Effect of a workplace-based group training programme combined with financial incentives on smoking cessation: a cluster-randomised controlled trial

Floor A van den Brand, Gera E Nagelhout, Bjorn Winkens, Niels H Chavannes, Onno C P van Schayck

Summary

Background Financial incentives are potentially useful tools to aid smoking cessation, but robust evidence to support their efficacy, particularly in combination with other interventions (eg, group counselling), has not been reported. We aimed to investigate whether financial incentives combined with a smoking cessation group training programme (compared with a training programme with no incentives) organised at the workplace would increase 12-month abstinence rates in tobacco-smoking employees with different education and income levels.

Methods This cluster-randomised controlled trial was done in the Netherlands with companies that offer a smoking cessation group training programme to all of their smoking employees. Eligible participants were tobacco-smoking employees and spouses of employees who were at least 18 years of age. Participants in the control group received a weekly 90-min session of smoking cessation group training for 7 weeks at the workplace; in addition to the group training, participants in the intervention group received vouchers for being abstinent (€50 at the end of the training programme, €50 3 months after completion of the programme, €50 after 6 months, and €200 after 12 months). Companies were randomly assigned by an independent research assistant to the intervention group or the control group with a digital randomisation programme, using a biased urn method. The primary outcome was carbon monoxide-validated continuous abstinence at 12 months. All randomised participants were included in the modified intention-to-treat analyses, with the exception of unavoidable loss (participants who had died or moved to an untraceable address (according to the Russell Standard), and in the sensitivity analyses, except the complete case analysis, which included only participants for whom all variables included in the model were not missing. This study is registered with the Dutch Trial Register, number NTR5657.

Findings Between March 1, 2016, and March 1, 2017, 61 companies with 604 participating smokers were enrolled. 31 companies (319 smokers) were randomly assigned to the intervention group and 30 companies (285 smokers) to the control group. 12 months after finishing the smoking cessation programme, the proportion of individuals abstaining from smoking in the intervention group was significantly higher than that in the control group (131 [41%] of 319 *vs* 75 [26%] of 284; adjusted odds ratio 1·93, 95% CI 1·31–2·85, p=0·0009; adjusted for education level, income level, and Fagerström score).

Interpretation Financial incentives in addition to a smoking cessation group training programme can significantly increase long-term smoking abstinence. The results of the current study could motivate employers to facilitate a workplace smoking cessation programme with financial incentives to help employees to quit smoking.

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Department of Family Medicine (F A van den Brand MSc, G E Nagelhout PhD, Prof O C P van Schayck PhD), **Department of Health Promotion** (G E Nagelhout), **and Department of Methodology and Statistics** (B Winkens PhD), **Care and Public Health Research Institute, Maastricht University, Maastricht, Netherlands; IVO Addiction Research Institute, The Hague, Netherlands** (G E Nagelhout); **Department of Public Health and Primary Care, Leiden University Medical Center, Leiden, Netherlands** (Prof N H Chavannes PhD); **and Usher Institute of Population Health Sciences and Informatics, University of Edinburgh, Edinburgh, UK** (Prof O C P van Schayck)

Correspondence to: Ms Floor A van den Brand, Department of Family Medicine, Care and Public Health Research Institute, Maastricht University, Maastricht 6200 MD, Netherlands **f.vandenbrand@maastrichtuniversity.nl**

Introduction

Financial incentives can increase smoking cessation in diverse populations, with evidence showing moderate effects.[1–4] However, the quality of this evidence is low because of inadequate randomisation and allocation procedures, deficient outcome reporting, and confounding.[2] Furthermore, the effectiveness of incentives is difficult to determine because of a wide range in type and size of the incentives. Additionally, previous studies[2,3] were mainly done in the USA, which might limit generalisability. Finally, most studies[5–7] have solely investigated the effect of incentives, without accompanying group counselling for smoking cessation. The effect of the combination of incentives with counselling is especially important to assess, considering evidence that group counselling can effectively enhance quit success.[8]

Previous studies provided an indication of which aspects of incentive-based programmes are effective. A study[9] comparing different incentive schemes showed that reward-based incentive programmes (ie, smokers receive a reward) can possibly be more effective than deposit-based programmes (ie, smokers receive a refund of their own money deposit) in increasing smoking cessation, because of relatively high acceptance of

Research in context

Evidence before this study

We searched PubMed and Google Scholar for research articles published in English using various search terms, including "financial incentives", "incentives", "monetary reward", "smoking cessation", "stop smoking", "workplace", "employers", and "employees". No date restrictions were used. We explored the Cochrane library and found a relevant review on incentives for smoking cessation, a review on workplace interventions for smoking cessation, and a review on group behaviour therapy programmes for smoking cessation. We also scanned reference lists of relevant papers to identify additional papers (snowballing). Previous reviews have shown a modest effect of incentives on quit rates, but the quality of the evidence was graded as low due to inadequate randomisation and allocation procedures, deficient outcome reporting, and confounding. Furthermore, most research has been done in the USA, and there is lack of evidence on the effect of incentives in a workplace setting outside the USA. Finally, some high-quality studies used solely incentives as an intervention, although a combination of incentives with a group cessation training programme might be more effective to help smokers quit.

Added value of this study

This study shows that financial incentives for smoking cessation in combination with a tobacco cessation group training programme can increase continuous abstinence compared with a group training programme alone. The current study shows a number needed to treat of seven for a single additional quitter, which shows that incentives combined with a smoking cessation group training programme are an effective treatment strategy compared with pharmacotherapy.

Implications of all the available evidence

Tobacco smoking is a major health threat, and more effective methods to decrease smoking are necessary. The current study adds evidence to the existing literature showing that incentives can help people to quit smoking. The biochemically validated smoking cessation rates in the current study of 41% after 12 months have rarely been observed in the literature and indicate that this approach should be further investigated. Additionally, it is especially encouraging that the results show that incentives are effective for individuals with a low level of education and income, and might therefore be effective in decreasing the socioeconomic gap in smoking prevalence when specifically directed at this group. The current study shows that incentives in addition to an existing smoking cessation programme can increase quit rates, and whether incentives could also be used in other (health-care) settings to increase the effectiveness of existing smoking cessation programmes should be explored.

reward-based incentive programmes. Additionally, group counselling is more effective than self-help or less intensive help, such as brief support from a health-care provider.[8]

The workplace can be a constructive environment to stimulate tobacco cessation,[10] and promotion of tobacco cessation is financially beneficial for employers. Employees who smoke tobacco show increased workplace absenteeism, loss of productivity due to smoking breaks or withdrawal symptoms, and increased health-care costs.[11–13] Moreover, ex-smokers show decreased absenteeism and productivity losses compared with continuing smokers within 1–4 years.[11] For employees, a smoking cessation training programme at the workplace is easily accessible, because it does not require a financial contribution, does not cost extra travel time, and is situated in a familiar environment. Furthermore, group counselling with colleagues can have an extra advantage of social support and peer pressure during and between counselling sessions.[10,14]

In the Netherlands in 2017, 23% of individuals aged 18 years and older among the general population smoked on a regular basis.[15] However, smoking prevalence is much higher among people with a low level of education (defined as elementary school and lower secondary education) in the Netherlands (29%) than among people with a high level of education (18%; defined as upper secondary education and university), and this difference in smoking prevalence is also found between people with lower and higher incomes.[15] Smoking among employees strongly varies between work settings and can be substantially higher within certain companies.[16] Since 2004, by government decree, all employees are entitled to a smoke-free workplace and smoking in public places is prohibited; however, many companies have special rooms or cabins for smoking inside their building, or sheltered smoking areas on the company premises.

Although incentives for smoking cessation have been studied in different ways, these studies show modest quit rates at best. Although previous studies have shown evidence that reward-based incentives, group counselling, and workplace-situated interventions are effective,[5,8,10] to our knowledge, no study has effectively combined these elements. The aim of the current study was to examine the effectiveness of a combination of these effective components within a cluster-randomised trial. We hypothesised that incentives in combination with a group smoking cessation training programme organised at the workplace would increase quit rates compared with a group training programme alone. A second aim was to investigate whether incentives might result in different cessation rates for employees with different levels of education, income, or nicotine dependency.

Methods

Study design

This study is a cluster-randomised controlled trial done in the Netherlands among companies that offer a

smoking cessation group training programme to all of their smoking employees. The protocol of this study with a detailed description of the methods has been published[17] and can be consulted for additional information regarding research methods. The study protocol was approved by the Medical Research Ethics Committee of Atrium Medical Centre Heerlen, Heerlen, Netherlands (number 16-N-13).

Participants

We approached companies of varying size and from different industry types in the Netherlands to participate in this study by email and phone. Companies were required to facilitate a smoking cessation training programme at the workplace during or directly after working hours. Employees within participating companies were recruited by the company management using flyers, posters, email, and intranet messages, and spouses could also participate. Participants needed to be current tobacco smokers aged at least 18 years. Exclusion criteria were an acute life-threatening disease, not being a currently active smoker, not being able to read or speak Dutch, and having already started an attempt to quit smoking at the moment of inclusion. Before the start of the study, all participants were informed about the design of the study and the possibility to receive vouchers for quit success. All participants gave written informed consent.

Randomisation and masking

Participants were randomly assigned on a cluster level to the intervention or control group. Participants from the intervention companies received financial incentives of up to €350 for successful smoking cessation, whereas participants from the control companies did not receive financial incentives. A cluster was defined as the assembly of participants within a company who followed the smoking cessation training programme together as a group. By cluster randomisation, all participants within a group were allocated to the same (intervention or control) group to prevent possible feelings of unfairness. The randomisation sequence was generated by a digital programme using the biased urn method, in order to maintain allocation to intervention groups as balanced as possible.[18] The randomisation programme was written by a statistician (BW), but companies were randomly allocated by an independent research assistant not involved in the study. Group allocation was not revealed to participants or employers until the start of the first training session.

Because of the nature of the intervention, it was not possible to mask the outcome assessor for the intervention groups. However, during the statistical analyses, which were first done at the 6-month follow-up and repeated at the 12-month follow-up, all researchers, including the statistician, were masked to treatment allocation. Allocation was unblinded after the first analyses were completed and the research team unanimously agreed on the interpretation of the findings.

	Intervention group (n=31)	Control group (n=30)
Company size		
0–50	2 (6%)	2 (7%)
51–100	2 (6%)	3 (10%)
101–200	3 (10%)	4 (13%)
201–500	8 (26%)	5 (17%)
501–1000	9 (29%)	4 (13%)
>1000	7 (23%)	12 (40%)
Industry type*		
Administrative and support service activities	3 (10%)	0
Agriculture, forestry, and fishing	1 (3%)	0
Education	3 (10%)	1 (3%)
Financial and insurance activities	2 (6%)	2 (7%)
Human health and social work activities	4 (13%)	8 (27%)
Manufacturing	7 (23%)	9 (30%)
Mining and quarrying	1 (3%)	0
Professional, scientific, and technical activities	0	2 (7%)
Public administration and defence, and compulsory social security	2 (6%)	3 (10%)
Real-estate activities	0	1 (3%)
Transportation and storage	4 (13%)	2 (7%)
Water supply, sewerage, waste management, and remediation activities	1 (3%)	2 (7%)
Wholesale and retail trade	3 (10%)	0
Company smoking regulations†		
Smoking is allowed		
Yes	254/319 (80%)	236/285(83%)
No	51/319 (16%)	38/285 (13%)
Missing	14/319 (4%)	11/285 (4%)
Employees can take a smoking break whenever they like		
Yes	174/319 (55%)	188/285 (66%)
No	130/319 (41%)	86/285 (30%)
Missing	15/319 (5%)	11/285 (4%)
Cluster size	10·6 (3·5)	10·4 (3·6)

Data are n (%) of companies, n/N (%) of employees, or mean (SD). *Based on the Standard Industrial Classification. †Based on self-report of individual employees, since possibilities to take a smoking break could vary depending on the type of job the employee had within a company.

Table 1: **Company characteristics**

Procedures

A smoking cessation group training programme was organised at each of the participating companies. The training programme consisted of a 90-min session per week for 7 weeks. The training sessions were given by professional coaches from the Dutch company SineFuma, which is experienced in giving smoking cessation group training in a workplace setting. The pre-existing training programme was designed to help participants to initiate a quit attempt and guide them through the first few difficult weeks of quitting smoking, with an important role for group dynamics and peer support. Participants quit together at the start of the third session, and had quit smoking for about 1 month at the last session.

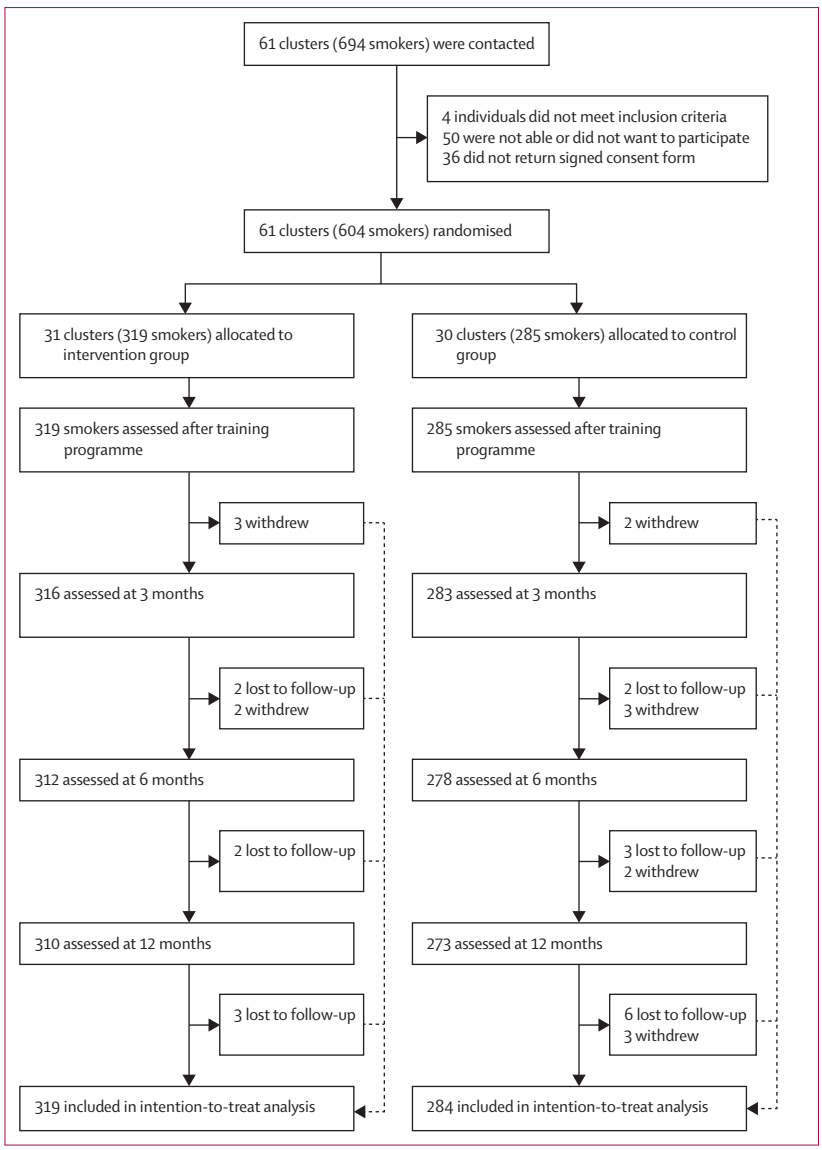

Figure 1: **Trial profile**

Participants in the intervention group could earn four vouchers with a total worth of €350. The first €50 voucher was received on the condition of biochemically validated smoking abstinence at the end of the smoking cessation training programme. The second and third €50 vouchers could be earned when participants were abstinent 3 and 6 months after finishing the cessation programme. At the end of the study (12 months after completion of the cessation programme), participants could earn an additional €200 voucher.[17] The value of the incentives was chosen to be high enough to motivate quitting smoking, while remaining acceptable for employers to implement in the future. The payment schedule was designed so that the first reward was received relatively soon (ie, directly after finishing the training) and so that the reward that was given after the longest period of abstinence (12 months) was the largest, to be attractive to the participants from the start of the intervention and taking into account the typical discounting of delayed rewards.[19] The vouchers were sent by email in the form of a digital code that could be exchanged via a web shop for a large range of products or activities.

Outcomes

The primary outcome was 12-month carbon monoxide (CO)-validated continuous smoking abstinence according to the Russell Standard.[20] Smoking abstinence was assessed by self-report of continuous abstinence, biochemically validated by CO measurement. Secondary outcomes were CO-validated smoking abstinence and self-reported abstinence directly after completing the smoking cessation training programme, after 3 months, and after 6 months. A PiCO Smokerlyzer (Bedfont Scientific, Kent, UK) was used to measure expired-air CO concentrations, with a cutoff point of 9 parts per million.[20] In case of disagreement between participants' self-report of smoking and CO measurement, participants were classified as smokers. Missing values on self-reported smoking and missing CO validation on endpoint measurements were counted as smokers. That is, if an individual self-reported or was found to be smoking at 3 or 6 months but was abstinent at the 12-month visit, they would not receive the €200 financial incentive and would not be classified has having met the primary endpoint.

We used a baseline questionnaire to assess participant characteristics. Participants were asked to state their highest completed education, which was recoded into three categories: low (none completed, primary school and lower secondary education), moderate (middle secondary education) and high (upper secondary education and university). We assessed net monthly household income with a multiple-choice item with 13 categories. Income was individualised for each participant by taking the mean of the lower and upper boundary of each household income category and dividing this amount by the square root of the number of people in the household.[21] The individualised income was divided into three categories based on tertiles. Furthermore, we assessed whether participants had attempted to quit smoking in the past (yes or no), and how many cigarettes on average they smoked per day. We calculated pack-years to assess life-time smoking and we measured nicotine dependence with the Fagerström Nicotine Addiction questionnaire, in which a scale from 1 (not addicted) to 10 (heavily addicted) determines the level of nicotine addiction.[22]

Statistical analysis

Estimates for the sample size calculation were based on a previous study with 15% quitters in the intervention group versus 5% in the control group.[5] With an alpha of 0·05 and 80% power to detect this effect, a sample size of

141 participants per group was required. Considering the cluster-randomised design and assuming a mean of 12 participants per cluster (m), and an intra-class correlation (ICC) of 0·05,[23] the design effect [=1+(m−1) ICC] equalled 1·55, which yielded a sample size of 219 participants per group. Taking into account 15% loss to follow-up due to unexpected employee turnover,[5] at least 516 participants within at least 44 clusters needed to be included in the study. We present participant characteristics using frequencies (%) for categorical variables and means (SDs) for numerical variables. In the modified intention-to-treat analysis, all randomly assigned participants were included in the denominator for calculating abstinence with the exception of unavoidable loss (participants who had died or moved to an untraceable address), as stated in the Russell Standard.[20] We assessed the difference in continuous smoking abstinence (within 1, 3, 6, or 12 months) between the intervention group and the control group using a generalised linear mixed-effects model analysis with a logit link (binary outcome) and a random intercept at the company level to adjust for the clustering of participants within a company. The fixed part of the model included group (intervention *vs* control) and prespecified variables known to be related to the outcome: income (three categories), education (three categories), and nicotine dependency (Fagerström score). We imputed missing data on these variables using the other fixed variables that were included in the model, and used sex, company, number of attended sessions (0–7), and continuous abstinence as predictors. We used multiple imputation to create 50 complete datasets, where the maximum number of iterations was set to 20 and trace lines were used to check convergence. We used the complete case analysis (including only participants for whom all variables included in the model were not missing), as well as the model that only included group as the fixed factor (no correction for other variables), as sensitivity analyses. We investigated the possible effect modification of income, educational level, and nicotine dependency (Fagerström score) by including these factors as interactions with group in the model. Two-sided p values of 0·05 or less were considered statistically significant. We used IBM SPSS Statistics for Windows (version 23.0) to compute descriptive statistics. We used the RStudio version 1.1.383 mice package for multiple imputation and lme4 package (glmer function) for the generalised linear mixed-effects models.

The trial is registered at the Dutch Trial Register, number NTR5657.

Role of the funding source

The funder had no role in the study design, the collection or analysis of the data, the interpretation of data, the writing of the report, or the decision to submit the article for publication. The corresponding author had full access to all of the data and the final responsibility to submit for publication.

	Intervention group (n=319)	Control group (n=285)
Age, years	43·9 (10·4)	46·6 (9·7)
Sex		
Women	102 (32%)	121 (42%)
Men	217 (68%)	164 (58%)
Educational level		
Low	97 (30%)	62 (22%)
Middle	136 (43%)	119 (42%)
High	75 (24%)	90 (32%)
Missing	11 (3%)	14 (5%)
Income level		
Low	111 (35%)	68 (24%)
Middle	91 (29%)	84 (29%)
High	76 (24%)	105 (37%)
Missing	41 (13%)	28 (10%)
Attempted to quit in the past		
Yes	253 (79%)	228 (80%)
No	55 (17%)	48 (17%)
Missing	11 (3%)	9 (3%)
Cigarettes per day		
≤10	58 (18%)	55 (19%)
11–20	179 (56%)	159 (56%)
21–30	59 (18%)	58 (20%)
≥31	9 (3%)	3 (1%)
Missing	14 (4%)	10 (4%)
Pack-years	21·6 (13·2)	23·5 (13·0)
Missing	24 (8%)	11 (4%)
Fagerström test for nicotine dependence	4·4 (1·9)	4·5 (2·0)
Missing	19 (6%)	12 (4%)
Used nicotine replacement therapy during quit attempt		
Yes	134 (42%)	130 (46%)
No	156 (49%)	117 (41%)
Missing	29 (9%)	38 (13%)
Used medications* during quit attempt		
Yes	77 (24%)	43 (15%)
No	212 (66%)	204 (72%)
Missing	30 (9%)	38 (13%)
Used e-cigarettes during quit attempt		
Yes	52 (16%)	58 (20%)
No	235 (74%)	184 (65%)
Missing	32 (10%)	43 (15%)

Data are mean (SD) or n (%). *Varenicline, bupropion, or other smoking cessation medications.

Table 2: **Participant baseline characteristics**

Results

61 companies were recruited from March 1, 2016, to March 1, 2017 (table 1). 694 smokers were contacted, of whom four did not meet the inclusion criteria, 50 were not able or did not want to participate in the study, and 36 did not provide a signed informed consent form (figure 1). The remaining 604 participants (of whom one was a spouse) were randomly assigned to the control group (30 clusters, 285 participants) or the intervention group (31 clusters, 319 participants), and used as the

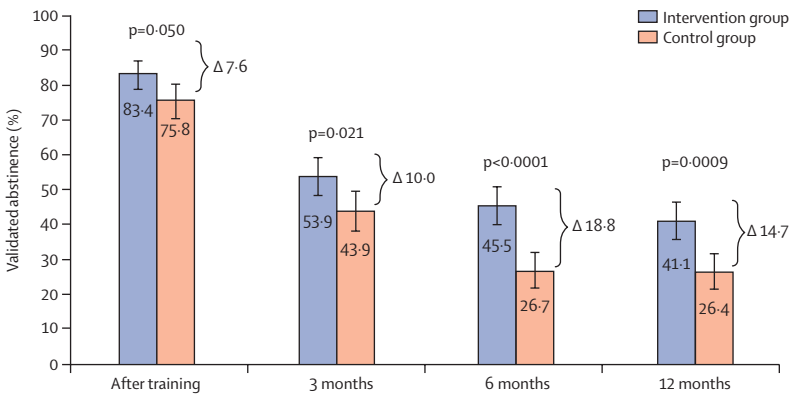

Figure 2: **Validated smoking abstinence in the intervention *vs* control groups**
Figure shows histogram of modified intention-to-treat analysis with multiple imputation, adjusted for education level, income level, and Fagerström score, with percentages of validated abstinence in the intervention (smoking cessation programme plus financial incentive) and control (smoking cessation programme only) groups directly after the smoking cessation training programme, at 3 months, 6 months, and 12 months. Δ=risk difference.

	Intervention group (n=319)	Control group (n=285)	Adjusted odds ratio* (95% CI)	p value	Number needed to treat for one abstinent smoker
Abstinence after programme completion	..	..	..	..	13
Self-reported	267 (84%)	226 (79%)	1·50 (0·81–2·75)	0·195	..
Biochemically validated	266 (83%)	216 (76%)	1·77 (1·00–3·12)	0·050	..
3-month abstinence	..	..	..	..	10
Self-reported	181 (57%)	137 (48%)	1·46 (1·00 –2·15)	0·051	..
Biochemically validated	172 (54%)	125 (44%)	1·55 (1·07–2·24)	0·021	..
6-month abstinence	..	..	..	..	5
Self-reported	149 (47%)	95 (33%)	1·78 (1·21–2·64)	0·0039	..
Biochemically validated	145 (45%)	76 (27%)	2·39 (1·62–3·52)	<0·0001	..
12-month abstinence	..	..	..	..	7
Self-reported	132 (41%)	80 (28%)	1·81 (1·24–2·65)	0·0022	..
Biochemically validated	131 (41%)	75/284 (26%)†	1·93 (1·31–2·85)	0·0009	..

Data are n (%) or n/N (%). Modified intention-to-treat analysis with multiple imputation. *Adjusted for education level, income level, and Fagerström score. †One participant excluded from the analysis because of unavoidable loss to follow-up according to the Russell Standard.

Table 3: **Continuous abstinence at endpoints**

denominator in all analyses according to the modified intention-to-treat protocol, with the exception of the biochemically validated outcome at 12 months, where one participant from the control group was excluded from the analysis because of unavoidable loss to follow-up (figure 1). The mean age of the participants was 45 years (SD 10·17), and the majority were men (table 2). 481 (80%) of 604 participants reported having tried to quit in the past (table 2). Participants reported a mean of 22 pack-years (SD 13·17) and a mean Fagerström score of 4·4 (1·98; table 2). The mean net annual individualised household income in our study was €24170·97 (SD 8788·53; appendix), which makes the €350 incentive 1·45% of the participants' average annual household income.

The smoking cessation training programme consisted of seven sessions, of which participants attended a mean of 5·5 sessions (SD 1·6) in the control group and a mean of 5·8 sessions (1·4) in the intervention group (appendix). Participants from both groups who were abstinent from smoking at 12 months after the training programme had attended, on average, about one session more than participants who had relapsed to smoking.

In all cases in which participants self-reported that they were abstinent and CO verification was done, the CO score confirmed the participants' self-report (figure 2; table 3). For the primary outcome at 12 months, 131 (41%) of 319 participants in the intervention group and 75 (26%) of 284 participants in the control group were verified quitters (adjusted odds ratio [OR] 1·93, 95% CI 1·31–2·85; p=0·0009; table 3). Directly after completion of the smoking cessation training programme, 266 (83%) of 319 participants in the intervention group and 216 (76%) of 285 participants in the control group were verified quitters (adjusted OR 1·77, 95% CI 1·00–3·12; p=0·050; table 3). At 3 months, the proportion of quitters was 172 (54%) of 319 in the intervention group and 125 (44%) of 285 in the control group (adjusted OR 1·55, 95% CI 1·07 to 2·24; p=0·021; table 3). At 6 months, the difference in the proportion of participants who were abstinent between the intervention group and control group increased to 19% (adjusted OR 2·39, 95% CI 1·62–3·52; p<0·0001; table 3).

The analyses investigating possible effect modification of income, education, or nicotine dependency showed no significant interactions (all p values ≥0·079; appendix), indicating similar effects for these subgroups. The results for the lowest income and education groups show similar patterns to the whole group; that is, an intervention effect was obtained after 6 months (table 4).

In the sensitivity analysis (appendix) in which only study group was included as the fixed factor, with no correction for other variables, ORs and corresponding p values were in the same direction and of similar magnitude as in the main analysis. The results of the adjusted (n=507) complete case analysis that included only participants for whom none of the variables in the model were missing also showed results similar in size and direction to those of the main analysis (12-month CO-validated abstinence complete case analysis OR 2·14; main analysis OR 1·93; appendix). The intra-class correlation in the CO-validated adjusted complete case analysis was 0·043 for the 12-month measurement point (appendix).

Discussion

In this cluster-randomised controlled trial, we aimed to determine whether financial incentives in addition to a smoking cessation group training programme (compared with a training programme with no incentives) was

See Online for appendix

effective in increasing abstinence in tobacco-smoking employees. Our findings show that financial incentives for abstinence in combination with a tobacco cessation group training programme at the workplace stimulate smoking cessation and are effective in smokers with a low level of education and income. Incentives can increase the number of successful quitters compared with a group training programme alone.

Incentives significantly increased 12-month continuous abstinence, with validated quit percentages of 41% in the intervention group with 26% in the control group. In two similar, large studies[5,7] that investigated incentives for smoking cessation within companies, 12-month quit rates were considerably lower than in the current study. In one of those studies,[5] 12-month quit rates were 9·4% in the incentive group and 3·6% in the control group, even though the amount of money used as an incentive in that study (US$750) was considerably higher than in the current study (€350, which is approximately $410). Although participants in that study[5] were encouraged with a $100 incentive to seek smoking cessation counselling, counselling was not a standard part of the protocol, and few people participated in a counselling programme (15·4% in the incentive group and 5·4% in the control group). Therefore, the higher quit rates observed in the current study than in other workplace-based incentive studies[5,7] might be explained by the addition of the smoking cessation programme, in which all participants of the current study were enrolled. Although the current study was not designed to assess the effectiveness of the training programme, and quit success might also result from factors outside the training programme, motivation to quit smoking elicited by the incentive is likely to increase quit success if smokers are supported in a professional group training programme that increases knowledge and skills, provides social support, and removes barriers to quitting. This notion is supported by the observation that, in the current study, the control group (no incentives) also showed high quit rates at 3 months (44%), while in the control group of the study by Volpp and colleagues[5] only 11·8% of participants were abstinent at the first measurement. These numbers might reflect the effectiveness of a comprehensive group training programme with multiple sessions, as was used in the current study, and are in line with earlier research that showed the value of smoking cessation counselling and its contribution to successful quitting.[8,24] Another similar study done in Switzerland investigated the effect of large incentives up to $1650 (without counselling) for 12-month abstinence.[6] The results showed 12-month abstinence rates of 9·5% in the incentive group (and 3·7% in the control group). The current study used much smaller incentives but had higher quit rates than the study of Etter and Schmid,[6] which suggests that modest incentives might have the potential to be as effective as large incentives if combined with additional smoking cessation support.

	Adjusted odds ratio* (95% CI)	p value
Abstinence after programme completion		
Low education	1·45 (0·58–3·65)	0·428
Low income	1·27 (0·54–2·96)	0·582
3-month abstinence		
Low education	1·54 (0·77–3·07)	0·219
Low income	1·96 (1·04–3·73)	0·039
6-month abstinence		
Low education	3·84 (1·81–8·12)	0·0005
Low income	3·99 (1·90–8·38)	0·0003
12-month abstinence		
Low education	2·71 (1·28–5·70)	0·0091
Low income	1·90 (0·96–3·74)	0·064

159 participants had a low level of education and 179 participants had a low income. *Adjusted for education level, income level, and Fagerström score.

Table 4: **Analyses for biochemically validated continuous abstinence for participants with a low level of education and low income**

This study showed that the effect of incentives on smoking abstinence was similar among smokers with high, medium, and low levels of education and income, indicating that the intervention was effective even for the low income and education groups. This result is important, because smokers with low socioeconomic status are less likely to quit,[25] and many existing smoking cessation interventions are more effective among those from higher socioeconomic status groups,[26] which leads to increasing differences in smoking prevalence.[27] Therefore, financial incentives for smokers with low socioeconomic status could be an effective strategy to decrease the socioeconomic gap in smoking.

Although most participants in this study were initially successful in quitting smoking during the smoking cessation training programme, quit rates rapidly declined within the first 3 months after the training programme had finished. Steep relapse curves are also found in smokers who quit without assistance, where most relapses occur in the first 8 days of a quit attempt.[28] The results showed that the proportion of participants who were abstinent remained fairly stable between the 6 and 12 months of follow-up in both groups, which is in line with research suggesting that the risk of relapse declines to almost zero after 100 days of continuous abstinence.[29] Importantly, in the present study, the difference in abstinence between the intervention and control group increased over time (from about 8% to about 15%), which shows that incentives are not only effective in motivating initial quit attempts, but can also be a crucial factor for sustained abstinence. The results of this study suggest that professional support can help to lengthen a quit attempt, but raises the question about whether smoking cessation guidance should be extended to a longer period, with, for example, a refresher session within the first 6 months after finishing the smoking cessation programme. The right

incentive size and timing of delivery might flatten the relapse curve, but research in this area is scarce.[2,30,31] Therefore, future studies should determine the optimal size and timing of incentives to facilitate quitting, by varying incentive schemes and amounts.

The current study has some limitations that should be taken into consideration. Although this study was executed within a large number of diverse companies, the results might not be generalisable to every company, since employee characteristics might affect outcomes.[16] Participants volunteered to follow the smoking cessation training programme and were therefore assumed to be motivated and ready to quit. Participants in the control group were not masked to the intervention condition of receiving vouchers for quit success. This had the advantage that both groups could be recruited with an identical strategy, which prevented selection bias between the intervention and control group while using the incentives to increase enrolment.[32] However, this might have led to disappointment or loss of motivation when the randomisation result was revealed during the first training session. However, only a small number of participants withdrew from the study in either study group. Furthermore, the mean number of training sessions attended was similar between the intervention and control groups, with a small (but significant) difference (5·8 *vs* 5·5 sessions). This difference might have been caused by a mediating effect of the incentives; for example, the incentives might have increased the participant's motivation to be present at the training sessions. Another limitation of the current study was that these results show quit rates while the incentives were still in place. More research is needed to determine whether incentives also contribute to long-term smoking cessation when the incentives are removed.[2] Although a considerable effort was made to verify each self-reported quitter with biochemical testing (eg, by making extra company visits and scheduling home appointments) CO verification could not be done for every participant. This was mostly caused by scheduling problems, vacations, or illness. According to protocol, the participants were included as smokers in the analysis. Since participants in the intervention group could have been more willing to attend the CO measurement appointments in order to receive the incentive, this could explain the small difference between self-reported and biochemically validated quit rates. In the current study, expired air CO measurement was chosen as biochemical verification. Although CO is the preferred method to detect recent smoking,[20] there is no objective way of verifying abstinence over the full 12 months. A particular concern with incentive-based trials is that the opportunity to receive a reward in combination with the relatively short detection period of CO measurement might enable gaming (in which participants deliberately mislead study investigators about their smoking behaviour to obtain financial incentives). A previous study[33] involving financial incentives for smoking cessation in pregnant women that investigated gaming by comparing smoking abstinence based on self-report and CO measurement with cotinine measurement found that only 4% of participants showed false reporting of smoking status. Although gaming in the current study cannot be ruled out completely, the fact that there were no CO measurements that did not correspond with the participant's self-report of abstinence strengthens confidence in the results. Notably, three participants who at first claimed to be abstinent, upon further inquiry, turned out to have a different definition of abstinence from the research criteria; all participants had quit smoking cigarettes, but one participant still smoked cigars, another smoked marijuana, and the third used a hookah to smoke tobacco. This shows that it is important to clarify what is considered as tobacco smoking when assessing self-report of smoking.

The results of the current study could have implications for current tobacco cessation treatment methods. Previous research has shown that proof of effectiveness of incentives is an important contributor to the acceptability of incentives for quitting smoking.[34,35] The results of the current study might therefore increase support for this relatively new strategy to decrease smoking. The number needed to treat for a single additional quitter during at least 12 months in the current study was seven (table 3), which shows that incentives are a very effective treatment strategy, whereas previous research showed less favourable numbers need to treat for a single additional quitter in case of pharmacotherapy (number needed to treat for varenicline was ten, for bupropion 18, and 23 for nicotine replacement therapy).[36] This study showed that modest incentives can elicit substantial quit success. The results of the current study might therefore motivate employers to facilitate a smoking cessation programme combined with incentives at the workplace to help employees to quit smoking.

Contributors

OCPvS and NHC conceived and designed the study. FAvdB wrote the first draft of the paper. BW did the statistical analysis. The paper was revised and edited by FAvdB, GEN, OCPvS, BW, and NHC. All authors read and approved the final manuscript.

Declaration of interests

We declare no competing interests.

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