Respiratory Medicine 132 (2017) 164–169

Contents lists available at ScienceDirect

Respiratory Medicine

journal homepage: www.elsevier.com/locate/rmed

Predictors of smoking cessation: A longitudinal study in a large cohort of smokers

Mathias Holm[a,*], Linus Schiöler[a], Eva Andersson[a], Bertil Forsberg[b], Thorarinn Gislason[c,d], Christer Janson[e], Rain Jogi[f], Vivi Schlünssen[g,h], Cecilie Svanes[i,j], Kjell Torén[a,k]

[a] Department of Occupational and Environmental Medicine, Sahlgrenska University Hospital, Gothenburg, Sweden
[b] Department of Public Health and Clinical Medicine, Division of Occupational and Environmental Medicine, Umea University, Umea, Sweden
[c] Medical Faculty, University of Iceland, Reykjavik, Iceland
[d] Department of Respiratory Medicine and Sleep, Landspitali University Hospital, Reykjavik, Iceland
[e] Department of Medical Sciences: Respiratory Medicine and Allergology, Uppsala University, Uppsala, Sweden
[f] Lung Clinic, Tartu University Hospital, Tartu, Estonia
[g] Department of Public Health, Section for Environment, Occupation and Health, Aarhus University, Aarhus, Denmark
[h] National Research Centre for the Working Environment, Copenhagen, Denmark
[i] Department of Occupational Medicine, Haukeland University Hospital, Bergen, Norway
[j] Centre for International Health, University of Bergen, Bergen, Norway
[k] Section of Occupational and Environmental Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

ARTICLE INFO

Keywords:
Smoking
Cessation
Longitudinal
Predictors

ABSTRACT

Background: There are few studies on predictors of smoking cessation in general populations. We studied the smoking cessation rate in relation to several potential predictors, with special focus on respiratory and cardiovascular disease.

Methods: Smokers (n = 4636) from seven centres in Northern Europe, born between 1945 and 1973, who answered a questionnaire in 1999–2001 (the RHINE study) were followed up with a new questionnaire in 2010–2012. Altogether 2564 answered the questionnaire and provided complete data on smoking. Cox regression analyses were performed to calculate hazard ratios (HRs).

Results: A total of 999 subjects (39%) stopped smoking during the study period. The smoking cessation rate was 44.9/1000 person-years. Smoking cessation was more common with increasing age, higher education and fewer years of smoking. Asthma, wheeze, hay fever, chronic bronchitis, diabetes and hypertension did not significantly predict smoking cessation, but smokers hospitalized for ischaemic heart disease during the study period were more prone to stopping smoking (HR 3.75 [2.62–5.37]).

Conclusions: Successful smoking cessation is common in middle-aged smokers, and is associated with few smoking years and higher education. A diagnosis of respiratory disease does not appear to motivate people to quit smoking, nor do known cardiovascular risk factors; however, an acute episode of ischaemic heart disease encouraged smoking cessation in our study population.

1. Introduction

Tobacco smoking is a leading risk factor for global burden of disease [1], and on average smokers can expect a considerably shorter life compared with non-smokers. However, smoking cessation will gradually reverse the health risks associated with smoking, especially in younger individuals [2].

The global smoking prevalence has decreased during the last few decades [3], and in many Northern Europe countries the decline has been noticeable [3–5]. Nevertheless, smoking still has an immense impact on general health in these countries.

Smoking cessation interventions importantly contribute to the struggle against the smoking epidemic. Many smokers make several attempts to quit, but commonly fail to stay abstinent [6]. Therefore, it is important to find factors that are significant in predicting success of smoking cessation, as can be identified in prospective longitudinal studies.

Most studies of predictors of smoking cessation have been performed as intervention trials in smokers seeking help for their addiction, and not in general populations. The smoking cessation issue is

* Corresponding author. Department of Occupational and Environmental Medicine, Sahlgrenska University Hospital, Box 414, SE 405 30 Gothenburg, Sweden.
E-mail address: mathias.holm@amm.gu.se (M. Holm).

http://dx.doi.org/10.1016/j.rmed.2017.10.013
Received 24 April 2017; Received in revised form 13 October 2017; Accepted 16 October 2017
Available online 19 October 2017

complex and depends on individual factors as well as factors that are prevalent in the society where the smoker lives. Smoking cessation studies in the general population are important as they give a total overview of quitters, both those that have been seeking professional help to quit and those who have managed to stop on their own. A relatively recent systematic review of prospective, non-interventional studies on predictors of smoking cessation in adult general populations found large methodological heterogeneity between the eight included studies [7]. The only consistent finding was a negative association between success of quit attempts and signs of dependency to nicotine. Motivational factors and a past quit attempt were predictive for making quit attempts, but not for their success. In separate prospective studies not included in the systematic review, older age, male gender, higher socioeconomic status, lower alcohol intake, impaired lung function, a strong desire to quit smoking, lower nicotine dependence, and no other smokers in the household have been reported to predict smoking cessation in the general population [8–15]. Apart from impaired lung function, it seems reasonable to assume that individuals with known respiratory disease or cardiovascular risk factors/disease would be more concerned about their health and would therefore be more eager to stop smoking. The few available data are not consistent [9–12,15,16], but they do seem to concur that having an acute cardiovascular event encourages smoking cessation [9,16]. In addition, most previous incidence studies have not used incidence rates based on person-years, which means that the distribution of smoking cessation during the study period has not been investigated and that the actual time "at risk" for smoking cessation has not been taken into account.

These factors, taken together, suggest a need for prospective, general population studies in smokers to identify predictors for successful smoking cessation. Determinants of smoking cessation have been studied in the 1999–2001 follow-up of the European Community Respiratory Health Survey (ECRHS) II [13]. However, in that study the predictive value of respiratory disease, heart disease or cardiovascular risk factors for smoking cessation was not investigated. Two follow-ups, in 1999–2001 and in 2010–2012, have been conducted in ECRHS participants from Estonia and the Nordic countries Denmark, Iceland, Norway and Sweden in a study called the Respiratory Health in Northern Europe (RHINE) study. The aim of the current study was to investigate the smoking cessation rate among smokers in the RHINE general population sample between these two follow-ups in relation to potential predictors identified in the literature, with special focus on respiratory and cardiovascular disease.

2. Materials and methods

The RHINE study is a large prospective, questionnaire-based cohort study, with participants from Bergen (Norway), Umeå, Uppsala and Gothenburg (Sweden), Reykjavik (Iceland), Aarhus (Denmark) and Tartu (Estonia) born between 1945 and 1973. The study was initiated in 1989–1994, and follow-ups were conducted in 1999–2001 and 2010–2012 [17–19]. In the first survey, smoking was not asked for in all study centres. However, the questionnaire in 1999–2001 comprised items about smoking history, respiratory diseases and symptoms, allergy, weight, height, hypertension, diabetes and heart disease. Among the 15,839 individuals providing complete data on smoking, 4636 reported that they were current smokers, by answering "yes" to the question "Are you a smoker (answer in the affirmative even if you smoke just a single cigarette, cigar or pipe per week)?"

A new questionnaire was distributed in 2010–2012 and 3114 (67%) of those who had been smoking in 1999–2001 answered the questionnaire. Those who did not answer whether they were a smoker or not (n = 265), who failed to give the year of smoking cessation (n = 132), or who answered that they had quit before the study period (n = 153) were excluded. The remaining 2564 were included in the study. Local ethics committees approved the study and all participants consented to participate. Smoking cessation at follow-up, i.e. in the 2010–2012 questionnaire, was defined as a negative answer to the above quoted question on smoking. Year of smoking cessation was derived from the participants' answers to "If you are an ex-smoker, how old were you when you stopped smoking?"

The 1999–2001 questionnaire included a question about years of smoking as well as a question about number of cigarettes, cigars or packages of pipe tobacco smoked every week. One cigar was assumed to be equivalent to five cigarettes and pipe tobacco was converted to equivalence by weight [20]. Presence of hypertension, or heart disease, diabetes, wheeze, asthma, and hay fever at baseline (1999–2001) were inferred from positive answers to "Do you have hypertension?", "Do you have heart disease?", "Has any physician told you that you have diabetes?", "Have you had whistling or wheezing in your chest at any time during the past 12 months?", "Do you have or have you ever had asthma?" and "Do you have hay fever or any other allergic rhinitis?"

Chronic bronchitis was defined as chronic productive cough at least 3 months a year for 2 consecutive years [21,22]. The diagnosis was derived from a positive answer to all of the following questions: "Do you usually cough up phlegm from your chest, or do you have phlegm in your chest that is difficult to bring up?", "Do you bring up phlegm like this on most days for at least 3 months each year?" and "Have you had such periods during at least 2 consecutive years?" [23]. Body mass index (BMI) was calculated from reported weight and height in the 1999–2001 questionnaire using the formula BMI = mass (kg)/(height (m))^2. Educational level was derived from the answer to "What is your highest level of education?" (less than high school, high school or similar, and university or similar). Parental smoking was derived from the answer to the question "Did your mother/father ever smoke regularly when you were a child?" in the 2010–2012 questionnaire.

In the 2010–2012 questionnaire, the same questions about asthma, chronic bronchitis, and diabetes were asked as in the 1999–2001 questionnaire. In addition, the following questions were asked: "Have you ever had hypertension diagnosed by a doctor?", "Have you ever been treated in hospital for myocardial infarction or angina pectoris?" and "Have you ever had a stroke?" Subjects answering "yes" to any of the questions were also asked to report the year of diagnosis/the event. These questions were used to investigate whether the smoking cessation rate was higher in those relatively recently diagnosed with a disease.

The SAS statistical package, version 9.4 (SAS Institute, Cary, NC, USA), was used for most of the analyses. For the incidence rate analyses, STATA (College Station, TX, USA) was used. The smoking cessation rate (number of new smoking cessation cases/1000 person-years) with 95% confidence interval (CI) was calculated for the study period (from 1999–2001 to 2010–2012). Subjects ceased to contribute person-years after smoking cessation. Cox regression analyses (PROC PHREG) were used to calculate hazard ratios (HRs). Separate analyses were performed for men and women. The effect of developing asthma, chronic bronchitis, diabetes, hypertension, stroke, or angina pectoris/myocardial infarction during the study period was analysed by separate Cox models including a time dependent variable for the diagnosis. Mutual adjustments for all potential risk factors were made.

3. Results

The characteristics of the study participants are shown in Table 1. Among the 2564 smokers, 999 (cumulative incidence 39%) reported that they had stopped smoking during the study period (from 1999–2001 until 2010–2012) and stayed abstinent. Reported smoking cessation time points were relatively evenly distributed over the study period and the smoking cessation rate for each year during the study period is shown in Fig. 1. The crude smoking cessation rate over the whole study period was 44.9/1000 person-years and was lower in relation to chronic bronchitis, presence of wheeze, > 20 years of smoking, smoking > 140 cigarettes per week and low education in the univariate analyses (Table 2). Age, gender, BMI ≥ 30, diabetes, hypertension, heart disease, hay fever, asthma, and parental smoking

Table 1
Demographic characteristics of the study population at baseline in 1999–2001, with educational data and parental smoking during childhood reported in 2010–2012.

	All (n = 2564)	Ex-smokers at follow-up (n = 999)	Smokers at follow-up (n = 1565)
Age, years (SD)	40.7 (7.0)	40.4 (7.1)	40.9 (6.9)
Female gender	53.5%	55.5%	52.2%
BMI ≥ 30	8.6%	8.4%	8.8%
Diabetes	1.7%	1.4%	1.9%
Hypertension	6.9%	7.3%	6.7%
Heart disease	2.7%	2.5%	2.7%
Chronic bronchitis	9.8%	8.1%	10.9%
Hay fever	19.9%	20.0%	19.9%
Wheeze	34.0%	30.2%	36.4%
Asthma	8.7%	8.5%	8.9%
Years of smoking (SD)	21.3 (8.3)	19.9 (8.6)	22.1 (8.1)
Cigarettes per week (SD)	90.2 (82.4)	83.0 (78.8)	94.7 (84.4)
Parental smoking	74.8%	74.0%	75.3%
Less than high school	16.9%	13.3%	19.3%
High school or similar	49.0%	46.7%	50.5%
University or similar	34.0%	40.0%	30.2%

BMI = body mass index; SD = standard deviation.

during childhood did not seem to significantly affect the smoking cessation rate (Table 2).

Results from Cox regression models are presented in Table 3. Higher age, higher education and few smoking years were factors that predicted smoking cessation. There was some heterogeneity associated with centre, with participants from Tartu, Estonia, being less likely to have stopped smoking.

Stratification for gender revealed that higher age predicted smoking cessation only in women (Table 3). In addition, higher BMI seemed to predict smoking cessation in men but not in women. Also, men with chronic bronchitis at baseline were less likely to quit smoking during the study period compared with those without chronic bronchitis (Table 3).

Those developing asthma (n = 45), chronic bronchitis (n = 78), diabetes (n = 65) or hypertension (n = 307) during the study period while still smoking were not more prone to quit smoking (Table 4). The same was true for smoking subjects having a stroke (n = 28), but smokers hospitalized for myocardial infarction or angina pectoris (n = 72) during the study period were more likely to stop smoking (Table 4). Twenty-nine per cent of those who quit smoking after their asthma diagnosis did so in the year they were diagnosed. Corresponding figures for chronic bronchitis, diabetes, hypertension, stroke, and myocardial infarction or angina pectoris were 23%, 10%, 43%, 86%, and 71%, respectively.

4. Discussion

In the current longitudinal study of 2564 middle-aged smokers, nearly 40% quit smoking during an approximately 10-year study period. There was an association between fewer smoking years and a high level of education, and smoking cessation. In addition, men with higher BMI and older women were more likely to quit smoking. Neither presence of airway disease nor the known cardiovascular risk factors hypertension and diabetes seemed to predict smoking cessation. This was true also for those who developed airway disease, diabetes or hypertension during the study period. Known heart disease at baseline did not predict smoking cessation, but an acute episode of ischaemic heart disease during the study period was associated with a fourfold increased chance of smoking cessation. In those with an episode of stroke, no such association was seen. The majority of those who quit smoking among individuals with an acute episode of ischaemic heart disease or stroke did so in close connection with the episode.

We focused on successful smoking cessation. Individuals who declared that they did not smoke at follow-up were requested to give the year of smoking cessation so that the smoking cessation rate could be calculated. Smoking cessation time points were reasonably evenly distributed over the study period, which means that many of the ex-smokers in our study had a long smoking-free period. Therefore, the predictors under study can be regarded as predictors for successful smoking cessation. Our results are similar to those from a study in a middle-aged Japanese population where 25% of smokers had quit during a 10-year study period [14]. However, in a nationally representative sample of US adults, almost 40% tried to quit during a 3-year study period, but fewer than 5% of those who tried succeeded [24]. The divergent results of the studies reflect the complexity of smoking behaviour that can be influenced by a wide variety of factors

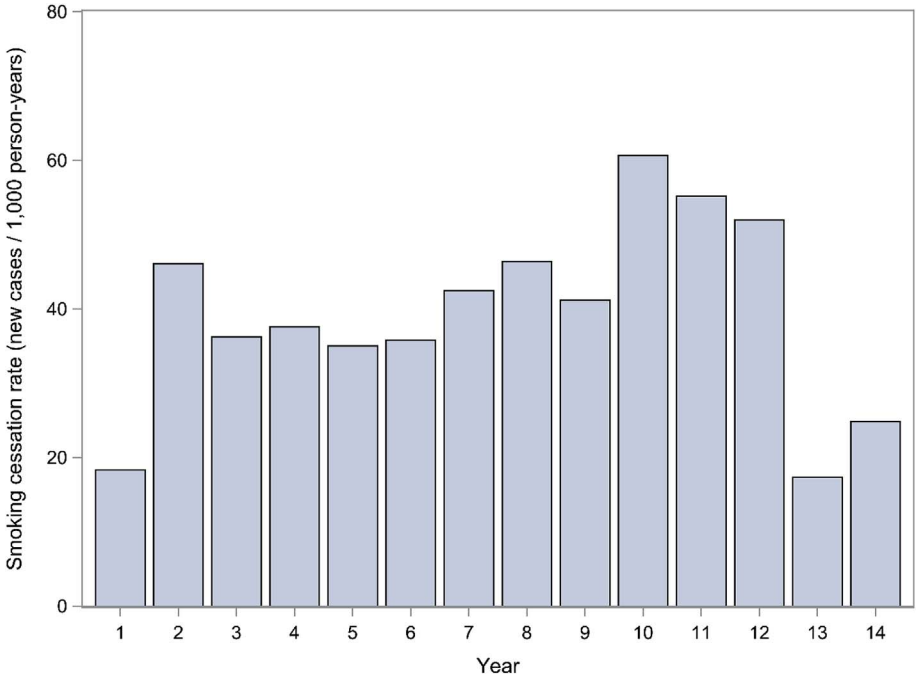

Fig. 1. Smoking cessation rate (number of new smoking cessation cases/1000 person-years) each year during the study period.

Table 2
Smoking cessation rates (cases/1000 person-years) and crude relative risks for smoking cessation in relation to age, gender, body mass index (BMI), diabetes, hypertension, heart disease, chronic bronchitis, hay fever, wheeze, asthma, and smoking history at baseline in 1999–2001, and to educational level in 2010–2012.

	Smoking cessation rate (95% confidence interval)	Smoking cessation rate ratio (95% confidence interval)
All n = 2564	44.9 (42.1–47.7)	
> 40 years old		
Yes	42.8 (39.3–46.6)	0.90 (0.79–1.02)
No	47.5 (43.3–52.0)	
Woman		
Yes	47.0 (43.2–51.1)	1.11 (0.98–1.26)
No	42.4 (38.6–46.6)	
BMI ≥ 30		
Yes	42.5 (33.9–52.7)	0.94 (0.74–1.17)
No	45.4 (42.5–48.5)	
Diabetes		
Yes	32.1 (17.6–53.9)	0.71 (0.39–1.20)
No	45.1 (42.3–48.0)	
Hypertension		
Yes	45.6 (35.8–57.4)	1.02 (0.79–1.29)
No	44.8 (42.0–47.8)	
Heart disease		
Yes	38.1 (24.6–56.2)	0.82 (0.52–1.21)
No	45.1 (42.3–48.0)	
Chronic bronchitis		
Yes	35.2 (28.0–43.8)	0.77 (0.60–0.96)
No	46.0 (43.0–49.0)	
Hay fever		
Yes	45.6 (39.5–52.3)	0.98 (0.84–1.15)
No	44.7 (41.6–47.9)	
Wheeze		
Yes	38.6 (34.4–43.2)	0.80 (0.70–0.92)
No	48.2 (44.7–51.9)	
Asthma		
Yes	44.4 (35.5–54.9)	0.99 (0.78–1.24)
No	44.9 (42.0–47.9)	
> 20 years of smoking		
Yes	39.0 (35.8–42.4)	0.71 (0.63–0.81)
No	54.8 (49.8–60.2)	
> 140 cigarettes per week		
Yes	36.5 (31.3–42.4)	0.78 (0.66–0.92)
No	46.8 (43.4–50.3)	
Parental smoking		
Yes	44.4 (41.2–47.7)	0.96 (0.83–1.11)
No	46.3 (40.8–52.3)	
Educational level		
University or similar	56.2 (50.8–62.0)	1.70 (1.39–2.08)
High school or similar	41.8 (38.1–45.8)	1.26 (1.04–1.55)
Less than high school	33.1 (27.7–39.2)	

[16].

Data for the Nordic countries Denmark, Iceland, Norway and Sweden show that the smoking prevalence has decreased substantially during the last few decades [3–5]. In part, this is probably an effect of an increased smoking cessation rate and is therefore in line with the results of the current study. By contrast, in Estonia the smoking prevalence seems to have been fairly constant since 1980 [3], which may be reflected in the lower smoking cessation rate among the participants from Tartu.

In the current study, chronic bronchitis did not seem to predict smoking cessation. On the contrary, men with chronic bronchitis at baseline were less likely to quit smoking. There are other prospective studies supporting that chronic bronchitis does not predict smoking cessation [10,12], and we found the same result for asthma, wheeze, and hay fever. In addition, asthma and chronic bronchitis, which started during the study period, were not associated with smoking cessation. These results are in line with results from a recent study by Tsai et al., which showed that “respiratory disease” did not predict smoking cessation [15]. It therefore appears that respiratory symptoms and known airway disease do not affect the chance of successful smoking cessation, which is somewhat surprising since many ex-smokers report that health concerns were a major reason why they quit smoking [25].

Another intriguing finding in our study was that smokers at baseline reporting risk factors for cardiovascular disease such as hypertension and diabetes, and even smokers with heart disease did not seem to have an increased rate of successful smoking cessation. However, subjects reporting an acute episode of ischaemic heart disease during the study period were more prone to quit smoking. In these latter subjects, and in individuals with stroke, the vast majority chose to quit smoking in the same year as the event occurred, and very few stopped at a later time point. This pattern was not seen in those diagnosed with hypertension, diabetes, or respiratory disease, during the study period, and they did not show a significantly higher smoking cessation rate. Probably the majority of these individuals were diagnosed in connection with a health care visit. In that case, this visit probably did not affect their smoking behaviour, which is a poor reflection of the health care system. There are few other prospective studies in general populations on this question, but a study in middle-aged Taiwanese male smokers showed similar results to ours [15]. The authors of the Taiwanese study found that a first emergency visit or development of coronary heart disease, but not a new diagnosis of hypertension or diabetes, predict smoking cessation. In a Danish longitudinal study, reported angina pectoris did not predict smoking cessation [10]; by contrast, data from the Framingham Heart Study show that development of heart disease predicts smoking cessation within the following 2 years [9].

In the current study, higher BMI was predictive of smoking cessation, but only in men. Overweight has been shown to predict smoking cessation in women and it has been suggested that subjects with higher BMI are less concerned about weight gain associated with quit attempts [11,12]. On the other hand, data from the ECRHS II indicate that overweight women are less likely to quit smoking [13].

High social status and education have been shown to predict smoking cessation [10,13], but there are contradictory data [7,15]. In the current study, we found a strong association between educational level and smoking cessation, based on reported educational level at follow-up.

In our study, higher age was a significant but fairly weak predictor for smoking cessation, which is in agreement with several other studies [8–10,12,15]. However, in a recent systematic review, age did not seem to consistently predict quit attempt success [7]. In most cases, smoking starts early in life and it may be argued that older smokers have smoked for a longer time and are, therefore, more addicted. It has been convincingly shown that a lower level of nicotine dependence predicts smoking cessation [7–12,15] and in our study we found that those with few smoking years were more prone to quit. In fact, the effect of age was revealed after we had made adjustments for number of smoking years and number of cigarettes smoked per week.

In a general review, it has been claimed that women compared with men are less likely to succeed in quitting smoking [26]. However, no gender differences were found in the systematic review by Vangeli et al. [7], which is in agreement with our study. A recent review found large variations in sex/gender differences in smoking cessation between prospective observational studies. The authors suggested that this could be attributed to bio-psycho-social variation in samples over time and location [27].

The present study has several strengths but it also has limitations. When using self-reported data, recall bias is a threat to the validity of a study. However, the prospective design of the major part of this study reduces this potential hazard. In observational studies there is also a possible risk of misclassification, and we did not validate the self-reported smoking status with any biochemical marker. The incidence rate of smoking cessation could be over-estimated as many individuals do not want to define themselves as smokers. However, most participants who reported that they had stopped smoking described a long period of

Table 3
Adjusted hazard ratios (with 95% confidence intervals) of smoking cessation in relation to age, sex, body mass index (BMI), diabetes, hypertension, heart disease, chronic bronchitis, hay fever, wheeze, asthma, smoking history, educational level, and centre, based on Cox regression analysis. One Cox regression model per column.

	All	Men	Women
Age	1.02 (1.00–1.03)	1.01 (0.99–1.03)	1.02(1.00–1.04)
Sex	1.07 (0.93–1.23)		
BMI	1.02 (1.00–1.03)	1.03 (1.00–1.06)	1.00 (0.98–1.03)
Diabetes	0.63 (0.34–1.18)	0.87 (0.41–1.86)	0.39 (0.13–1.23)
Hypertension	1.09 (0.84–1.43)	1.20 (0.84–1.72)	0.95 (0.61–1.47)
Heart disease	1.04 (0.66–1.63)	1.20 (0.69–2.10)	0.74 (0.34–1.62)
Chronic bronchitis	0.87 (0.67–1.13)	0.62 (0.41–0.92)	1.16 (0.83–1.63)
Hay fever	1.01 (0.85–1.20)	1.17 (0.90–1.52)	0.94 (0.75–1.18)
Wheeze	0.87 (0.74–1.02)	0.82 (0.64–1.03)	0.91 (0.74–1.13)
Asthma	1.07 (0.83–1.38)	1.12 (0.74–1.70)	1.04 (0.75–1.44)
Years of smoking	0.97 (0.96–0.98)	0.98 (0.96–0.99)	0.96 (0.95–0.98)
Packs of cigarettes per week	0.99 (0.97–1.01)	0.99 (0.96–1.02)	0.99 (0.96–1.01)
Parental smoking	0.94 (0.81–1.11)	0.98 (0.77–1.24)	0.92 (0.74–1.13)
High school or similar vs less than high school	1.24 (0.99–1.56)	1.40 (1.00–1.96)	1.12 (0.82–1.53)
University or similar vs less than high school	1.59 (1.26–2.01)	1.75 (1.23–2.50)	1.46 (1.07–2.00)
Centre (vs Bergen)			
Aarhus	1.02 (0.83–1.26)	1.09 (0.81–1.46)	0.96 (0.72–1.29)
Gothenburg	0.95 (0.75–1.21)	0.97 (0.66–1.41)	0.94 (0.69–1.29)
Reykjavik	0.86 (0.68–1.08)	0.94 (0.67–1.31)	0.80 (0.57–1.11)
Tartu	0.53 (0.40–0.71)	0.47 (0.31–0.73)	0.58 (0.39–0.88)
Umea	0.80 (0.62–1.04)	0.67 (0.42–1.06)	0.88 (0.64–1.23)
Uppsala	0.83 (0.64–1.08)	0.90 (0.61–1.31)	0.80 (0.56–1.13)

Table 4
Adjusted hazard ratios (with 95% confidence intervals) of smoking cessation in relation to diagnosis of asthma, chronic bronchitis, diabetes, hypertension, and stroke, and hospitalization for myocardial infarction or angina pectoris during the study period, based on Cox regression analysis. One Cox regression model per row.

	All
Asthma (n = 45)	1.38 (0.77–2.46)
Chronic bronchitis (n = 78)	0.80 (0.45–1.43)
Diabetes (n = 65)	0.71 (0.36–1.40)
Hypertension (n = 307)	1.26 (0.97–1.65)
Stroke (n = 28)	1.28 (0.60–2.70)
Hospitalization for angina pectoris or myocardial infarction (n = 72)	3.75 (2.62–5.37)

abstinence, which probably decreased the risk of "false" smoking cessation, and data from reviews and separate studies not included in the reviews indicate that self-reports of smoking are fairly accurate [28–34]. In our study, individuals who reported that they had quit smoking, but did not give the year of smoking cessation, or who answered that they had quit before the study period were excluded. This will, of course, have resulted in a somewhat lower smoking cessation rate than if a correct year had been given by all participants.

A long period of follow-up, the relatively large sample size, and a fairly high response rate are all strengths of this study. Even though little is known about selection bias at baseline, predictors of long-term participation have been thoroughly investigated in the RHINE cohort [19]. In the cohort, female sex and increasing age were both predictors for long-term participation; also, respiratory symptoms, except rhinitis, were somewhat underestimated among long-term participants [19]. However, exposure-outcome associations seemed largely unaffected by loss to follow-up [19]. Taken together, we consider the results of the current study to be generalizable.

5. Conclusions

It is encouraging that a large proportion of middle-aged smokers seemed to be able to successfully quit smoking. We saw an association between few smoking years and smoking cessation, and also between higher education and smoking cessation. Higher BMI was predictive of smoking cessation in men but not in women. In addition, an acute ischaemic heart disease event seemed to be a strong predictor for smoking cessation. On the other hand, respiratory disease or known cardiovascular risk factors did not appear to discourage individuals from smoking, even those recently diagnosed. In the meeting with smoking patients, health care staff need to be more active and engaged in assisting those with respiratory disease and cardiovascular risk factors to quit smoking.

Acknowledgements

This study was supported financially by the Norwegian Research Council (grant No. 214123), the Bergen Medical Research Foundation, the Western Norwegian Regional Health Authorities (grant No. 911 892 and 911 631), the Norwegian Labour Inspection, the Norwegian Asthma and Allergy Association, the Faculty of Health at Aarhus University (project No. 240008), the Wood Dust Foundation (project No. 444508795), the Danish Lung Association, the Swedish Heart and Lung Foundation, the Vårdal Foundation for Health Care Science and Allergy Research, the Swedish Council for Working Life and Social Research, the Bror Hjerpstedt Foundation, the Swedish Asthma and Allergy Association, the Icelandic Research Council, and the Estonian Science Foundation (grant No. 4350).

References

[1] S.S. Lim, T. Vos, A.D. Flaxman, G. Danaei, K. Shibuya, H. Adair-Rohani, et al., A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010, Lancet 380 (2012) 2224–2260.
[2] R. Doll, R. Peto, J. Boreham, I. Sutherland, Mortality in relation to smoking: 50 years' observations on male British doctors, BMJ 328 (2004) 1519.
[3] M. Ng, M.K. Freeman, T.D. Fleming, M. Robinson, L. Dwyer-Lindgren, B. Thomson, et al., Smoking prevalence and cigarette consumption in 187 countries, 1980-2012, JAMA 311 (2014) 183–192.
[4] P. Midlöv, S. Calling, J. Sundquist, K. Sundquist, S.E. Johansson, The longitudinal age and birth cohort trends of smoking in Sweden: a 24-year follow-up study, Int. J. Public Health 59 (2014) 243–250.
[5] G. Norheim, M. Sadarangani, O. Omar, L.M. Yu, K. Mølbak, M. Howitz, et al., Association between population prevalence of smoking and incidence of meningococcal disease in Norway, Sweden, Denmark and The Netherlands between 1975 and 2009: a population-based time series analysis, BMJ Open 4 (2014) e003312, , http://dx.doi.org/10.1136/bmjopen-2013-003312.
[6] J. Stapleton, Cigarette smoking prevalence, cessation and relapse, Stat. Methods Med. Res. 7 (1998) 187–203.
[7] E. Vangeli, J. Stapleton, E.S. Smit, R. Borland, R. West, Predictors of attempts to stop smoking and their success in adult general population samples: a systematic review, Addiction 106 (2011) 2110–2121.

[8] W.P. McWhorter, G.M. Boyd, M.E. Mattson, Predictors of quitting smoking: the NHANES I followup experience, J. Clin. Epidemiol. 43 (1990) 1399–1405.
[9] K.M. Freund, R.B. D'Agostino, A.J. Belanger, W.B. Kannel, J. Stokes 3rd, Predictors of smoking cessation: the Framingham study, Am. J. Epidemiol. 135 (1992) 957–964.
[10] M. Osler, E. Prescott, Psychosocial, behavioural, and health determinants of successful smoking cessation: a longitudinal study of Danish adults, Tob. Control 7 (1998) 262–267.
[11] M. Osler, E. Prescott, N. Godtfredsen, H.O. Hein, P. Schnohr, Gender and determinants of smoking cessation: a longitudinal study, Prev. Med. 29 (1999) 57–62.
[12] N.S. Godtfredsen, E. Prescott, M. Osler, J. Vestbo, Predictors of smoking reduction and cessation in a cohort of Danish moderate and heavy smokers, Prev. Med. 33 (2001) 46–52.
[13] C. Janson, N. Künzli, R. de Marco, S. Chinn, D. Jarvis, C. Svanes, et al., Changes in active and passive smoking in the European Community Respiratory Health Survey, Eur. Respir. J. 27 (2006) 517–524.
[14] K. Honjo, H. Iso, M. Inoue, S. Tsugane, JPHC Study Group. Smoking cessation: predictive factors among middle-aged Japanese, Nicotine Tob. Res. 12 (2010) 1050–1054.
[15] A.C. Tsai, Y.A. Lin, H.J. Tsai, Predictors of smoking cessation in 50-66-year-old male Taiwanese smokers: a 7-year national cohort study, Arch. Gerontol. Geriatr. 55 (2012) 295–300.
[16] J.J. Yang, M. Song, H.-S. Yoon, H.-W. Lee, Y. Lee, S.-A. Lee, J.-Y. Choi, J.-K. Lee, D. Kang, What are the major determinants in the success of smoking cessation: results from the health examinees study, PLoS One 10 (2015) e0143303, , http://dx.doi.org/10.1371/journal.pone.0143303.
[17] K. Torén, T. Gislason, E. Omenaas, R. Jögi, B. Forsberg, L. Nyström, et al., A prospective study of asthma incidence and its predictors: the RHINE study, Eur. Respir. J. 24 (2004) 942–946.
[18] C. Janson, J. Anto, P. Burney, S. Chinn, R. de Marco, J. Heinrich, et al., The European Community Respiratory Health Survey: what are the main results so far? European Community Respiratory Health Survey II, Eur. Respir. J. 18 (2001) 598–611.
[19] A. Johannessen, G. Verlato, B. Benediktsdottir, B. Forsberg, K. Franklin, T. Gislason, et al., Longterm follow-up in European respiratory health studies - patterns and implications, BMC Pulm. Med. 14 (2014) 63.
[20] P. Lange, S. Groth, J. Nyboe, J. Mortensen, M. Appleyard, P. Schnohr, et al., Determinants of chronic mucus hypersecretion in a general population with special reference to the type of tobacco smoked, Int. J. Epidemiol. 18 (1989) 882–887.
[21] Ciba Guest Symposium, Terminology, definitions, and classification of chronic pulmonary emphysema and related conditions. Standardized questionnaires of respiratory symptoms, Thorax 14 (1959) 286–299.
[22] ATS statement, Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease, Am. J. Respir. Crit. Care Med. 152 (5Pt2) (1995) S77–S121.
[23] M. Holm, J.L. Kim, L. Lillienberg, T. Storaas, R. Jögi, C. Svanes, et al., Incidence and prevalence of chronic bronchitis: impact of smoking and welding. The RHINE study, Int. J. Tuberc. Lung Dis. 16 (2012) 553–557.
[24] C. Rafful, O. García-Rodríguez, S. Wang, R. Secades-Villa, J.M. Martínez-Ortega, C. Blanco, Predictors of quit attempts and successful quit attempts in a nationally representative sample of smokers, Addict. Behav. 38 (2013) 1920–1923.
[25] E. Gilpin, J.P. Pierce, J. Goodman, D. Burns, D. Shopland, Reasons smokers give for stopping smoking:do they relate to success in stopping? Tob. Control 1 (1992) 256–263.
[26] P. Caponnetto, R. Polosa, Common predictors of smoking cessation in clinical practice, Respir. Med. 102 (2008) 1182–1192.
[27] P.H. Smith, A.J. Bessette, A.H. Weinberger, C.E. Sheffer, S.A. McKee, Sex/gender differences in smoking cessation: a review, Prev. Med. 92 (2016) 135–140.
[28] D.L. Patrick, A. Cheadle, D.C. Thompson, P. Diehr, T. Koepsell, S. Kinne, The validity of self-reported smoking: a review and meta-analysis, Am. J. Public Health 84 (1994) 1086–1093.
[29] S. Connor Gorber, S. Schofield-Hurwitz, J. Hardt, G. Levasseur, M. Tremblay, The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status, Nicotine Tob. Res. 11 (2009) 12–24.
[30] M.S. Pearce, L. Hayes, Self-reported smoking status and exhaled carbon monoxide, Chest 128 (2005) 1233–1238.
[31] M.A. Fisher, G.W. Taylor, B.J. Shelton, S.M. Debanne, Sociodemographic characteristics and diabetes predict invalid self-reported non-smoking in a population-based study of U.S adults, BMC Public Health 7 (2007) 33.
[32] J.S. Wilson, J.S. Elborn, D. Fitzsimons, E. McCrum-Gardner, Do smokers with chronic obstructive pulmonary disease report their smoking status reliably? A comparison of self-report and bio-chemical validation, Int. J. Nurs. Stud. 48 (2011) 856–862.
[33] C.M. van der Aalst, H.J. de Koning, Biochemical verification of the self-reported smoking status of screened male smokers of the Dutch-Belgian randomized controlled lung cancer screening trial, Lung Cancer 94 (2016) 96–101.
[34] R.M. Mejia, S. Braun, L. Peña, S.E. Gregorich, E.J. Pérez-Stable, Validation of non-smoking status by spouse following a cessation intervention, J. Smok. Cessat. 12 (2017) 38–42.