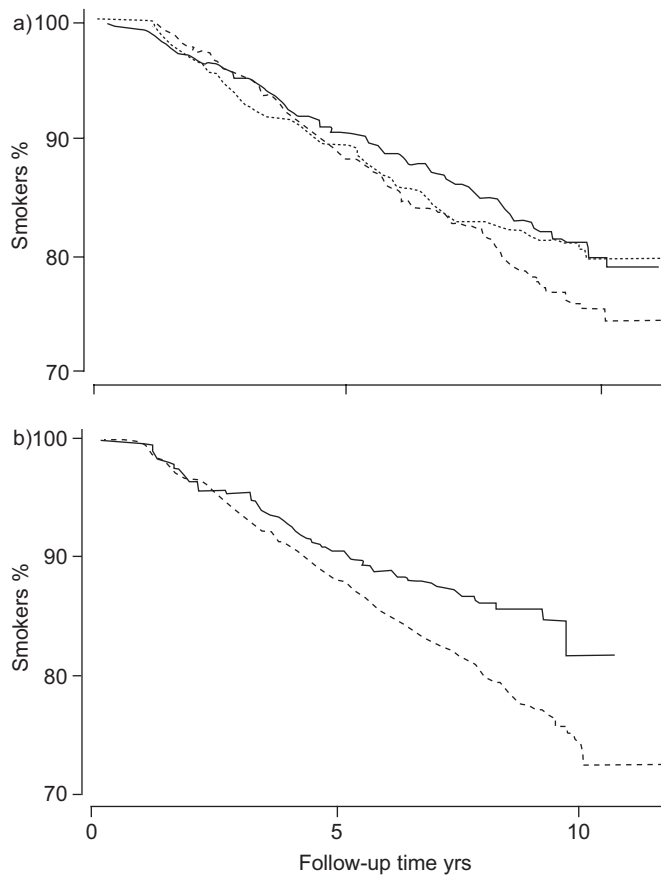
Age yrs <sup>#</sup>	Females <sup>†</sup>		Males	
	Prevalence	Net change -10 yr <sup>-1</sup>	Prevalence	Net change -10 yr <sup>-1</sup>
20-<28	26.6	-2.0 (-4.6-0.5)	35.6	-4.7 (-7.2- -2.1)
28-<34	31.9	-5.8 (-8.2- -3.3)	39.0	-7.5 (-10- -4.9)
34-<40	35.1	-4.1 (-6.4- -1.8)	37.2	-9.0 (-12- -6.2)
40-48	31.3	-6.0 (-8.0- -4.1)	35.9	-8.9 (-12- -6.3)
20-48	31.2	-4.5 (-5.7- -3.3)	36.9	-7.5 (-8.9- -6.2)

Data are presented as %, unless otherwise stated. <sup>#</sup>: age difference of  $p=0.002$ ; <sup>†</sup>: sex difference of  $p=0.001$ .

### Determinants for change in active smoking status

Among the 3,147 smokers in the ECRHS I, 822 (28.8%) had stopped smoking during the follow-up, while 129 (3.2%) of the 4,047 never-smokers in the ECRHS I were smokers in the ECRHS II. The chance of having stopped smoking was lower in the lowest socio-economic status group and in subjects with a lower educational level (fig. 2). The association between educational level remained significant after adjusting for exposure to other peoples smoking (table 3). Smokers that were living with other smokers or exposed to workplace smoking in the ECRHS II were less likely to have stopped smoking (fig. 3; table 3). The chance of quitting decreased with the quantity smoked in the first survey (table 3).

A significant sex interaction was found in the relationship between quitting and BMI ( $p=0.007$ ). Overweight females (BMI 25–30  $\text{kg}\cdot\text{m}^{-2}$ ) were less likely to have stopped smoking than females with a normal BMI (HRR (95% CI): 0.52 (0.35–0.78)), whereas no association was found between quitting and



**FIGURE 2.** Proportion of smokers that continued smoking during the study period in relation to a) socio-economic status and b) educational level. —: low; ---: high; - - - -: intermediate. In socio-economic status  $p=0.01$  and in educational level  $p=0.002$ .

being overweight in males (1.05 (0.80–1.36)). Females were significantly less likely than males to stop smoking if they were living with a smoker in both surveys (HRR (95% CI): 0.32 (0.21–0.50) versus 0.61 (0.43–0.87),  $p=0.03$ ). No between-country heterogeneity was found in the association between quitting and sex, BMI, household smoking or smoking quantity.

The risk of having started smoking in previous never-smokers decreased with increasing age (table 3). Subjects that were living with a smoker in both surveys had a higher risk of starting to smoke (table 3).

### Change in the prevalence of passive smoking

The overall exposure to passive smoking in subjects that were nonsmokers in the ECRHS I and II had declined by 18.4% (16.8–20.0) per 10-yr follow-up (table 1). There was a significant decrease in all but three centres, but there was still heterogeneity between the centres ( $p<0.0001$ ; fig. 4).

In the ECRHS I, the prevalence of passive smoking in nonsmokers at home was 17.9%, while 20.6% were exposed to passive smoking at work. During the follow-up the prevalence of passive smoking at home had declined by 8.7% (7.5–9.8) per 10 yrs while the prevalence of passive smoking at work decreased by 10.9% (9.5–12.3) per 10 yrs.

**TABLE 3** Determinants of change in smoking status during the study period

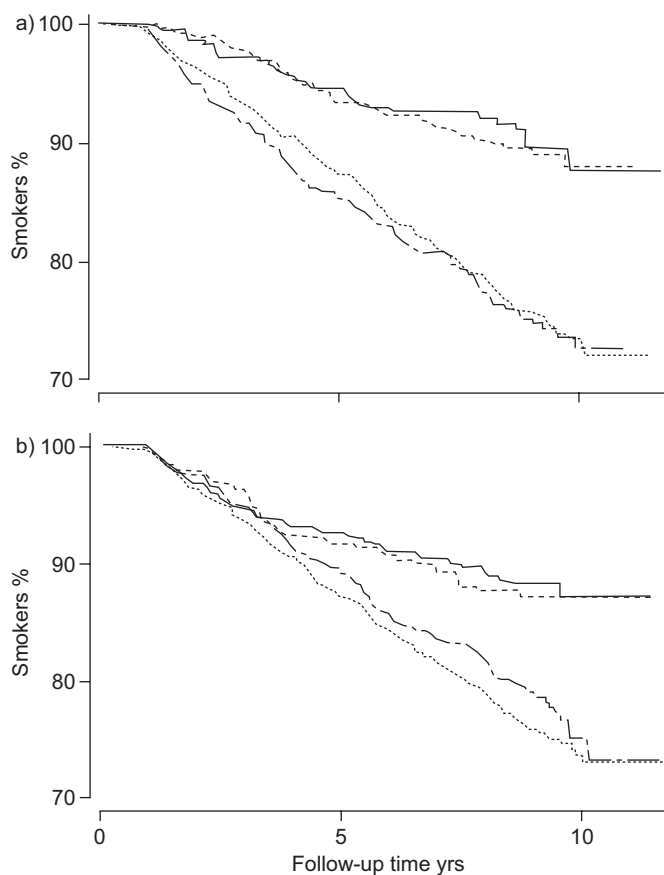
	Stopped smoking	Started smoking
<b>Females</b>	0.85 (0.72–1.01)	0.62 (0.32–1.21)
<b>Age in ECRHS I yrs</b>		
40–48	1	1
34–<40	0.99 (0.79–1.25)	5.08 (0.56–46.1)
28–<34	0.96 (0.76–1.21)	7.54 (0.91–62.2)
20–<28	0.77 (0.60–0.99)	22.2 (2.93–168)
<b>Not living with a smoker</b>	1	1
<b>Living with a smoker in ECRHS II</b>	0.43 (0.28–0.65)	3.06 (0.95–9.90)
<b>Living with a smoker in ECRHS I</b>	1.09 (0.90–1.33)	1.45 (0.52–4.06)
<b>Living with a smoker in both surveys</b>	0.45 (0.34–0.59)	4.78 (2.03–11.2)
<b>No smoking at workplace</b>	1	1
<b>Workplace smoking in ECRHS II</b>	0.68 (0.48–0.97)	1.32 (0.39–4.42)
<b>Workplace smoking in ECRHS I</b>	1.06 (0.86–1.30)	1.33 (0.55–3.22)
<b>Workplace smoking in both surveys</b>	0.69 (0.50–0.95)	1.59 (0.55–4.65)
<b>Professionals</b>	1	1
<b>Nonmanual</b>	0.90 (0.71–1.16)	
<b>Manual</b>	0.88 (0.71–1.09)	1.13 (0.40–3.22)
<b>Low educational level<sup>#</sup></b>	0.73 (0.54–0.98)	1.02 (0.38–2.78)
<b>Smoking in ECRHS I</b>		
≤5 cigarettes·week <sup>-1</sup>	1	
>5–≤10 cigarettes·week <sup>-1</sup>	0.81 (0.64–1.03)	
>10–≤20 cigarettes·week <sup>-1</sup>	0.66 (0.53–0.81)	
>20 cigarettes·week <sup>-1</sup>	0.58 (0.44–0.78)	

Data are presented as adjusted hazard ratio (95% confidence interval). The hazard risk ratios were adjusted for centre and the variables in the table. ECRHS: European Community Respiratory Health Survey. <sup>#</sup>: entered separately in the table, replacing occupational status.

### Determinants for change in exposure status to passive smoking

Among the 2,213 nonsmokers who reported being exposed to passive smoking in the first survey, 55.8% reported being no longer exposed in the ECRHS II. However, 11.4% of the 3,226 nonsmokers that were not exposed to passive smoking in the ECRHS I reported being exposed to passive smoking in the ECRHS II.

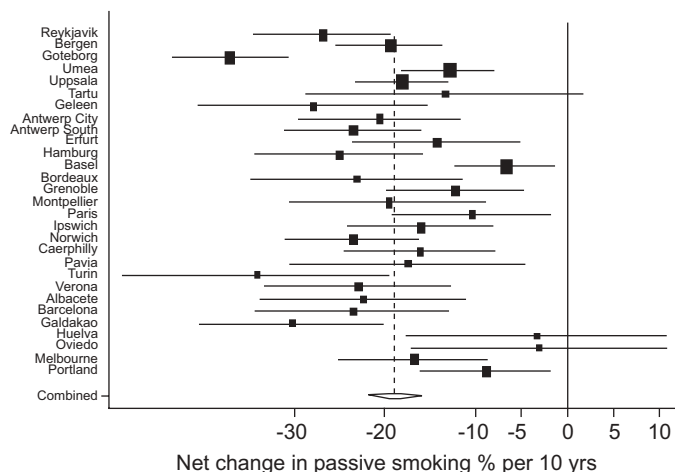
Subjects in the youngest age group were more likely to have both become and ceased being exposed to passive smoking during the study period, while manual workers and subjects that stopped full-time education before the age of 16 yrs were less likely to have ceased being exposed and more likely to have become exposed during the follow-up (table 4). No between-country heterogeneity was found in relation to change in exposure status and age or socio-economic status. Analyses of change in passive smoking at home or at work showed a similar pattern to the analyses above.



**FIGURE 3.** Proportion of smokers that continued smoking during the study period in relation to a) living with a smoker and b) workplace smoking. The subjects were divided into four groups: 1) no reported exposure in any of the surveys (---); 2) reported exposure in the first but not the second survey (European Community Respiratory Health Survey (ECRHS) I only; - - -); 3) reported exposure in the second but not the first survey (ECRHS II only; - · - ·); and 4) reported exposure in both surveys (—).

### DISCUSSION

In this international cohort, a relatively modest decline in the prevalence of current smoking was found, while the exposure to passive smoking in nonsmokers decreased quite dramatically. The significant decline in the prevalence of current smoking is in accordance with what is seen in repeated national surveys [10–12]. The decline was not homogeneous between the centres, but no specific geographical pattern was found except quite a large increase in the prevalence of current smoking in Tartu in Estonia. This increase may be related to the large socio-economic changes in this society after the disintegration of the Soviet Union and the public marketing activities of the Western tobacco industry into these countries [23]. The large decrease in exposure to passive smoking in most of the centres is probably an effect of the increasing awareness of the negative effects of passive smoking among the general public in combination with legislative actions [7–9]. The present results are also in accordance with JARVIS *et al.* [13], who found a large decrease in exposure to passive smoking in English children during the 1990s. The magnitude of the decrease in passive smoking varied between different centres, although no distinct geographical pattern was found. Despite



**FIGURE 4.** Net change in the prevalence of reported exposure to passive smoking in nonsmokers with 95% confidence interval (CI) in each centre. The area of each square is proportional to the reciprocal of the variance of the estimate for the centre. The diamond has the width of its 95% CI. - - -: combined random effects estimate.

the decrease, there still remain large differences in the prevalence of passive smoking in the different centres and, to some extent, this may be related to variations in legislation concerning smoke-free areas in Europe [9].

In the present study, the authors found that both active and passive smoking is increasingly becoming a socio-economic issue, with a lower quitting rate and a higher risk of becoming exposed to passive smoking in more deprived groups. The current data are in accordance with previous data showing that the social gradient in cigarette smoking has changed, with smoking becoming less common among persons with higher socio-economic status and relatively more frequent in less affluent social groups [24, 25]. A lower success rate in participants from lower socio-economic groups has also been found in smoking cessation studies [14, 15].

The present results underscore that apart from being a health hazard in itself, passive smoking also has a negative influence on smoking behaviour. Subjects living or working with smokers were less likely to have stopped smoking and the risk of starting to smoke was higher among subjects that were living with smokers. A higher quit rate in subjects with nonsmoking spouses has been reported in other studies [15, 16]. The effect of working with other smokers is less studied, but the current results support the findings of FICHTENBERG and GLANTZ [26] who reported that smoke-free workplaces reduce the prevalence of smoking. As in previous studies, the present authors found that smokers with a higher level of nicotine dependency or higher tobacco consumption were less likely to quit smoking [15, 17].

The decline in the prevalence of current smoking was lower in the youngest age group than among the older participants. The age difference was caused by a higher number of new starters among the younger participants. The decline in males was higher than in females. This trend has already been reported in many Western European countries [27]. The reason for this sex difference is unclear. It is well known that quitting smoking is

**TABLE 4** Determinants of change in passive smoking status during the study period

	Stopped being exposed	Started being exposed
<b>Females</b>	1.13 (0.93–1.36)	1.04 (0.82–1.32)
<b>Age in ECRHS I yrs</b>		
40–48	1	1
34–<40	1.30 (1.00–1.67)	1.22 (0.89–1.68)
28–<34	1.45 (1.12–1.89)	1.48 (1.08–2.04)
20–<28	1.66 (1.28–2.15)	1.59 (1.13–2.32)
<b>Professionals</b>	1	1
<b>Nonmanual</b>	0.73 (0.55–0.95)	1.39 (0.98–1.98)
<b>Manual</b>	0.48 (0.37–0.61)	2.21 (1.61–3.03)
<b>Low educational level<sup>#</sup></b>	0.64 (0.48–0.87)	1.55 (1.01–2.38)

Data are presented as adjusted odds ratio (95% confidence interval). The odds ratio was adjusted for centre and the variables in the table. ECRHS: European Community Respiratory Health Survey. #: entered separately in the table, replacing occupational status.

related to a moderate weight gain [20] and fear of increasing weight has been presented as an important obstacle for quitting [28]. The current results indicate that this obstacle may be present in females more than in males, since overweight females were significantly less likely to have quit smoking than females with a normal weight, whereas no such association was found in males.

A drawback of the present study is that there are no objective measurements of active or passive smoking. Results from previous studies indicate that self-reported data on these issues are fairly reliable [29, 30]. The current authors also lack information regarding smoking cessation interventions, but as the participants were from general population samples, the numbers that have participated in such an intervention is probably small. In the present study, a subject was defined as an ex-smoker if they had not smoked within the last month. Increasing the required abstinence period to 1 yr decreased the decline in smoking to 4.9% (4.0–5.8) per 10 yrs, but did not change any of the results of the other analyses.

Loss to follow-up is a problem in any longitudinal study and the present response rates are comparable to several recent population studies [31, 32]. Smokers were over-represented among those not responding, which may result in an overestimation of the actual decline in current smoking. To some extent this was also true for passive smoking, although here the difference between participants and non-participants was smaller. It is also possible that loss of follow-up may have influenced the analyses of factors related to change in smoking habits. There was, however, no significance between country heterogeneity when analysing factors related to change in active and passive smoking, indicating that the effect of determinants for change in smoking status did not differ between countries with a higher or lower response rate. Re-analysing the data and only including centres with a response rate of  $\geq 70\%$  also gave almost identical results to the analyses with the whole data set (data not shown).

In conclusion, the prevalence of active and passive smoking has decreased in this international cohort. The quitting rate was lower and the risk of exposure to passive smoking higher among subjects with lower socio-economic status and educational level. Exposure to other people's smoking at decreased quitting rates increased the risk of starting to smoke. This suggests that the current trends in active and passive smoking are widening social inequalities in health and that decreasing passive smoking may be an effective way of reducing active smoking in all social groups.

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