Predictors of Success for Smoking Cessation at the Workplace: A Longitudinal Study

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Key Words

Comprehensive smoking cessation intervention ·
Motivational counselling · Nicotine replacement ·
Predictors of nicotine abstinence · Smoking cessation ·
Workplace

Abstract

Background: The effectiveness of worksite interventions to reduce smoking is debatable. **Objectives:** A comprehensive smoking cessation intervention was implemented in a community of more than 17,000 employees at three different health care companies. The primary endpoint was abstinence at 24 months (self-reported and confirmed by exhaled carbon monoxide ≤ 6 parts per million). Predictors of long-term abstinence were analysed by multivariable regression analysis. **Methods:** The study was designed as an investigator-initiated and investigator-driven, open, multi-centre, cohort study; 887 smokers were enrolled in the programme. The intervention included intensive individual counselling as well as nicotine replacement and/or bupropion according to individual preferences. Re-interventions for relapse were offered during the 24-month follow-up.

Results: The abstinence rate was 37% at 24 months and did not differ among the various medication groups ($p > 0.05$ for all). Predictors of successful cessation were higher age (odds ratio, OR 1.47, 95% confidence interval, CI 1.08–2.00, $p < 0.01$), breathlessness on exertion (OR 2.26, 95% CI 1.1–4.9, $p = 0.03$), and a higher educational level (OR 1.81, 95% CI 1.06–3.09, $p = 0.03$). Higher Fagerström (OR 0.76, 95% CI 0.59–0.97, $p < 0.01$) and craving scores (OR 0.75, 95% CI 0.63–0.89, $p < 0.01$), chronic sputum production (OR 0.52, 95% CI 0.31–0.87, $p = 0.01$) and use of antidepressants (OR 0.54, 95% CI 0.32–0.91, $p = 0.02$) were associated with ongoing smoking. **Conclusion:** A comprehensive smoking cessation intervention at the workplace achieves high, stable, long-term abstinence rates. Elderly, well-educated employees with breathlessness on exertion have higher odds of quitting smoking. In contrast, those with high physical dependency and more intense craving, and those reporting use of antidepressant medication or sputum production have poorer chances to quit.

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Introduction

In addition to the impact of smoking on the individual health status, the economic costs associated with a smoking workforce are considerable [1, 2]. There is evidence that employees who smoke are more often absent from work than their non-smoking colleagues due to more frequent episodes of respiratory-tract infections [3, 4]. In particular male, single and older smokers appear to take 22–38% more sick leave as compared to the non-smoking staff. [3] Smoking at the place of work also results in a loss of productivity caused by repeated ‘small cigarette breaks’ during working hours [5]. Recently, awareness of the dangers of passive smoking has raised concerns about the health of non-smoking employees and the need to protect them against ambient smoke [6].

Currently, the majority of businesses have instituted policies that restrict or prohibit smoking at their facilities. A general ban on smoking may decrease both the cigarette consumption by smokers during working hours and the exposure of non-smoking employees to tobacco smoke [7]. Its effect on total cigarette consumption, however, is less certain and smokers may perceive such restrictions as negative, e.g. as a curtailment of freedom [8]. Data on workplace interventions aimed at helping individuals to stop smoking are limited; such efforts appear to increase the likelihood of smoking cessation, although the absolute numbers of successful quitters is rather low [9]. On the other hand, there is a lack of evidence that comprehensive programmes to promote smoking cessation aimed at the workplace actually reduce the prevalence of smoking among the workforce [10].

The objective of our study was to evaluate the effectiveness of a comprehensive, long-term smoking cessation programme aimed at individual workers and the workplace as a whole in three large health care companies. The primary endpoint of the study was abstinence at 24 months. In addition, predictors of long-term abstinence were identified.

Methods

Setting and Study Population

The study was designed as an investigator-initiated and investigator-driven, open, multicentre cohort study and was conducted between May 2005 and January 2009 in Basel, Switzerland. Smoking employees at the University Hospital of Basel (UHBS, Basel, Switzerland) and two local pharmaceutical companies [Novartis Pharma AG (Novartis), and F. Hoffman-La Roche AG (Roche), Basel, Switzerland] were recruited on a voluntary basis from a total

of 17,000 employees for a smoking cessation programme at the workplace. Subjects were invited to take part through local advertising such as posters, newsletters and flyers. Employees of the UHBS received a written invitation in the form of a standardized pre-screening letter (online suppl. material; for all online suppl. material, see www.karger.com/doi/10.1159/000346646). The inclusion criteria were: current employment at one of the three sites, minimum age of 17 years, daily consumption of at least 5 cigarettes and willingness to quit smoking.

The programme consisted of a total of 10 visits, including 7 on-site ones and 3 telephone calls during the 24-month follow-up and was, thus, in accordance with the Swiss and international clinical guidelines for smoking cessation [11–13]. All employees provided their written informed consent to a scientific analysis of their data.

Earlier on, Novartis, Roche and UHBS had limited the use of tobacco to designated smoking areas; they introduced a general ban on tobacco with the start of or during the smoking cessation programme.

The study was approved by the local joint ethical committee of the Canton of Basel, Switzerland, in January 2005 (EKBB 34/05).

Assessments

At enrolment, demographic data of the study subjects were collected, followed by a thorough assessment of their health status, including medical history, use of medication, relevant comorbidities and further risk factors in addition to cigarette smoking. If indicated, additional medical reports were obtained from family physicians. Subjects with previously undetected or unstable health problems were immediately referred to an appropriate medical specialist. Health care providers elicited the dietary and physical activity behaviour of the subjects using individualized, tailored messages; if found inadequate, the employees were encouraged to participate in in-house nutritional counselling or exercise groups. Body mass index, blood pressure, spirometry and the exhaled concentration of carbon monoxide were measured and respiratory symptoms were documented for all smokers.

Data on smoking were collected with standardized questions about current and previous smoking habits, including pharmacological and non-pharmacological strategies of prior attempts to quit, as well as personal reasons for the current attempt to quit. Nicotine dependence was assessed by the Fagerström Score (Fagerström test for nicotine dependence, FTND) and the intensity of craving was quantified on a visual analogue scale (VAS) [13]. Individual general motivation to quit smoking was estimated by both the employee and the study physician on VAS. The individual quality of life was measured by the Satisfaction with Life Scale (QoL) [14]. Relevant outcome variables were assessed at enrolment and after 3, 12 and 24 months (see online suppl. material for details).

Intervention (Motivational Counselling and Pharmacological Cessation Support)

The primary intervention consisted of 6 on-site visits during the first 3 months, each with an individual face-to-face counselling of at least 15 min. At visit No. 1, a quit date was fixed with each participant, based on an individual action plan. Counselling support covered standard cognitive-behavioural strategies, such as enhancing motivation, highlighting health benefits, or coping with cravings and the prevention of a relapse. Employees were encouraged to use pharmacological support consisting of either nicotine

monotherapy or different combinations of nicotine replacement therapy (NRT), as preferred. Bupropion could be added to NRT or was prescribed as monotherapy (see online suppl. material).

Follow-Up and Re-Interventions

Employees were interviewed about their smoking and health status up to 24 months after enrolment, either by a brief telephone call or an on-site consultation after 12 and 24 months. In case of a smoking relapse after the primary intervention, employees had the opportunity to participate in a re-intervention (A) or, after a second relapse, in a re-intervention (B), each consisting of two additional on-site visits within 1 week offering motivational counseling and the possibility to begin a new cessation attempt using the pharmacological treatment of their choice. A re-intervention was defined as successful if employees had stopped smoking at the second re-intervention visit.

Objectives and Outcome Measurements

The primary endpoint was smoking cessation rate 24 months after enrolment. Subjects were classified as successful quitters if they reported smoking cessation confirmed by a carbon monoxide concentration in exhaled air of ≤ 6 parts per million (ppm) measured by a Micro Smokerlyser (Bedfont, UK) [15]. This threshold was considered to reflect abstinence during the last 24 h. Current smokers, on the other hand, were those who either admitted continuous smoking or those denying smoking but presenting exhaled carbon monoxide concentrations > 6 ppm. Individuals who did not attend follow-up visits and/or withdrew from the study or did not provide information about their smoking status, were still considered to be smokers, following a conservative, intention-to-treat approach.

Statistics

Proportions and frequencies between different groups were compared using the χ^2 test. Differences in ordinal variables were analysed with the two-sample t test or with the Mann-Whitney test, as appropriate. Differences in abstinence rates between medication groups were tested using Cox regression. NRT-treated employees (monotherapy and combination therapy) were chosen as a reference group. Univariate and multivariate logistic regression analyses were performed, including potentially predictive factors for success such as demographic, socioeconomic, clinical and motivational determinants. Variables of clinical interest were selected a priori. The model was adjusted by age, gender, centre and other possible confounding factors. Results are presented as odds ratios (OR) and 95% confidence intervals (CI) with corresponding p values. For continuous or ordinal variables, OR had to be based on a meaningful difference of the predicting variable. They were expressed as the ratio of the odds from the 3rd to the 1st quartile, representing a typical above-average to a typical below-average value. All tests were two tailed; $p \leq 0.05$ was defined as significant. The data were analysed using R-Project version 2.13.2 or SPSS 19.

Results

Study Population

Of around 17,000 employees of the UHBS and the two companies, a total of 887 subjects provided written con-

sent for participation in the study and entered the programme. During the follow-up phase, however, 3 study sub-centres were closed due to internal re-structuring of a company, leading to the exclusion of 184 employees. Thus, 703 subjects were available for the final data analysis. Baseline characteristics of the excluded participants did not significantly differ from the overall cohort (data not shown).

Baseline characteristics and smoking-related data of the 703 employees are summarized in table 1. The study population was middle aged, had a medium daily cigarette consumption of 10–30 cigarettes/day and was highly motivated to quit smoking. Nicotine dependence (FTND) was classified as high or very high in 40% of the employees, and higher craving scores (≥ 70 VAS) were present in one third of all participants. Two thirds of the smokers reported the presence of at least one respiratory symptom at enrolment. Lung function testing was performed in 695 (98%) patients. Based on the testing of lung function, 9% of the subjects ($n = 61$) met the criteria for a diagnosis of chronic obstructive pulmonary disease according to the GOLD guidelines; 121 employees (17%) were on regular antidepressant medication. A psychiatric disorder had been diagnosed in 97 employees (14%).

Rate of Smoking Cessation

Abstinence rates at 12 and 24 months were 38.8 and 37%, respectively. In our population, the current self-reported smoking status at the clinical consultations agreed well with measured exhaled carbon monoxide. The number of employees who were redefined as on-going smokers, due to a no-show at clinical follow-ups, for example, is reported in table 2. Cessation rates over time for the various medication groups are shown in figure 1. A Cox regression analysis model with nicotine replacement (mono- and combined therapy) as the reference group revealed no statistically significant influence of the choice of medication on the individual success of smoking cessation within 24 months ($p_{\text{overall}} = 0.20$): NRT versus counselling advice only [abstinence: 38.3 vs. 45.5%] $p = 0.39$, NRT vs. bupropion alone (abstinence: 38.3 vs. 37.5%) $p = 0.97$, NRT versus monotherapy NRT combined with bupropion (abstinence: 38.3 vs. 42.3%) $p = 0.37$, or NRT versus combined NRT with bupropion (abstinence: 38.3 vs. 34.3%) $p = 0.24$.

Re-Interventions

A total of 327 re-interventions visits were performed during the 24 months of the programme; 114 of 166 employees (69%) successfully completed the first re-intervention and stopped smoking within 1 week. Most re-

Table 1. Baseline and smoking-related characteristics of employees participating in a smoking cessation programme at the workplace (n = 703)

Characteristics	(n = 703)	Characteristics	(n = 703)
<i>Demographics</i>		<i>Smoking-related history</i>	
Age, years ^a	44±22	Self-assessed motivation to quit (VAS) ^a	89±49
Gender, males ^b	389 (55)	Physician-assessed motivation to quit ^a (VAS)	84±25
Height, cm ^c	173 (167–180)	Time to last attempt to quit, months ^a	51±67
Weight, kg ^c	75 (64–84)	Years smoked, n ^a	22±9.4
Civil status ^b		Cigarettes smoked ^b	
Single	238 (34)	<10 cigarettes/day	89 (12)
Married	347 (49)	11–20 cigarettes/day	347 (49)
Divorced	103 (15)	21–30 cigarettes/day	201 (29)
Widowed	11 (2)	>30 cigarettes/day	66 (10)
Education ^b		FTND, points ^a	4.43±2.3
University	102 (15)	Intensity of craving, VAS ^a	57±22
Technical school	48 (7)	Exhaled CO, ppm ^c	21 (13–31)
Apprenticeship	498 (72)	<i>Pharmacological support</i>	
Basic education	45 (6)	NRT ^b	
<i>Comorbidities^b</i>		Monotherapy	87 (12)
Arterial hypertension	43 (6)	Combined	137 (19)
Coronary artery disease	29 (4)	Monotherapy + bupropion	99 (14)
Diabetes mellitus	17 (2)	Combined + bupropion	282 (41)
Malignancy	29 (4)	Bupropion	49 (7)
Epilepsy	15 (2)	Counselling advice only	49 (7)
Psychiatric disorder	97 (14)	FEV ₁ = Forced expiratory volume in 1 s; FVC = forced vital capacity; pred. = predicted.	
Antidepressant medication	121 (17)	^a Values are means ± SD, ^b absolute numbers (%) or ^c medians with interquartile ranges.	
Snoring	241 (34)		
Satisfaction with Life Scale (Qol) ^c	27 (24–30)		
<i>Respiratory symptoms^b</i>			
Cough	271 (39)		
Sputum production	187 (27)		
Wheezing	131 (19)		
Breathlessness at rest	49 (7)		
Breathlessness on exertion	310 (44)		
<i>COPD GOLD stage (FEV₁/FVC <70%)</i>			
Mild (FEV ₁ >80% pred.)	32		
Moderate (50% pred. < FEV ₁ < 80% pred.)	23		
Severe (FEV ₁ <50% pred.)	6		
<i>Lung function^c</i>			
FEV ₁ , liters	3.37 (2.81–4)		
FEV ₁ , % pred.	97 (88–106)		
FVC, liters	4.2 (3.53–5.01)		
FVC, % pred.	102 (93–112)		
FEV ₁ /FVC	81 (76–85)		
<i>Blood pressure, mm Hg^c</i>			
Systolic	125 (115–135)		
Diastolic	80 (70–85)		
<i>Smoking-related history</i>			
Age at start of smoking, years ^a	17.4±3.8		
Prior attempts to quit ^a	3±3.5		
Duration of longest nicotine abstinence, months ^a	20±52

Fig. 1. Cox regression analysis for abstinence rates between medication groups with NRT as reference.

Table 2. Smoking cessation rates and treatment failures of a smoking cessation programme at the workplace (n = 703)

Visit (at month)	Non-smokers CO <6 ppm	Ongoing smokers	
		CO >6 ppm	LFU
4 (1)	518 (74)	61 (9)	124 (17)
6 (3)	399 (57)	137 (19)	167 (24)
8 (12)	273 (39)	169 (24)	261 (37)
10 (24)	260 (37)	153 (22)	290 (41)

CO = Exhaled CO; LFU = lost to follow-up, i.e. individuals who admitted to smoking, disagreed with re-intervention, 3rd smoking relapse, did not attend the follow-up visit, withdrew informed consent or did not provide information about the smoking status.

interventions (n = 76) were required at the end of the primary smoking cessation attempt, i.e. after 3 months. Another 43 re-interventions were performed after 6 months and 35 re-interventions after 12 months respectively. Another 12 re-interventions followed after 18 months. Thirty employees required a secondary re-intervention (re-intervention B) after a renewed relapse, which was successful in 17 employees (57%).

Predictors of Successful Smoking Cessation

Variables for predicting long-term abstinence were chosen by a priori knowledge based on clinical plausibility and univariate logistic regression analysis (table 3). A total of 14 variables were selected for inclusion in the multivariate model (table 4).

Regarding demographic characteristics, higher age (49 vs. 35 years) was the only independent predictor of long-term abstinence in the study population (OR 1.47, 95% CI 1.08–2.0, $p = 0.01$). Smoking employees with higher education had a significantly greater probability to quit smoking when compared to those with a lower educational level (university degree vs. apprenticeship: OR 1.81, 95% CI 1.06–3.09, $p = 0.03$; technical school vs. apprenticeship: OR 2.16, 95% CI 1.1–4.54; $p = 0.04$). Additionally, breathlessness on exertion (exertional dyspnoea) was associated with a 2.3-fold increase in the likelihood to quit (OR 2.26, 95% CI 1.09–4.86, $p = 0.03$). Conversely, the use of antidepressant medication (OR 0.54, 95% CI 0.32–0.91, $p = 0.02$), higher FTND (6 vs. 3 points; OR 0.76, 95% CI 0.59–0.89, $p = 0.04$) or craving score (70 vs. 50 VAS; OR 0.75, 95% CI 0.63–0.89, $p < 0.01$), as well as the presence of chronic sputum (OR 0.52, 95% CI 0.31–0.87, $p = 0.01$) were associated with a lower chance of quitting after 24 months of the intervention.

Table 3. Univariate logistic regression analysis to predict 2-year long-term nicotine abstinence (n = 703)

Variables	OR	95% CI	p
Age (49 vs. 35 years)	1.02	1.01–1.04	<0.01
Body mass index (30 vs. 20)	1.03	0.99–1.07	0.16
Gender			
(Male)	–	–	–
Female	0.94	0.69–1.28	0.69
Civil status			
(Married)	–	–	–
Single	1.13	0.8–1.59	0.50
Divorced	1.07	0.66–1.73	0.79
Widowed	0.71	0.18–2.76	0.63
Education			
(Apprenticeship)	–	–	–
University	1.75	1.13–2.69	0.02
Technical school	1.66	1.20–3.02	0.01
Basic education	0.71	0.36–1.42	0.17
Respiratory symptoms			
Cough	0.6	0.43–0.83	<0.01
Sputum	0.51	0.35–0.74	<0.01
Wheezing	0.62	0.41–0.95	0.02
Breathlessness at rest	1.04	0.51–1.9	0.90
Breathlessness on exertion	0.59	0.43–0.82	<0.01
Lung function (spirometry)			
FEV ₁	1.03	1.50	0.02
FEV ₁ /FVC	0.83	1.12	0.65
Psychiatric diagnosis	1.45	0.91–2.32	0.11
Antidepressant medication	0.64	0.38–0.75	<0.01
FTND (6 vs. 3 points)	0.85	0.8–0.91	<0.01
Number of previous attempts to quit (4 vs. 1 attempt)	1.05	1–1.11	0.05
Duration of longest nicotine abstinence (300 vs. 5 days)	1	1–1.10	0.07
Intensity of craving (100 vs. 80 VAS)	0.99	0.54–0.99	<0.01
Self-assessed motivation to quit (100 vs. 80 VAS)	1.01	1.01–1.02	<0.01
Physician-assessed motivation to quit	1.02	1.01–1.03	<0.01
Satisfaction with Life Scale (QoL) (30 vs. 24 points)	1.02	0.99–1.05	0.22
Reinforcement (negative)	–	–	–
Positive	1.64	1.05–1.64	0.03
Positive + negative	1.29	0.82–2.04	0.45
Pharmacotherapy (NRT) (combined + bupropion)	–	–	–
NRT			
Monotherapy	0.95	0.57–1.57	0.83
Combined	1.09	0.71–1.66	0.70
Monotherapy + bupropion	1.29	0.81–2.08	0.29
Bupropion monotherapy	0.98	0.52–1.84	0.95
Counselling advice only	1.96	1.02–3.76	0.04

The reference category for discontinuous or ordinal variables is given in parentheses. For continuous or ordinal variables, OR had to be based on meaningful differences of the predicting variable. FEV₁ = Forced expiratory volume; FVC = forced vital capacity.

Table 4. Multivariable logistic regression analysis to predict 2-year long-term nicotine abstinence (n = 703)

Variables	OR	95% CI	p
Age (49 vs. 35 years)	1.47	1.08–2.00	0.01
Gender			
(Male)	–	–	–
Female	1.18	0.79–1.77	0.43
Civil status			
(Married)	–	–	–
Single	1.24	0.78–1.97	0.89
Divorced	1.19	0.68–2.10	0.35
Widowed	0.93	0.21–4.00	0.70
Education			
(Apprenticeship)	–	–	–
University	1.81	1.06–3.09	0.03
Technical school	2.16	1.10–4.54	0.04
Basic education	0.60	0.25–1.40	0.23
Respiratory symptoms			
Cough	0.88	0.56–1.37	0.57
Sputum	0.52	0.31–0.87	0.01
Wheezing	0.92	0.54–1.58	0.76
Breathlessness on exertion	2.26	1.09–4.86	0.03
Lung function (spirometry)			
FEV ₁	1.30	0.98–2.45	0.07
FEV ₁ /FVC	0.98	0.82–1.18	0.84
Antidepressant medication	0.54	0.32–0.91	0.02
FTND (6 vs. 3 points)	0.76	0.59–0.89	0.04
Number of previous attempts to quit (4 vs. 1 attempt)	1.14	0.95–1.37	0.15
Duration of nicotine abstinence (300 vs. 5 days)	1.02	0.98–1.05	0.38
Intensity of craving (70 vs. 50 VAS)	0.75	0.63–0.89	<0.01
Self-assessed motivation to quit (100 vs. 70 VAS)	1.10	0.81–1.49	0.52
Physician-assessed motivation to quit (100 vs. 70 VAS)	1.47	0.94–2.29	0.09
Satisfaction with Life Scale (Qol) (30 vs. 24 points)	0.85	0.67–1.08	0.18
Reinforcement (negative)			
Positive	0.73	0.45–1.20	0.22
Positive + negative	0.91	0.59–1.41	0.39

The reference category for discontinuous or ordinal variables is given in parentheses. For discontinuous or ordinal variables, OR had to be based on meaningful differences of the predicting variable. The model was adjusted by age, gender and centre. FEV₁ = Forced expiratory volume; FVC = forced vital capacity.

Discussion

To the best of our knowledge, this is the largest study integrating a long-term smoking cessation programme into a general health care action plan consisting of both individual counselling and pharmacological support and spe-

cifically addressing health care employees. The findings of this study suggest that an intensified and structured intervention achieves smoking cessation rates which outrange those of most randomized, controlled studies. Predictors of successful quitting were older age, higher education level and self-reported breathlessness on exertion. Chronic sputum production, higher nicotine dependence and craving as well as the use of antidepressant medication were, in contrast, negative predictors for long-term abstinence.

Several randomized, controlled studies and systematic reviews on smoking cessation confirmed the efficacy of individual counselling, which resulted in quit rates between 10 and 30% [16]. Noteworthy, most randomized data were obtained from preselected populations of smokers, who were either hospitalized due to smoking-associated medical conditions or participated in rehabilitation programmes [17–19]. There are several possible explanations for the remarkably high cessation rate of 37% in the present study. Employees who applied for participation in the smoking cessation programme were highly motivated and potentially more interested in health issues than those not applying, reflecting their individual ‘readiness to quit’ [20, 21]. Despite a lack of comparable data in the literature, some experts may hypothesize that a health care population might be particularly convinced of the need to quit smoking and, thus, more receptive for such intervention. Of note, previous smoking cessation programmes at the workplace did not provide a comprehensive strategy consisting of individual counselling and pharmacological therapy, thereby perhaps resulting in lower abstinence rates [22, 23].

Another important finding is that the high cessation rate achieved at 12 months could be maintained up to the 24-month follow up. In contrast, comparable trials did not provide follow-up beyond 12 months. A high number of face-to-face consultations and renewed counselling support for smoking relapse appears to be associated with an enhanced likelihood of smoking cessation [24]. Moreover, allowing personal needs and preferences to guide pharmacological support may increase efficacy [25]. Accordingly, a change in addictive behaviour may also relate to personal skills and capacities [26, 27].

Randomized controlled trials confirmed the efficacy of individual counselling combined with several NRT products [11, 28]. Interestingly, as compared to counselling alone, abstinence rates achieved with pharmacological means did not significantly differ in our study, suggesting that in a non-randomized, ‘real-life’ situation the influence of pharmacological support might be less prominent than in randomized settings. Supportive counselling obviously plays a key role in the quitting process [29].

The general motivation of the employees to quit smoking was not an independent predictor of long-term success, suggesting that motivation may be predictive for an individual to make an attempt to quit, but not for the subjects' final success to stop smoking.

Partly inconsistent findings with regard to demographic differences between quitters and non-quitters were reported in the literature. Similar to the present study, a somewhat older age has been described as a predictor for successful cessation [30]. In contrast to some, but not all previous results, neither gender [31, 32] nor marital status [33] did autonomously influence the outcome of an attempt to quit in an independent manner.

In accordance with the present study, an association of the educational level with the probability of abstinence has commonly been described in the past [34, 35]. Thereby, higher education was often considered to reflect differences in personal circumstances and social support, resulting in better coping strategies and a higher response to promotional health interventions [36].

For the first time in the literature, we describe the presence of breathlessness on exertion to be significantly associated with a successful attempt to quit. It is tempting to hypothesize that affected subjects felt more motivated to quit smoking because of their respiratory limitation. Conversely, the presence of sputum production was independently associated with a reduced chance to quit. We have no simple explanation for this observation. Nevertheless, smokers with symptoms of chronic bronchitis are considered to have a greater risk of developing chronic obstructive pulmonary disease, making smoking cessation a major aim for these individuals [37].

The relationship of persistent smoking and clinical depression requiring antidepressant medication was well described by earlier investigators [38]. Smokers with current or past symptoms of depression are thought to have reduced fears that smoking may affect their health and stronger convictions that smoking reduces negative feelings.

The severity of nicotine dependence was a robust predictor for smoking cessation in several, but not all earlier investigations [39, 40]. This study suggests that determinants of nicotine dependence, such as FTND and craving intensity, correlate with the risk of failure in a quit attempt. In contrast to previous results, negative reinforcement, i.e. smoking to prevent withdrawal symptoms, was not associated with lower quit rates [41].

The present study has some limitations. The findings of this study may have limited generalizability to other subgroups of smokers, e.g. non 'healthy workers'. Beyond

individual characteristics, behavioural changes in successful quitters are, at best, the result of a large number of complex interactions encompassing the smoker's personal attitude towards addictive behaviour, self-efficacy and outcome expectancy of an attempt to quit. Future data analysis may yield further insights and help characterizing these determinants more completely. Currently, the absolute effect size of environmental and several socioeconomic variables, including workplace conditions, positive peer pressure provided by co-workers, local tobacco policies or personal resources of social support, remains unclear. However, despite the lack of a control group, we believe that the net effect of the intervention in our study was substantial. Assuming a smoking prevalence of 25% in the overall Swiss population, at least 4,250 from a total of 17,000 employees at the three job locations were active smokers [42, 43]. Within the programme, an estimated 20% or 887 of the employees smoking could be motivated to quit smoking. Assuming that 1 of 3 employees would die prematurely due to on-going smoking, 86 of 260 continuously abstinent employees would have been saved from premature death [44].

Conclusion

The study findings suggest that a comprehensive, long-term smoking cessation programme addressing health care workers, which was tailored to individuals, provided at the workplace and oriented towards the company as a whole, is a viable and effective approach to promote health care.

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Financial Disclosure and Conflicts of Interest

The authors declare no conflict of interest.

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