

## Lack of sustainable prevention effect of the “Smoke-Free Class Competition” on German pupils

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### Abstract

**Background.** This study examines the effectiveness of the school-based campaign “Smoke-Free Class Competition” as a means of preventing young non-smokers from taking up smoking.

**Methods.** Based on two measurements of the Heidelberg Children’s Panel Study (1998 and 2000), a longitudinal sample of 1704 pupils was examined: 948 in the intervention group and 756 in the control group. In order to evaluate the effects of the intervention, we compared the smoking behavior in the intervention and the control group at two points in time, shortly before, and 18 months after the intervention, on an individual case basis.

**Results.** (1) Stabilization of never-smoking rates: the proportion of pupils remaining a never-smoker at the follow-up is 62.1% in the intervention group and 61.5% in the control group (OR 1.02, 95% CI: 0.83–1.24); (2) Lowering of relapse rates among ex-smokers: the proportion of former smokers who had not started smoking again in the follow-up is 45.1% in the intervention group and 41.4% in the control group (OR 1.07, 95% CI: 0.77–1.49).

**Conclusion.** The “Smoke-Free Class Competition” did not prevent smoking among adolescents and does not appear to be an effective substitute to the complete ban of tobacco advertising, the abolition of vending machines and the creation of smoke-free environments in German schools. © 2005 Elsevier Inc. All rights reserved.

**Keywords:** Smoking; Smoking prevention; School-based intervention; Adolescents; Youth; Competition

### Introduction

Smoking is the leading cause of numerous serious chronic diseases, of premature deaths and of costs amounting to billions of Euros [1–3]. Although in most developed countries prevalence rates among adults, especially among men, have declined in recent decades [4–6], the smoking prevalence among adolescents remained stable or even increased in the United States and Europe during the 1990s [7–9]. In Germany, for instance, in the year 2004, more than 41% of 12- to 15-year-old adolescents had already smoked and 16% of them were current smokers [10]. Compared to a smoking prevalence in this age group of 10% in 1989, this represents an increase of 60% [11]. The average age of German youths starting smoking today is below 14 years and more than 80% of the 12- to 25-

year-olds have their first experiences of smoking before their 16th birthday [10,12]. This is distressing as it is well known that people who start smoking early in life are more likely to develop a smoking-related disease and to become heavy smokers [13–15]; they also have a lower cumulative probability of quitting smoking [16–18]. Therefore, smoking prevention should target young people before they start consuming tobacco products in their early adolescence.

This circumstance has given rise to a great variety of tobacco-specific prevention programs for adolescents in the last decade, exploiting in particular educational opportunities available through the school system [19–21]. Primary goals of school-based intervention programs are to enable never-smokers and ex-smokers to abstain from any tobacco use, and to enable and encourage young people who have experimented with smoking, or who are regular tobacco users to cease this use as soon as possible [22]. The stabilization of never-smoking among lifetime non-smokers (1) and the lowering of

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relapse rates among ex-smokers (2) are crucial points for the present study.

The “Smoke-Free Class Competition” is the biggest single school-based and tobacco-related prevention program to pursue these aims in Germany in recent years: more than 780 classes from 420 schools entered the competition in the school year of 1998/99. This amounts to a turnout of more than 12,000 pupils; in subsequent years, there was even an increase in participation [23]. One major part of the 1998/99 competition in Germany took place at schools in the Rhine-Neckar region, which consists of Heidelberg, Mannheim and the Rhine-Neckar County. Schools in that area had already been included at this time in the Heidelberg Children’s Study, which had raised questions about the health habits of youths. In the framework of this *panel study*, the effectiveness of the “Smoke-Free Class Competition” can be analyzed with regard to two central intervention goals formulated above (stabilization of never-smoking, lowering of relapse rates among ex-smokers).

In a number of publications, the German initiators of the campaign have concluded that the intervention is effective in preventing or delaying the uptake of smoking among young people on the basis of a 6-month follow-up study [24–26]. These studies mostly use a cross-sectional approach and compare smoking prevalence at three points in time (pre-test, 1-month and 6-month follow-up). The aim of our study is to evaluate the effectiveness of the “Smoke-Free Class Competition” after 18 months with a longitudinal approach on an individual case basis. However, we only want to assess the effect of the program in total and not of specified features of its course, since we assume that only a comprehensive analysis of this intervention program can give us an impression of its effectiveness under conditions of every day life.

## Material and methods

### Intervention

The “Smoke-Free Class Competition” (named “Be smart—don’t start” in Germany) is a school-based smoking prevention program for pupils from grades 6 to 8 (aged between 11 and 15 years), which primarily intends to prevent the smoking onset among adolescents. This program, which has been implemented in several countries, has been facilitated by the European Commission as part of the EU action plan “Europe against Cancer”. It consists of a competition and a curricula aiming at preventing smoking among the pupils [27].

The *competition* is based upon some general rules, which are the same in each participating country: (a) the school classes decide to be a non-smoking class for a period of six months; (b) the school classes monitor their (non)smoking behavior and report it regularly to the organizers of the competition; (c) as long as less than 10% of its pupils are smoking, the class can still participate in the competition [28]. Classes which do not achieve this goal are excluded from the competition. Those classes who remain non-smoking for a 6-month period take part in a national and an international draw to win a number of attractive prizes.

The *intervention* consists of weekly curricula comprising information about the health effects of smoking, how to quit smoking, how to deal with peer pressure and the strategies of the tobacco industry. These topics can easily be integrated in various educational subjects by the teachers. The teachers who are responsible for carrying out the intervention in their class were invited to attend an information session before the start of the program. Additionally, they received brochures informing them about the rules of the competition and giving suggestions and recommendations for measures to help prevent smoking among their pupils. Detailed descriptions of the rules of the competition can be found elsewhere [27–29].

### Study design

In this study, the evaluation of the intervention is conducted using data from the Heidelberg Children’s Panel Study carried out by the German Cancer Research Center in Heidelberg, Mannheim and the Rhine-Neckar County. The basis for the baseline survey was a total selection of all classes of the 7th grade in Heidelberg, as well as a random sample of schools of Mannheim and the

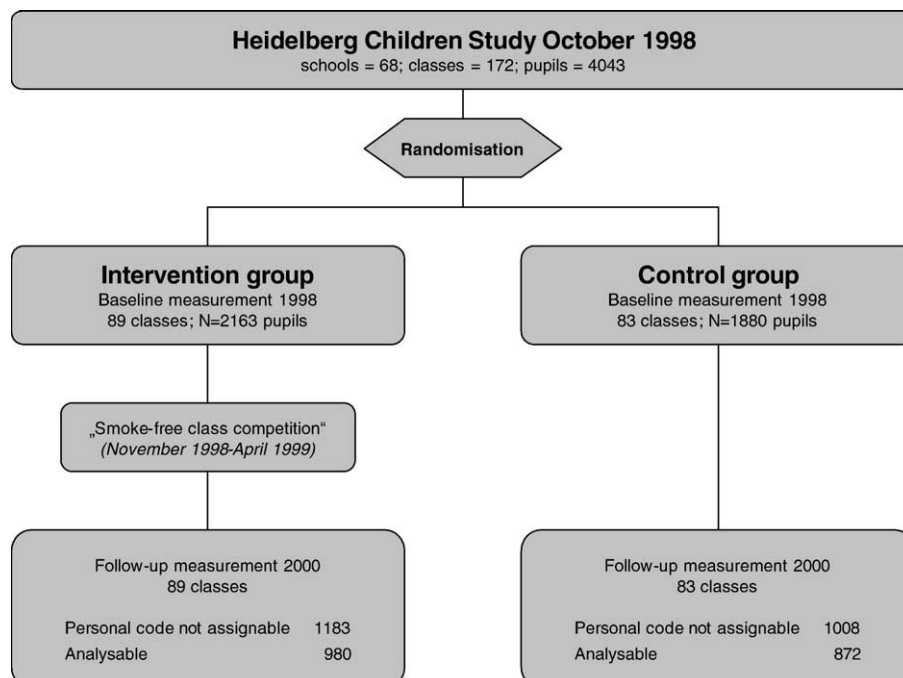


Fig. 1. Experimental study design of the “Smoke-free Class Competition” in the Rhine-Neckar region 1998–2000 (Heidelberg, Mannheim and the Rhine-Neckar County).

Rhine-Neckar County, which were stratified by school type and number of the classes. From this school-sample, all classes of the 7th grade were selected. Thus, a random sample of 172 classes of the 7th grade from 68 schools of different school-types (29 'Hauptschulen', 16 'Realschulen', and 23 'Gymnasien') was drawn. The baseline survey was conducted in October 1998 in these selected classes, yielding information from 4043 pupils.

After the first measurement, the 172 classes were stratified by school type and regional similarities (size of the school and rural or urban region). Matched pairs of schools were formed and randomly assigned to intervention and control group, because classes belonging to one school were only assigned collectively to one of the two groups in order to prevent interaction effects. No school had classes in intervention and control group at the same time. All of the 86 randomly assigned intervention classes gave their consent to participate in the competition. However, 3 classes of one school assigned to the control group were unwilling to forego the intervention: thus in 89 classes (with 2163 pupils), the above-specified intervention was performed from November 1998 to April 1999. 83 classes (with 1880 pupils) provide the basis for the control group. 18 months after the end of the intervention, the follow-up measurement was carried out in all 172 classes of the intervention and control group. Fig. 1 depicts the study design.

The baseline and the follow-up measurement is based upon a longitudinal design, which means that in both measurements the same classes and thus mainly the same pupils were surveyed, each pupil being identified by a 6-digit personal code. This code resulted from personal information of the respondent (first two letters of the first name of the mother, date of birthday and first two letters of the first name of the father). The codes were used to ensure strict data protection and to avoid possible public concerns, despite the associated risk of not identifying all pupils. So after the follow-up questioning of 3924 pupils in October 2000, about 46% of the 4043 pupils of the baseline sample from October 1998 could be identified in both measurements. This represents a total of 1852 pupils, 980 in the intervention group and 872 in the control group. The bisection of the original sample into identifiable and non-identifiable students is primarily due to class variations because of temporary absence of some students during the measurement. The official number of students attending the class and the actual number of them participating in a survey differ substantially, in the range of 10–30% per class. Another reason is that some respondents could not be assigned because their personal code was incomplete or not unique. Some students were not able to reproduce their personal code in the follow-up, and therefore could not be properly identified—possibly because of mistakes, or because of changed personal information (e.g. different family structures, which result in a different name of one parent). The number of cases for the evaluation was further slightly reduced because of missing information on the reported smoking behavior, so finally, 948 pupils of the intervention group and 756 pupils of the control group were examined. Table 1 figures the demographic distribution of the original and the realized samples at the baseline measurement for the intervention as well as the control group. There are no substantial changes in the gender, age and smoking distributions due to the attrition in intervention and control group. Also, the gender distribution of the control group does not differ significantly from that of the intervention group, but there are differences in the age structure between the groups. As a result of the lower average age of the intervention group, 4.5% fewer pupils of the intervention group had already started smoking at the time of the baseline measurement.

### Measures

In the baseline survey of 1998 as well as in the follow-up survey of 2000, self-reported data were collected from the pupils at their schools by standardized questionnaires. This was carried out under the guidance of an independent external interviewer. Permission for the whole procedure was granted under the terms of the German data protection law. Participation was voluntary and no second attempt was made to contact non-responders. In the baseline-measurement of 1998, the question about the self-reported smoking status was framed as follows: "Which applies to you: (a) I have never smoked; (b) I have already smoked, but I quit smoking or (c) I am smoking regularly". Those giving answer (a) become the category of the never-smokers; answer (b) supplies the category of ex-smokers (which can be former regular smokers or those who have so far only experimented with cigarettes) and answer (c) yields the current smokers. In the follow-up, the question was more detailed, but with similar content: Here, pupils were asked "Please consider carefully which of

Table 1

Demographic distribution of the realized/analyzed sample (*n*) and the original sample (*N*) at the baseline measurement for intervention and control group (Heidelberg, Mannheim, and Rhine-Neckar County)

|              | Intervention group |          |                |                | Control group |          |                |                | <i>P</i> value <sup>a</sup> |
|--------------|--------------------|----------|----------------|----------------|---------------|----------|----------------|----------------|-----------------------------|
|              | <i>n</i>           | <i>N</i> | % <sup>n</sup> | % <sup>N</sup> | <i>n</i>      | <i>N</i> | % <sup>n</sup> | % <sup>N</sup> |                             |
| Boys         | 470 (1048)         |          | 48.0 (48.4)    |                | 386 (935)     |          | 44.3 (49.7)    |                | ns                          |
| Girls        | 510 (1113)         |          | 52.0 (51.5)    |                | 486 (940)     |          | 55.7 (50.0)    |                |                             |
| Missing      | 0 (2)              |          | 0.0 (0.1)      |                | 0 (5)         |          | 0.0 (0.3)      |                |                             |
| 11 years old | 1 (5)              |          | 0.1 (0.2)      |                | 1 (2)         |          | 0.1 (0.1)      |                | <0.05                       |
| 12 years old | 483 (985)          |          | 49.3 (45.5)    |                | 374 (789)     |          | 42.9 (42.0)    |                |                             |
| 13 years old | 453 (1008)         |          | 46.2 (46.6)    |                | 439 (912)     |          | 50.3 (48.5)    |                |                             |
| 14 years old | 39 (144)           |          | 4.0 (6.7)      |                | 54 (154)      |          | 6.2 (8.2)      |                |                             |
| 15 years old | 3 (18)             |          | 0.3 (0.8)      |                | 3 (19)        |          | 0.3 (1.0)      |                |                             |
| Missing      | 1 (3)              |          | 0.1 (0.2)      |                | 1 (5)         |          | 0.1 (0.2)      |                |                             |
| Smoker       | 75 (250)           |          | 7.7 (11.6)     |                | 106 (307)     |          | 12.2 (16.3)    |                | <0.05                       |
| Ex-smoker    | 291 (686)          |          | 29.7 (31.7)    |                | 208 (497)     |          | 23.9 (26.4)    |                |                             |
| Never-smoker | 607 (1205)         |          | 61.7 (55.7)    |                | 454 (872)     |          | 52.1 (46.4)    |                |                             |
| Missing      | 7 (22)             |          | 0.7 (1.0)      |                | 104 (204)     |          | 11.9 (10.9)    |                |                             |
| Overall      | 980 (2163)         | 100      | (100)          |                | 872 (1880)    | 100      | (100)          |                |                             |

ns = not statistically significant at a level of 0.05.

<sup>a</sup> The *P* value refers to differences between the realized samples (*n*) of the intervention and the control group; for age, it was calculated by a *t* test, for sex and smoking status by  $\chi^2$ .

these answers apply to you: (a) I have never smoked; (b) I have already smoked, but I quit smoking more than 12 months ago; (c) I have already smoked, but I quit smoking less than 12 months ago; (d) I have already smoked, but I don't smoke regularly (not every week); (e) I smoke regularly (at least once a week)". Here, never-smokers follow from the answer (a), the category of the ex-smokers results from answers (b) and (c), and those who marked answers (d) or (e) were classified as smokers.

For the sake of consistency, ex-smokers at baseline who declared themselves to be never-smokers at follow-up (control *N* = 16; intervention *N* = 40) were assessed as ex-smokers thereafter. We assume them to be experimental smokers who either did not remember their experiences with cigarettes 2 years later or by then considered them to be irrelevant. It should also be noted that for the following analyses it is irrelevant whether the classes of the intervention group reached the goal of the intervention (at least 90% of the pupils are non-smoking for a period of 6 months) or not. This means that those classes that failed to reach the goal are also included in the calculation of the intervention effects, since they also started on the program and therefore contribute to the intervention results.

### Statistical analyses

In order to evaluate the intervention measures, pupils participating in the competition are compared with pupils who did not join the intervention program. This means comparing relative changes in the smoking prevalence (and never- or ex-smoking prevalence, respectively) of the intervention group and the control group between the first measurement shortly before the intervention and the second measurement 18 months after the intervention. For this purpose, we apply mobility tables, which are commonly used in social sciences research to assess social mobility. These mobility tables may also be applied to compare a former smoking status to a later one on an individual level and thus to examine mobility flows. On an individual level, the improvement (quitting: smoker becomes ex-smoker), deterioration (smoking onset or relapse: never-smoker becomes smoker or ex-smoker; and ex-smoker becomes smoker again) and the persistence of the smoking status come to the fore. Admittedly, looking at the persistence rate is somehow problematic for ex-smokers since it is not clear whether they were ex-smokers throughout the whole period. Some of them may have changed their status from ex-smoker at baseline to smoker in

the meantime and then returned to the status of ex-smoker again before follow-up. Nevertheless, we interpret the persistence rate of ex-smokers in a positive way. Finally, logistic regressions were computed in order to examine the differences between intervention and control group, adjusted for sex, age and school-type. The statistical software package SAS.V8 was used for all the analyses.

## Results

Table 2 shows the aggregated data of the baseline and the follow-up surveys with their marginal distributions and also their individual reviews in a cross-classified table. On the *aggregated level*, 18 months after the end of the intervention, 38.7% of the pupils of the intervention group and 40.1% of the pupils of the control group were currently smoking. But the relative increase of smoking rates between the baseline and the follow-up is higher in the intervention group than in the control group, as the smoking prevalence increases by a factor of five in the intervention group (from 7.7% to 38.7%) and only by a factor of three in the control group (from 13.8% to 40.1%).

Table 2  
Dynamics of smoking behavior on aggregate and individual level from 1998–2000

| <b>Intervention group</b> N = 948 |                |                |                   |                |
|-----------------------------------|----------------|----------------|-------------------|----------------|
| <b>Smoking Status</b>             | Smoker 2000    | Ex-smoker 2000 | Never-smoker 2000 | Overall 1998   |
| Smoker 1998                       | 64<br>(6.8%)   | 9<br>(1.0%)    | 0<br>(0.0%)       | 73<br>(7.7%)   |
| Ex-smoker 1998                    | 156<br>(16.5%) | 128<br>(13.5%) | 0<br>(0.0%)       | 284<br>(30.0%) |
| Never-smoker 1998                 | 147<br>(15.5%) | 77<br>(8.1%)   | 367<br>(38.7%)    | 591<br>(62.3%) |
| Overall 2000                      | 367<br>(38.7%) | 214<br>(22.6%) | 367<br>(38.7%)    | 948<br>(100%)  |
| <b>Control group</b> N = 756      |                |                |                   |                |
| <b>Smoking Status</b>             | Smoker 2000    | Ex-smoker 2000 | Never-smoker 2000 | Overall 1998   |
| Smoker 1998                       | 77<br>(10.2%)  | 27<br>(3.6%)   | 0<br>(0.0%)       | 104<br>(13.8%) |
| Ex-smoker 1998                    | 119<br>(15.7%) | 84<br>(11.1%)  | 0<br>(0.0%)       | 203<br>(26.9%) |
| Never-smoker 1998                 | 107<br>(14.2%) | 66<br>(8.7%)   | 276<br>(36.5%)    | 449<br>(59.4%) |
| Overall 2000                      | 303<br>(40.1%) | 177<br>(23.4%) | 276<br>(36.5%)    | 756<br>(100%)  |

|  |                                   |
|--|-----------------------------------|
|  | = improvement of smoking status   |
|  | = persistence of smoking status   |
|  | = deterioration of smoking status |

Absolute numbers and table percent of cross-tabulations of smoking status 1998 and of 2000 are presented, for intervention and control group (Heidelberg, Mannheim and Rhine-Neckar County).

Compared to this, the never-smoking prevalence decreased notably in both groups and, with 38%, by roughly similar amounts over the period shown: from 62.3% to 38.7% in the intervention group and from 59.4% to 36.5% in the control group. The proportion of ex-smokers was most clearly reduced in the intervention group: in the control group, this proportion declined by only 13%, from 26.9% to 23.4%, whereas the decrease in the intervention group from 30.0% to 22.6% represents a relative reduction of 25%.

In relation to a possible improvement, persistence or deterioration of the smoking status, these changes have to be analyzed at the *individual level*, which will be done subsequently (see also Table 2). Overall, 3.6% of the youths in the control group were able to improve their smoking status (smokers becoming ex-smokers), compared to only 1.0% in the intervention group. This means that the intervention induced only 9 of 73 baseline-smokers (12%) to quit smoking, whereas 27 out of 104 pupils (26%) of the control group managed to quit, despite not taking part in any intervention program. Furthermore, the smoking status of 40.1% of the pupils in the intervention group and of 38.6% of those in the control group deteriorated, which means that these pupils were never-smokers at the baseline and became ex-smokers or smokers at the follow-up or they were ex-smokers at the baseline and became smokers again at the follow-up. In fact, the majority of the young people maintained the smoking status they had at the baseline: at 59.0%, this figure is slightly higher for the intervention group than in the control group, where it is 57.8%. However, only those who remained ex-smokers or never-smokers during the entire period can be rated as a success of the intervention. Altogether, these are 52.2% of the pupils in the intervention group and 47.6% of those in the control group. Although these proportions seem to suggest an advantage of the intervention group, such a conclusion cannot actually be drawn since these table percentages are not independent of the whole distribution of the table. Thus, to better assess whether and how the intervention could strengthen non-smoking behavior, we must have a closer look at this group.

Table 3 provides information about the persistence rates of these never-smokers and ex-smokers. At approximately 62%, the percentage of those remaining never-smokers at the follow-up is about the same size in the intervention group as it is in the control group. This translates into an Odds Ratio of 1.02 (after adjustment for sex, age and school-type) which is not statistically significant. Indeed, the intervention shows a greater effect on boys: during the entire time, more boys in the intervention group stayed never-smokers than in the control group. The reverse was observed for girls. However, these differences are not statistically significant either. For boys, the Odds Ratio is 1.05 ( $P = 0.77$ ) and for girls it is 0.99 ( $P = 0.91$ ). Almost the same can be said for the effect of the intervention program in deterring ex-smokers from taking up regular smoking again. Altogether, the proportion of those who remained ex-smokers in the follow-up is higher in the intervention group (45.1%) than in the control group (41.4%); here too, the Odds Ratio of 1.07 is not statistically

Table 3  
Persistence rates of never-smokers and ex-smokers from 1998 to 2000 for intervention and control group

|                     | Intervention group |            |                       | Control group |            |                       | Odds Ratio <sup>a</sup> (CL-95%) <sup>P</sup> value |
|---------------------|--------------------|------------|-----------------------|---------------|------------|-----------------------|-----------------------------------------------------|
|                     | In 1998            | Still 2000 | Persistence 1998–2000 | In 1998       | Still 2000 | Persistence 1998–2000 |                                                     |
| <i>Never-smoker</i> |                    |            |                       |               |            |                       |                                                     |
| Overall             | 591                | 367        | 62.1%                 | 449           | 276        | 61.5%                 | 1.02 (0.83–1.24) <sup>0.88</sup>                    |
| Boys                | 275                | 181        | 65.8%                 | 187           | 119        | 63.6%                 | 1.05 (0.78–1.41) <sup>0.77</sup>                    |
| Girls               | 316                | 186        | 58.9%                 | 262           | 157        | 59.9%                 | 0.99 (0.75–1.29) <sup>0.91</sup>                    |
| <i>Ex-smoker</i>    |                    |            |                       |               |            |                       |                                                     |
| Overall             | 284                | 128        | 45.1%                 | 203           | 84         | 41.4%                 | 1.07 (0.77–1.49) <sup>0.68</sup>                    |
| Boys                | 146                | 73         | 50.0%                 | 97            | 42         | 43.3%                 | 1.13 (0.71–1.79) <sup>0.60</sup>                    |
| Girls               | 138                | 55         | 39.9%                 | 106           | 42         | 39.6%                 | 1.03 (0.64–1.65) <sup>0.91</sup>                    |

Absolute numbers of never-smokers and ex-smokers of 1998 as well as the proportion of those maintaining their smoking status until 2000 are presented (Heidelberg, Mannheim and Rhine-Neckar County).

<sup>a</sup> Odds Ratios apply to the control group and are adjusted for sex, age and school-type.

significant ( $P = 0.68$ ). This proportion of persisting ex-smokers is higher for boys than for girls, and the persistence rate of the boys in the intervention group is higher than that of the boys of the control group; but again, the calculated Odds Ratio of 1.13 is not statistically significant ( $P = 0.60$ ). For girls, there is likewise no statistically significant difference between the intervention group and the control group (Odds Ratio = 1.03,  $P = 0.91$ ).

## Discussion

As an important aspect of the possible behavioral intervention measures, school-based programs for the prevention of tobacco consumption are receiving particular attention and broad political support in Germany. This support is given despite the knowledge that even the most successful school-based intervention measures can at most delay the onset of smoking, but not totally prevent it [30–32]. A detailed review of all evaluations (until 2001) of behavioral interventions in schools to prevent smoking concludes that of the most valid studies reviewed, one half shows at least some positive effect of intervention on smoking prevalence while the other half fails to detect any effect on smoking prevalence [30]. Another recently published systematic review, which only evaluated studies with a long-term follow-up (at least 12 months), finds only little evidence that school-based interventions achieve the long-term effects which would speak for a widescale introduction of school-based tobacco prevention. This review finds that only one out of eight studies establishes a long-term effect of school-based smoking-prevention programs [31]. Even for the Hutchinson Smoking Prevention Project, the largest school-based prevention measure with its intensive 8-year program, no evidence could be found for any significant long-term deterrence from smoking among youths [32].

Recapitulating the results of our study and taking the two main goals of the intervention measures for young adolescents into account (stabilization of never-smoking rates, lowering relapse rates among ex-smokers), we can state that the school-based campaign “Smoke-Free Class Competition” has no significant long-term influence on the smoking behavior of adolescents aged between 11 and 15 years. *Firstly*, the primary

goal of stabilizing the never-smoking prevalence was not attained, since for both the intervention group and the control group, 62% of all pupils who were not smoking at the baseline still reported that they had never smoked at the follow-up. *Secondly*, the intervention shows no statistically significant effect in providing a greater deterrent for ex-smokers from taking up tobacco use again compared to normal conditions without an intervention.

The fact that the studies by Hanewinkel and Wiborg assert a certain success of the intervention in delaying the onset of smoking [24,25] is presumably due to the clearly shorter period between the end of the intervention and the follow-up, which was only 6 months in their studies. A survey from Finland, evaluating the “Smoke-Free Class Competition”, was unable to detect any effect of the intervention 1 year after its completion [29]. A randomized study from the Netherlands, focusing only on pupils in lower secondary education, could also not confirm a long-term effect 15 months after the end of the intervention [33]. This is in accordance with the results presented here, which, in the considered age group, do not reveal any long-term effect of the intervention 18 months after its completion. In view of these results, it has to be stated that the intervention measure “Smoke-Free Class Competition” in the Rhine-Neckar region achieved no medium- or long-term effects that would allow a positive overall evaluation of the program.

The potential limitations of our study are (1) *Selection bias*: Some systematic differences between intervention group and control group in relation to age and smoking status could be detected at the baseline. Although a randomized assignment to the groups should ensure that the two groups do not differ in their socio-demographic distribution, this is not true for the randomization at school/class level, since cluster effects may occur, thus leading to the observed bias. The higher percentage of smoking pupils in the control group is due to the higher average age in this group. But since the results presented are either based upon comparisons of relative percentages or are controlled for sex and age, these findings can be neglected. (2) *Attrition bias*: From the baseline to the follow-up measurement, we have an overall attrition rate of 54%. This is due to temporary absence of some students during the baseline and/or

the follow-up measurement and to miscoding. But there are no systematic differences between the intervention and the control group concerning losses at follow-up, nor regarding the rate of attrition. (3) *Cluster effects*: As the intervention is a class-based program, the random assignment to control and intervention group had to be made on the class level. But the effectiveness of this intervention can only be assessed at the individual level, as its aim is to change the pupils' behavior and behavioral changes should be analyzed at the individual level. Nevertheless, possible homogeneity within classes would lead to a high intra-class correlation. This could cause an inflation of Type I error (i.e. lead to a higher probability of rejecting the null hypothesis). As we do not reject the null hypothesis, however, this issue would not change the interpretation of the results. (4) *Social desirability bias*: Self-reported smoking behavior may be biased by social desirability. Since all answers were provided anonymously, this error should be small. But even if this bias was actually existent, the distortion of the results would be the same for both intervention and control group.

Some major strengths of this study include: (1) the relatively large sample size; (2) a school-matched control group and (3) a longitudinal approach, providing the opportunity to test effects of the intervention on an individual case basis. Furthermore, this is the only evaluation of the "Smoke-Free Class Competition" which, while suffering from the loss of single pupils, does not additionally lose complete classes and even schools by the time of the follow-up. The attrition rate of 54% in 2 years is indeed high, but most of the other evaluations of this intervention program show the same or even higher attrition rates after even shorter observation periods [24,33].

Helping young people to avoid starting smoking is a widely endorsed goal of public health. Thus, politicians of all German parties call for the protection of children and young people from tobacco use. But the necessary structural measures, such as the complete ban of tobacco advertising, the abolition of vending machines and the creation of smoke-free environments, have not yet been implemented. In a country like Germany with widespread tobacco advertising, few smoking restrictions – even in schools – and vending machines at every street corner, the basic social conditions are already weighed against deterring young people from tobacco consumption. Before investing additional funds in preventive school programs, it should be ensured first of all that children can grow up in a smoke-free environment [34]. Only in combination with such smoke-free surroundings, which establish non-smoking as the norm, can behavioral smoking prevention measures such as the "Smoke-Free Class Competition" become effective in the long term.

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