Effects of Smokefree Class Competition 1 year after the end of intervention: a cluster randomised controlled trial

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Accepted 11 October 2010
Published Online First 11 November 2010

ABSTRACT

Background The Smokefree Class Competition, a school-based smoking prevention intervention, is widely disseminated in Europe. Participating classes commit themselves to be smoke-free and self-monitor their smoking status. Classes that remain smoke-free for 6 months can win prizes. Effects of the intervention on current smoking, initiation and progression of smoking were investigated.

Methods Cluster randomised controlled trial. 84 schools (208 classes with 3490 students; mean age 12.6 years, 50.4% female) in Saxony-Anhalt, Germany, were randomly assigned to intervention or control condition. A baseline survey was conducted before the implementation of the programme, while post-test and follow-up surveys were carried out 7 (immediately after the end of the competition), 12 and 19 months after baseline. Effects of participation in the programme on current and lifetime smoking were analysed by multilevel models controlling for confounding variables.

Results Intervention students smoking occasionally at baseline smoked less frequently than students taking not part in the intervention at 7 and 12 months after baseline. Persistent beneficial programme effects were also found for lifetime smoking: intervention students were less likely to progress from experimental to established use.

Conclusion Data suggest that Smokefree Class Competition reduces the probability of progressing from occasional and experimental stages of smoking to more established forms of use.

Clinical trials registration number Trial registration ISRCTN27091233 in Current Control Trial Register.

INTRODUCTION

Smoking begins during adolescence and continues to be a problem worldwide.[1] Because of its major health consequences,[2] the prevention of smoking onset during adolescence is an important health goal. School-based prevention programmes offer one approach to the problem of youth smoking; however, it has been challenging to disseminate these programmes widely. The 'Smokefree Class Competition' (SFC)—a school-based programme to prevent smoking in adolescents—has been implemented Europe-wide since 1997, with high numbers of participating countries and classes (http://www.smokefreeclass.info). The approach of SFC is based on the established association between smoking in adolescents and their peers,[3] with peer smoking being one of the most influential risk factors.[4] The competition aims to correct the overestimation of smoking frequency in adolescents[5] by demonstrating that the class, an important reference group for students, is smoke-free. Correction of norms and fostering a commitment not to use are evidence-based criteria of successful substance-use prevention programmes.[6] Participating SFC classes commit themselves by contract management to stay smoke-free for a period of 6 months. Participation is voluntary and bound to an agreement that at least 90% of the students sign up for the SFC. Classes staying >90% smoke-free during the entire competition period can win prizes in a lottery after the end of the competition as a positive reinforcement of remaining smoke-free.

To date, four studies, including two randomised trials, have been published on the effects of the competition.[7–12] These studies reveal effects on smoking immediately after the competition, while longer-lasting effects (up to 2 years after baseline) were questioned.[8 10] However, none of the previously published studies address the complex methodological requirements inherent in an evaluation of SFC. First, in SFC, classes decide whether or not to take part in the competition. Thus, following a randomised allocation in a cluster randomised trial, all classes in the intervention group are offered the option to take part in SFC, but not all comply. Moreover, it is probable that the two class-level subgroups within the intervention arm differ on their smoking behaviour at baseline because of the criteria for selection—that the class has to be 90% smoke-free. Up to now, this challenge for study design and analysis has not been adequately addressed. Published studies rely on either before-and-after evaluations including only classes willing to participate[11 12] or evaluations in which allocation to the intervention group was equated with participation in SFC, that is classes did not have the option to decide whether to participate or to decline participation.[7 8] Another problem with existing studies is that classes are the levels at which the competition operates, but evaluation of SFC effects has been carried out only at the individual level. This ignores the hierarchical cluster design, in which observations in one class are dependent on each other.[13–15]

The current study addresses these different critical issues by using a more complex cluster randomised controlled group design and more rigorous multilevel analyses to evaluate the effects of SFC on smoking behaviour.

METHODS

Intervention

Classes participating in SFC decide to remain a non-smoking class for a period from November to April (6 months), and a contract is signed, stipulating that the classmates want to remain smoke-free. Requirements for participation in the competition are that at least 90% of pupils in class vote in favour of participation, and classes monitor their (non-)smoking behaviour on a weekly basis. On a monthly basis, they provide assurances to the organisers of the competition that they remain smoke-free (>90% non smokers) or admit this is not the case and drop out of the competition. Classes that refrain from smoking may win a number of prizes, the main prize being a class trip. For recruiting classes, fliers and posters are sent to all secondary schools (targeting 11- to 14-year-olds). After registration, participating classes receive a folder with comprehensive material containing the contract, feedback cards, a parents' leaflet and CD-ROM. Furthermore, a webpage (http://www.besmart.info) with information, online registration and feedback is available (for a detailed description of the competition see Wiborg and Hanewinkel[16]).

Design and randomisation

A two-arm four-wave cluster-randomised controlled trial was implemented at the beginning of the 2006 school year in Saxony-Anhalt, a Bundesland (state) of Germany. Data were collected in four waves: baseline (prior to the start of the intervention; October 2006), 7 months after baseline (shortly after the end of the intervention; May 2007),12 months after baseline (October 2007) and 19 months after baseline (June 2008).

After consenting to study participation and prior to first assessment, schools were randomly assigned to the intervention or the control arm with stratification on type of school. The allocating person was blind to the purpose of the study. Schools were sorted by type of school and then assigned to two groups by drawing lots. The ratio for allocation to intervention and control group was 60 to 40, since it was assumed that not all intervention classes would decide to participate. All intervention classes were offered the chance to participate in SFC, resulting in an intervention subgroup that registered for SFC (IG-participation) and a subgroup with classes having decided not to participate (IG-no participation). The classes in control group (CG) received 'usual curriculum.'

Procedure

Human subject approval was obtained through the Saxony-Anhalt IRB (Landesverwaltungsamt Sachsen-Anhalt, Reg.-Nr. 504-50/06). Only students with written parental consent were assessed. Data were collected through self-completed anonymous questionnaires, administered by teachers. To permit a linking of individual information on subsequent surveys, each questionnaire was labelled with a seven-digit individual code generated by the student, a procedure that had been tested in previous studies.[17] The procedure ensures anonymity but allows for the linking of questionnaires over time. Students were assured that their individual information would not be seen by parents or school administrators. Teachers received a book voucher amounting to €20 per assessment as an incentive for their effort.

Sample

Saxony-Anhalt was chosen as the study region because SFC was rarely implemented there before the school year 2006–2007. Saxony-Anhalt has two types of secondary schools: the 'Gymnasium' recruits primarily students with higher academic skills in comparison with the 'Sekundarschule'; both types were invited to participate (Gymnasium N=71, Sekundarschule N=141) after applying the following school exclusion criteria: (a) a closure of the school was foreseen in the following 2 years (N=24), (b) the school was already engaged in a tobacco control programme (N=51) or (c) classes of the school had participated in SFC before (N=21). In September 2006, the 212 eligible secondary schools were invited to enrol all of their seventh-grade classes, and 87 schools (41%) with 223 seventh-grade classes and 4454 students agreed to participate (figure 1).

Baseline data were collected from 3490 (78.3%) students from 208 classes from 84 schools. Two hundred and ninety-one (6.5%) students were disqualified because teachers refused to give permission, another 581 (13.1%) had no written parental permission for student participation, and 92 (2.1%) were absent on the day of the survey. Among the 208 classes with baseline data, 130 classes were in the intervention group, from which 68 (52%) decided to participate in SFC (IG-participation), and 62 (48%) decided not to participate (IG-no participation). Some 78 classes were enrolled in the control group.

Altogether, some 32 complete classes with a total of 577 students (16.5% of 3490 pupils with baseline data) were inadvertently missed at post-test, first and second follow-up evaluation, since their teachers withdrew consent to participate during the study period. Another 50 students (1.4% of 3490 pupils with baseline data) gave inconsistent answers on gender and age over time, and were excluded from the analyses for that reason. Further, 704 students (20.2%) were not successfully matched over the four waves, or were only present at baseline but not at (all) following assessments. At post-test, data of 3123 (89.5%) students were analysed, at first follow-up 2595 (74.4%) and at second follow-up 2420 (69.3%). Data sets from all four waves were available for 2159 students (61.9%). Dropout from the study was lowest in the control group (27.1% compared with 46.5% for IG-participation, and 43.5% for IG-no participation). The analyses rely in each case on the largest available sample at the respective wave (for detailed information on dropouts and samples analysed in each wave, see figure 1). A post hoc power calculation using STATA's commands sampsi and sampclus (α=0.05, 1−β=0.8, mean number of observations per cluster N=17) revealed for current smoking at post-test a sample size of 183 classes and 3096 students.

Measures

Data were collected in students and teachers with self reports of students being the main source of information. Current smoking was assessed by asking 'How often do you smoke at present?' to which respondents could answer 'I don't smoke,' 'less than once a month,' 'at least once a month, but not weekly,' 'at least once a week, but not daily' or 'every day,' collapsed into the categories non-smoker, occasional use (less than once per month or monthly) and regular use (weekly or daily). Lifetime smoking was assessed by asking 'How many cigarettes have you ever smoked in your life?' with response categories 'none,' 'just a few puffs,' '1 to 19 (less than a pack),' '20 to 100 (one to five packs)' or 'more than 100 (more than five packs),' resulting in the categorisation of never smokers, experimenters (a few puffs to 100 cigarettes lifetime) and established smoking (more than 100 cigarettes lifetime).[18]

Potential confounders included: age; gender; smoking in parents (none vs any), siblings (none vs any) and peers (none vs some vs most or all); rebelliousness and sensation-seeking (12-item index, Cronbach α=0.77)[19] with higher scores indicating

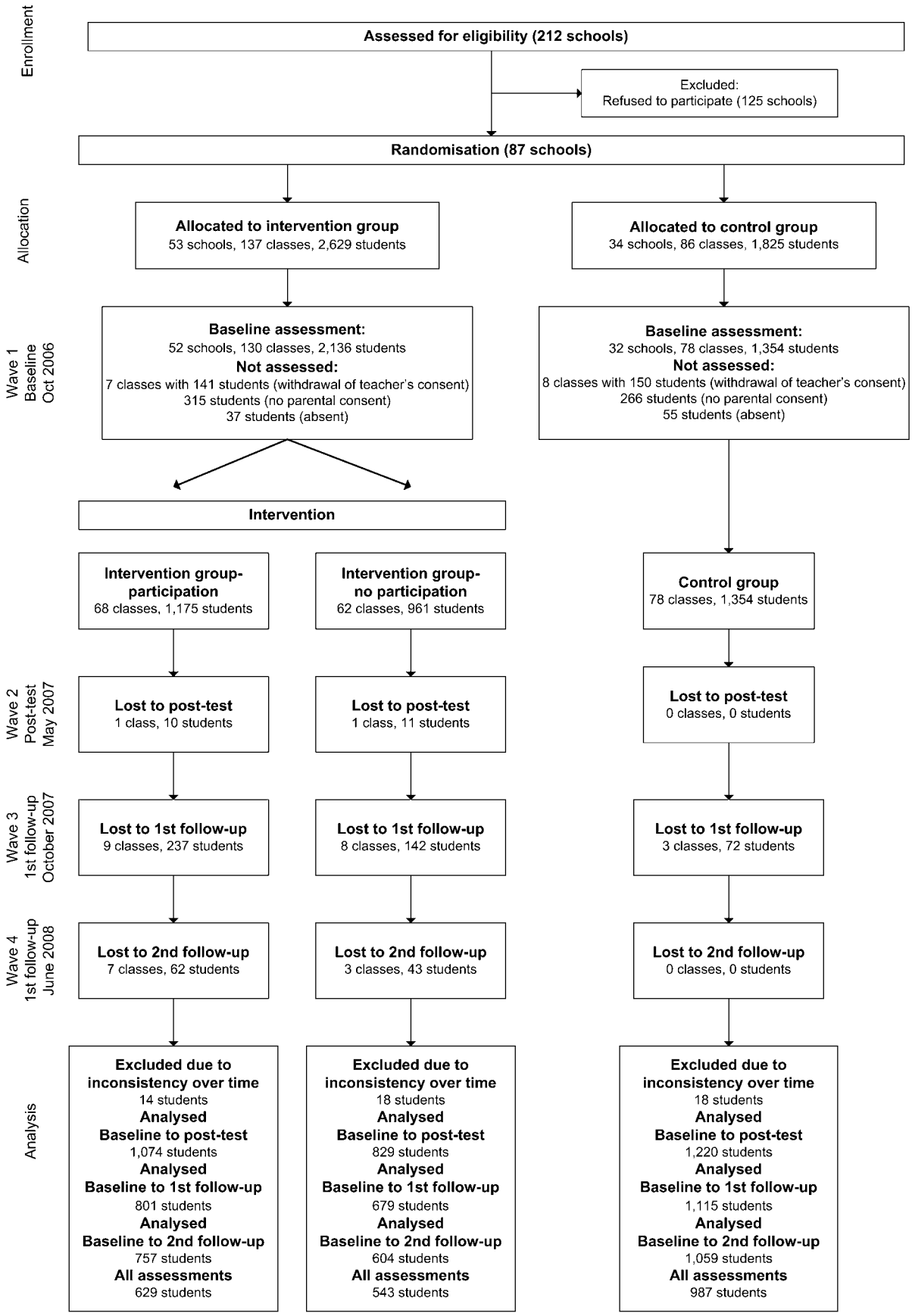

Figure 1 Participation flowchart.

a greater propensity for rebelliousness and sensation seeking. A general measure of parenting style was also included (eight-item index, α=0.68).[20] Higher scores on parenting style are indicative of higher levels of parental control and responsiveness. The type of school was used as a proxy for socio-econonmic status with 'Sekundarschule' being associated with lower socio-econonmic status than 'Gymnasium.'[21] Students rated their class climate (nine-item index, Cronbach α=0.77) as well as the teachers (11-item index, Cronbach α=0.85), which was entered as class-level variable.

Analysis

In order to test for possible baseline differences between the groups, analyses of variance and χ^2 tests were used. Baseline group differences in outcome and confounding variables were controlled for in analyses of later assessments to account for possible effects of self selection owing to the decision on participation in the competition.

Predictors of attrition were examined by logistic regression. Intervention effects on current smoking were tested with multilevel mixed-effects linear regressions that included baseline covariates (procedure LME in R).[22 23] Initiation and progression of smoking were analysed in discrete time multilevel logistic hazard regressions with data for lifetime smoking, for which backwards transitions were not allowed. Since data on teacher's perception of class climate were missing in 17 classes at baseline, these data were multiply imputed.[23] All analyses use statistical methods that assume missing data due to attrition are missing

Table 1 Comparison of groups at baseline (n=3440)

	Intervention group — participation, N=1161		Intervention group — no participation, N=943		Control group, N=1336		
	M	SD	M	SD	M	SD	
Demographics							
Age	12.54	0.69	12.73	0.76	12.69	0.73	$F_{(2,123)}$=6.52; p=0.002
	N	%	N	%	N	%	ICC_{Cls}=0.12, ICC_{Schl}=0.07
Gender							
Male	578	49.8	460	48.8	668	50.0	$\chi^2_{(2)}$=0.32; p=0.850
Female	583	50.2	483	51.2	668	50.0	
Nationality							
German	1122	97.3	897	95.6	1279	96.1	$\chi^2_{(2)}$=3.41; p=0.182
Others	31	2.7	41	4.4	52	3.9	
Smoking behaviour							
Lifetime smoking							$F_{(2,123)}$=4.15; p=0.018
No	635	55.1	449	48.0	732	55.2	ICC_{Cls}=0.07, ICC_{Schl}=0.11
Just a few puffs	278	24.1	519	23.4	272	20.5	
1–19 cigarettes	132	11.5	117	12.5	158	11.9	
20–100 cigarettes	52	4.5	72	7.7	94	7.1	
>100 cigarettes	56	4.9	78	8.3	70	5.3	
Current smoking							
No smoking	978	84.3	729	77.6	1099	82.3	$F_{(2,123)}$=4.95; p=0.009
Less than once a month	74	6.4	48	5.1	72	5.4	ICC_{Cls}=0.11, ICC_{Schl}=0.07
At least monthly, less than weekly	27	2.3	40	4.3	39	2.9	
At least weekly, less than daily	31	2.7	33	3.5	56	4.2	
Daily	50	4.3	89	9.5	69	5.2	
Confounders							
Sensation-seeking*	1.70	0.38	1.75	0.42	1.69	0.40	$F_{(2,123)}$=2.38; p=0.097
							ICC_{Cls}=0.06, ICC_{Schl}=0.04
Parenting†	3.13	0.50	3.06	0.55	3.09	0.52	$F_{(2,123)}$=2.32; p=0.102
							ICC_{Cls}=0.03, ICC_{Schl}=0.04
Parent smoking							
No	459	39.9	372	40.0	569	43.2	$\chi^2_{(2)}$=0.60; p=0.743
Any	692	60.1	557	60.0	748	56.8	
Sibling smoking							
No	849	74.1	638	68.5	955	72.2	$\chi^2_{(2)}$=2.97; p=0.227
Any	297	25.9	294	31.5	367	27.8	
Peer smoking							
No	503	43.8	330	35.3	552	41.8	$\chi^2_{(4)}$=4.87; p=0.087
Some	523	45.6	423	45.2	577	43.7	
Most or all	122	10.6	182	19.5	193	14.6	
Class climate							
Student's perception‡	2.13	0.49	2.17	0.48	2.13	0.47	$F_{(2,123)}$=0.99; p=0.373
							ICC_{Cls}=0.21, ICC_{Schl}=0.03
Teacher's perception§	2.25	0.32	1.95	0.40	2.06	0.33	$F_{(2,107)}$=11.96; p=0.001
							ICC_{Schl}=0.00

*Compliance rating ranging from 1 to 4, with higher scores indicating higher levels of sensation seeking/rebelliousness.
†Compliance rating ranging from 1 to 4, with higher values representing higher levels of parental control and responsiveness.
‡Compliance rating ranging from 1 to 4, with higher values representing a worse climate.
§Compliance rating ranging from 0 to 3, with higher values representing a better climate.
ICC, intraclass correlation or variance proportion (the student proportion is 1 minus school plus classroom ICCs); Cls, Class; Schl, School.

at random conditional on predictors included in the analytical or imputation model to minimise any potential attrition bias.

RESULTS

Baseline characteristics

The baseline sample consisted of 3440 students, of whom 50% were female. The mean age was 12.65 years (SD=0.73, range=11–16). The three groups were tested for baseline equivalence on all variables under study using multilevel models to take into account school and classroom level clustering. Evidence for inequality was found for several items (table 1): students from the IG-participation group were significantly younger. Lifetime and current smoking were more frequent in the IG-no participation group compared with the other two groups. Classes that voted against participation had a poorer class climate from their teacher's perspective.

Attrition

Attrition was related to own smoking and being exposed to smoking in social environment, higher levels of sensation seeking, worse class climate, older age, being a non-German citizen and attending the 'Sekundarschule.' Since attrition effects are especially problematic when study dropout is related to one of the outcome variables, we also checked interactions between covariates and intervention status with respect to attrition. However, we found significant interaction effects only for the variables age (interaction age×IG-no participation (ref. CG): OR=1.37 (1.08 to 1.74), p=0.009) and school type (interaction school type×IG-participation (ref. CG): OR=0.62 (0.43 to 0.88), p=0.006; interaction school type×IG-no participation (ref. CG): OR=0.69 (0.49 to 0.97), p=0.031): in the control group, the age difference between attrition and retention students was higher than in the two intervention groups where older students dropped out more frequently (CG: OR=1.20 (1.01 to 1.42), p=0.036; IG-participation: OR=1.21 (1.02 to 1.44), p=0.028; IG-no participation: OR=1.64 (1.38 to 1.94), p=0.000). In the IG-participation group, dropout rates did not vary substantially between students from 'Gymnasium' and 'Sekundarschule' (OR=1.13 (0.89 to 1.43), p=0.304), while students from 'Sekundarschule' dropped out more frequently in the other two groups (CG: OR=0.78 (0.60 to 1.00), p=0.046; IG-no participation: OR=0.70 (0.53 to 0.91), p=0.006).

Effects on current smoking

For the analysis of intervention effects on current smoking behaviour, IG-participation classes were compared with IG-no participation and control group, controlling for baseline differences and other relevant confounders. There was no intervention main effect on current smoking at any subsequent wave (table 2) after controlling for baseline smoking status and covariates. However, significant group differences are found at wave 2 and wave 3 for baseline occasional smokers, with less current smoking in IG-participation compared with students without participation in SFC. Other factors associated with change in smoking status among baseline occasional smokers included a higher level of use, higher age, female gender, high levels of sensation seeking as well as being exposed to peer, sibling and parent smoking.

The intervention effect for occasional users is illustrated by figure 2, which shows the adjusted means for current smoking frequency in waves 2, 3 and 4 separated by smoking frequency

Table 2 Multilevel mixed effects linear regressions for current smoking frequency in waves 2, 3 and 4 with baseline covariates

	Wave 2			Wave 3			Wave 4		
	Estimate	95% CI	p Value	Estimate	95% CI	p Value	Estimate	Estimate 95% CI	p Value
Intercept	1.20	1.08 to 1.32	0.000	1.24	1.08 to 1.40	0.000	1.40	1.20 to 1.60	0.000
IG-no participation and control group	0.01	−0.09 to 0.11	0.864	0.06	−0.06 to 0.18	0.327	0.07	−0.11 to 0.25	0.399
Occasional use	0.58	0.40 to 0.76	0.000	0.29	0.04 to 0.54	0.022	0.55	0.26 to 0.84	0.000
Regular use	2.33	2.11 to 2.55	0.000	2.28	1.95 to 2.61	0.000	2.05	1.66 to 2.44	0.000
Age	0.08	0.04 to 0.12	0.000	0.13	0.07 to 0.19	0.000	0.10	0.02 to 0.18	0.005
Female gender	0.08	0.02 to 0.14	0.006	0.11	0.03 to 0.19	0.005	0.22	0.12 to 0.32	0.000
Sensation Seeking	0.21	0.11 to 0.31	0.000	0.31	0.19 to 0.43	0.000	0.46	0.30 to 0.62	0.000
Parenting	−0.05	−0.11 to 0.01	0.126	0.02	−0.06 to 0.10	0.691	−0.02	−0.12 to 0.08	0.646
Parent smoking	0.06	0.00 to 0.12	0.057	0.12	0.04 to 0.20	0.004	0.15	0.05 to 0.25	0.002
Peer smoking	0.16	0.10 to 0.22	0.000	0.23	0.15 to 0.31	0.000	0.24	0.14 to 0.34	0.000
Sibling smoking	0.06	0.00 to 0.12	0.079	−0.01	−0.09 to 0.07	0.829	0.16	0.06 to 0.26	0.004
Student-rated class climate	0.00	−0.06 to 0.06	0.943	0.02	−0.08 to 0.12	0.617	−0.01	−0.13 to 0.11	0.807
Student smoking class level	0.08	−0.02 to 0.18	0.121	0.16	0.02 to 0.30	0.020	0.06	−0.12 to 0.24	0.504
Teacher-rated class climate	−0.04	−0.18 to 0.10	0.556	0.10	−0.06 to 0.26	0.217	0.01	−0.23 to 0.25	0.926
School type	−0.11	−0.23 to 0.01	0.058	−0.08	−0.22 to 0.06	0.246	−0.18	−0.36 to 0.00	0.057
IG-no participation and CG×occasional use	0.36	0.14 to 0.58	0.001	0.55	0.26 to 0.84	0.000	0.16	−0.19 to 0.51	0.386
IG-no participation and CG×regular use	0.16	−0.08 to 0.40	0.183	−0.28	−0.63 to 0.07	0.136	−0.12	−0.55 to 0.31	0.596
	N	ICC		N	ICC		N	ICC	
Students	3013	0.79		2505	0.81		2345	0.82	
Classes	205	0.12		186	0.08		182	0.09	
Schools	83	0.09		81	0.11		79	0.09	

CG, control group; IG, intervention group; ICC, intraclass correlation.

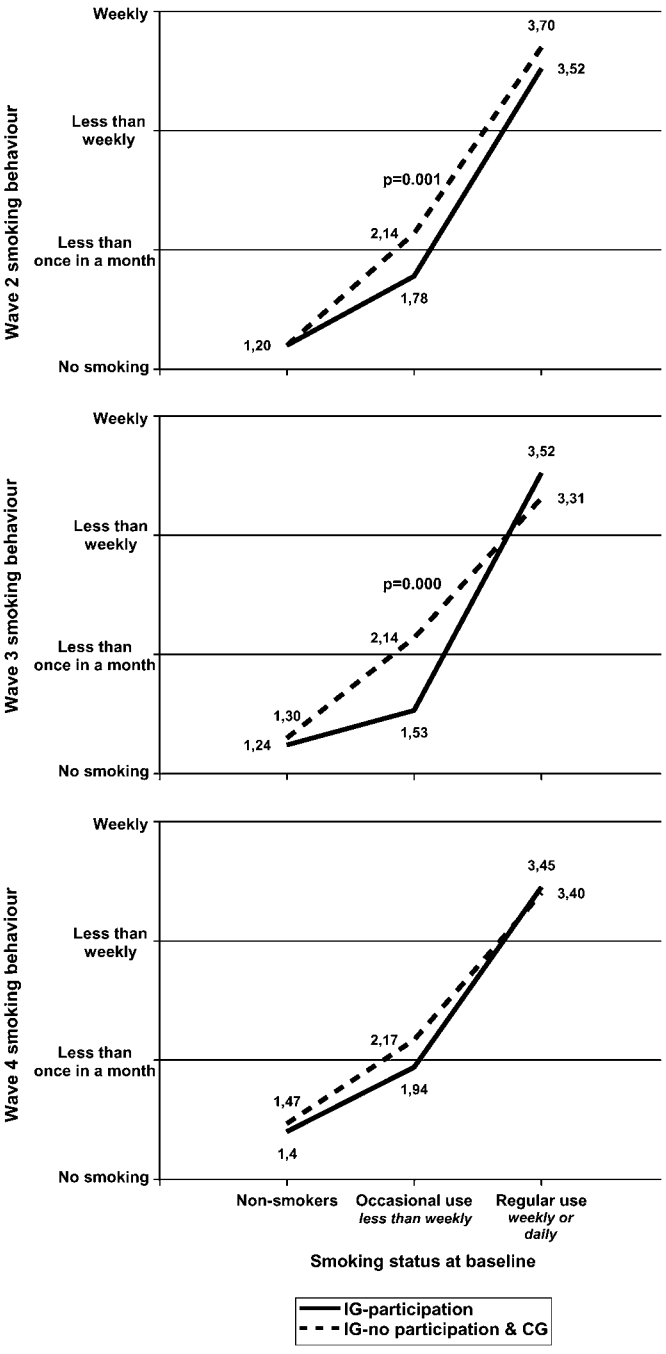

Figure 2 Adjusted means for frequency of current smoking in wave 2, 3, and 4 by baseline smoking status. Smoking frequency: 1=no smoking; 2=less than 1×/month; 3=at least 1×/month; 4=weekly; 5=daily; occasional use=2 or 3; regular use=4 or 5. CG, control group; IG, intervention group.

at baseline (index ranging from 1=no smoking to 5=daily smoking).

Effects on smoking initiation and progression of lifetime smoking

No group differences were found in the frequency of initiation of smoking among baseline lifetime never smokers during the study period (results available on request). However, the probability among baseline lifetime experimental smokers to progress to established use was higher for non-participants (adjusted HR=1.45 (1.00 to 2.10), p=0.047) (table 3). The interaction between time and group was not significant, indicating that the intervention effect on progression was stable over time.

DISCUSSION

The current study found evidence for preventive effects for a widely disseminated school-based smoking-prevention intervention 12 months after the end of the competition. Participation in SFC had short-term effects on current smoking among baseline occasional smokers and decreased the probability of progressing from experimental to established smoking over the entire study period of 19 months. No effects could be shown for current non-smokers or regular smokers; nor was there any intervention effect on initiation among baseline never smokers. Thus, the salient effect of the intervention is that it reduces the risk of a progression into higher stages of use among early experimental smokers. Taking into account the complex design requirements owing to the rules of the intervention and the clustering of the data as well as controlling for relevant confounding variables, the findings of the current study confirm and extend existing evidence for an intervention effect for this programme.

Owing to high risks for development of dependence once experimental smoking is begun,[24 25] the transition from occasional into regular and established use is a critical step in the course of adolescent smoking. Therefore, it is noteworthy that SFC appeared to impact this critical phase of smoking progression. A similar pattern of results—effects on experimental stages of smoking and no effects on never and established use—was also found in the evaluation of one of the largest US programmes in drug prevention, the project ALERT.[26] This pattern of results may suggest that early experimental smokers are the group most amenable to intervention effects.

There are some limitations to the study. First, it is limited to one federal state of Germany. For Germany at least, Saxony-Anhalt offered the last chance to evaluate an established intervention under real-life conditions in a randomised controlled trial. Because Saxony-Anhalt is a mainly rural region, the results may not apply to all regions in Germany or to adolescents in other nations. Second, data are based on students' self report. The validity of self-report data on adolescent smoking is overall rated as acceptable,[27–30] and several measures were implemented to minimise associations between the survey and SFC (eg, introduction of SFC after first assessment, completely neutral title and description of the study, instruction of teachers, second and fourth assessment after the competition's prize draw), but it cannot be ruled out completely that SFC students are influenced and biased in their reporting behaviour with more frequent concealing of smoking. Against that possible under-reporting, we observed that inconsistent response patterns over time (eg, backward transitions for lifetime use) did not differ by intervention status. Third, there was some attrition over the study period (consistent data for all four waves are available for only 61.9% of the initial sample, and dropout rates were higher in the two intervention groups than in the control group), a factor that could bias the results if attrition was related to intervention assignment and smoking status. However, our assessment of systematic attrition with attrition patterns differing by intervention status does not point to a strong bias. The difference in dropout rates between the two intervention groups and the control group might be caused by the difference in effort for teachers: participation in the study was less

Table 3 Discrete time multilevel logistic hazard regression for transition to established from experimental smoking using multiple imputation for missing teacher data

Fixed effects	Estimate	se	z	p Value	HR (95% CI)
Intercept	−3.47	0.282	−12.311	0.000	0.03 (0.01 to 0.06)
Wave 2—wave 3	−0.01	0.157	−0.047	0.962	0.99 (0.73 to 1.35)
Wave 3—wave 4	0.46	0.158	2.934	0.003	1.59 (1.16 to 2.17)
IG-no participation and control group	0.37	0.187	1.986	0.047	1.45 (1.00 to 2.10)
Age	−0.02	0.091	−0.258	0.797	0.98 (0.81 to 1.17)
Female	−0.12	0.139	−0.861	0.389	0.89 (0.67 to 1.17)
Sensation-seeking	0.65	0.184	3.546	0.000	1.92 (1.34 to 2.76)
Parenting	−0.11	0.130	−0.868	0.385	0.89 (0.69 to 1.16)
Parent smoking	0.11	0.150	0.729	0.466	1.12 (0.83 to 1.50)
Peer smoking	0.86	0.126	6.863	0.000	2.37 (1.85 to 3.03)
Sibling smoking	0.19	0.137	1.408	0.159	1.21 (0.92 to 1.59)
Student-rated class climate	0.10	0.152	0.689	0.491	1.11 (0.82 to 1.50)
Student smoking class level	0.40	0.166	2.439	0.015	1.50 (1.08 to 2.08)
Teacher-rated class climate	0.11	0.252	0.451	0.652	1.12 (0.68 to 1.84)
School type	−0.25	0.210	−1.183	0.237	0.78 (0.51 to 1.18)

Sample sizes	Wave 1 to wave 2	Wave 2 to wave 3	Wave 3 to wave 4
Students	1226	1095	796
Classrooms	201	178	164
Schools	83	81	77

IG, intervention group.

What is already known on this subject

Prevention of smoking in adolescents is a major task for public health, but school-based programmes often fail to reach effectiveness. The Smokefree Class Competition is a smoking prevention programme widely disseminated throughout European schools.

What this study adds

Participation in the Smokefree Class Competition seems to contribute to reduced rates of current smoking and progression to established use among adolescents with first experiences with smoking. With the Smokefree Class Competition, a tool for smoking prevention is available with hints for evidence of being both effective and easy to implement.

demanding for teachers in the control group who had to take care 'only' on the implementation of the surveys than for teachers in the two intervention groups who had to deal also with the competition.

The strengths of the current study include the random assignment of schools, the inclusion of outcome assessments in control classrooms as well as classrooms that opted out of participation in the competition, the multilevel analysis that included class-level variables for socio-econonmic status and class climate, individual controls for baseline group differences owing to self selection in the intervention classes, and a large sample with a total time frame of 19 months and four waves.

In summary, the current results confirm and extend hitherto existing findings on the effects of SFC,[7 8 11 12] documenting a modest effect on the transition from experimental to established smoking. Considering the wide dissemination of the competition in Europe—with more than half a million students participating each year—the preventive effect documented herein could have important public health implications.

Acknowledgements The authors would like to thank G Wiborg, who was involved in the planning of the study, and all teachers and classes taking part in this study.

Funding This study was funded by German Cancer Aid. After a positive decision on applying for study support, the German Cancer Aid did not influence the collection, analysis or interpretation of data nor the writing of the article and decision to submit it. The implementation of the Smokefree Class Competition in Germany was funded by German Cancer Aid, European Commission, Federal Centre for Health Education, German Heart Foundation, AOK-Bundesverband, German Lung Foundation and BKK-Landesverband Ost in the school year 2006/2007 and 2007/2008.

Competing interests IFT-Nord is responsible for both the implementation and evaluation of the competition.

Ethics approval Ethics approval was provided by the Saxony-Anhalt IRB (Landesverwaltungs-amt Sachsen-Anhalt, Reg.-Nr.504-50/06).

Contributors BI contributed to the conception and implementation of the study, to data management and analysis and wrote the manuscript. MM contributed to the conception of the study, to data analysis and writing of the manuscript. MS analysed the data. KM compiled and managed the data and contributed to data analysis. JDS contributed to data analysis and writing of the manuscript. RH was responsible for the entire study. All researchers had access to all the data.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. **Warren CW,** Jones NR, Eriksen MP, *et al*. Patterns of global tobacco use in young people and implications for future chronic disease burden in adults. *Lancet* 2006;**367**:749—53.
2. **Ezzati M,** Lopez AD. Estimates of global mortality attributable to smoking in 2000. *Lancet* 2003;**362**:847—52.
3. **Kobus K.** Peers and adolescent smoking. *Addiction* 2003;**98**(Suppl 1):37—55.
4. **Conrad KM,** Flay BR, Hill D. Why children start smoking cigarettes: predictors of onset. *Br J Addict* 1992;**87**:1711—24.
5. **US Department of Health and Human Services.** *Preventing Tobacco Use Among Young People: A Report of the Surgeon General*. Washington, DC: US Department of Health and Human Services, Public Health Service, Centers of Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1994.

6. **Cuijpers P.** Effective ingredients of school-based drug prevention programs. A systematic review. *Addict Behav* 2002;**27**:1009—23.
7. **Crone MR,** Reijneveld SA, Willemsen MC, *et al*. Prevention of smoking in adolescents with lower education: a school based intervention study. *J Epidemiol Community Health* 2003;**57**:675—80.
8. **Schulze A,** Mons U, Edler L, *et al*. Lack of sustainable prevention effect of the 'Smoke-Free Class Competition' on German pupils. *Prev Med* 2006;**42**:33—9.
9. **Hanewinkel R,** Wiborg G, Isensee B, *et al*. 'Smoke-free Class Competition': far-reaching conclusions based on weak data. *Prev Med* 2006;**43**:150—1.
10. **Schulze A,** Potschke-Langer M, Edler L, *et al*. Smoke-free Class Competition: a reply to the initiators of the program. *Prev Med* 2006;**43**:151—3.
11. **Vartiainen E,** Saukko A, Paavola M, *et al*. 'No Smoking Class' competitions in Finland: their value in delaying the onset of smoking in adolescence. *Health Promot Int* 1996;**11**:189—92.
12. **Wiborg G,** Hanewinkel R. Effectiveness of the 'Smoke-Free Class Competition' in delaying the onset of smoking in adolescence. *Prev Med* 2002;**35**:241—9.
13. **Murray DM,** Hannan PJ. Planning for the appropriate analysis in school-based drug-use prevention studies. *J Consult Clin Psychol* 1990;**58**:458—68.
14. **Murray DM,** Rooney BL, Hannan PJ, *et al*. Intraclass correlation among common measures of adolescent smoking: estimates, correlates, and applications in smoking prevention studies. *Am J Epidemiol* 1994;**140**:1038—50.
15. **Murray DM,** Varnell SP, Blitstein JL. Design and analysis of group-randomized trials: a review of recent methodological developments. *Am J Public Health* 2004;**94**:423—32.
16. **Wiborg G,** Hanewinkel R. Konzeption und Prozessevaluation eines schulischen Nichtraucherwettbewerbs. [Conception and process evaluation of a school-based smoking prevention project]. *Sucht* 2001;**47**:25—32. [in German].
17. **Galanti MR,** Siliquini R, Cuomo L, *et al*. Testing anonymous link procedures for follow-up of adolescents in a school-based trial: the EU-DAP pilot study. *Prev Med* 2007;**44**:174—7.
18. **World Health Organization.** *Guidelines for Controlling and Monitoring the Tobacco Epidemic*. Geneva: World Health Organization, 1998.
19. **Hanewinkel R,** Sargent JD. Exposure to smoking in popular contemporary movies and youth smoking in Germany. *Am J Prev Med* 2007;**32**:466—73.
20. **Jackson C,** Henriksen L, Foshee VA. The Authoritative Parenting Index: predicting health risk behaviors among children and adolescents. *Health Educ Behav* 1998;**25**:319—37.
21. **Richter M,** Hurrelmann K. Sozioökonomische Unterschiede im Substanzkonsum von Jugendlichen. [Socioeconomic differences in adolescent substance use]. *Sucht* 2004;**50**:258—68. [in German].
22. **R Project.** The R project for statistical computing. http://www.r-project.org 2008.
23. **Pinheiro JC,** Bates DM. *Mixed-Effects Models in S and S-Plus*. New York: Springer, 2000.
24. **DiFranza JR,** Rigotti NA, McNeill AD, *et al*. Initial symptoms of nicotine dependence in adolescents. *Tob Control* 2000;**9**:313—19.
25. **DiFranza JR,** Savageau JA, Rigotti NA, *et al*. Development of symptoms of tobacco dependence in youths: 30 month follow up data from the DANDY study. *Tob Control* 2002;**11**:228—35.
26. **Ellickson PL,** Bell RM. Drug prevention in junior high: a multi-site longitudinal test. *Science* 1990;**247**:1299—305.
27. **Kentala J,** Utriainen P, Pahkala K, *et al*. Verification of adolescent self-reported smoking. *Addict Behav* 2004;**29**:405—11.
28. **Mermelstein R,** Colby SM, Patten C, *et al*. Methodological issues in measuring treatment outcome in adolescent smoking cessation studies. *Nicotine Tob Res* 2002;**4**:395—403.
29. **Patrick DL,** Cheadle A, Thompson DC, *et al*. The validity of self-reported smoking: a review and meta-analysis. *Am J Public Health* 1994;**84**:1086—93.
30. **Velicer WF,** Prochaska JO, Rossi JS, *et al*. Assessing outcome in smoking cessation studies. *Psychol Bull* 1992;**111**:23—41.