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Effects of a School-Based Prevention Program on Smoking: Six-Month Follow-up of the 'Eigenständig werden' Cluster Randomized Trial

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ABSTRACT

Objectives: To test the effects of a school-based prevention program on students' smoking related behavior, attitudes and knowledge six months after program implementation has ended.

Design: Two-arm prospective cluster randomized controlled trial with a follow-up survey six months after end of program implementation.

Setting: Forty-five public secondary schools from four federal states in Germany (Bremen, Hesse, North Rhine-Westphalia, Schleswig-Holstein).

Participants: A total of 3,444 students from 172 classes at baseline with a mean age of 10.37 years (SD=0.59) and 47.9% girls. Analysis sample with follow-up up data merged to baseline data comprises 2,513 data sets (73.0%).

Intervention: "Eigenständig werden 5+6", a school-based prevention program for grade five and six to enhance substance specific and general life skills, consisting of 14 units (à 90 minutes) and two workshops (4 resp. 6 hours) being taught over a time period of two years by trained teachers.

Outcome measures: Lifetime and current smoking, incidence of smoking in baseline never smokers, smoking related knowledge, attitudes, perceived norms of smoking, self-efficacy to refuse cigarette offers were assessed in students.

Results: Six months after end of program implementation, students of intervention classes showed significantly lower rates for lifetime smoking (adjusted odds ratio [OR]=0.63; 95% confidence interval [CI]=[0.41; 0.96]; p=0.026) and incidence of smoking (adjusted OR=0.66; 95% CI=[0.43; 1.00]; p=0.047), a higher increase of smoking related knowledge (adjusted β=9.38; 95% CI=[6.73; 12.04]; p<0.001) and a greater change in attitudes towards a more critical perception of risks and disadvantages of smoking (adjusted β=0.10; 95% CI=[0.03; 0.16]; p=0.002). No group differences were found for current smoking, perceived norms of smoking and self-efficacy to refuse cigarette offers.

Conclusions: Participation in the school-based prevention program "Eigenständig werden 5+6" may have small effects on smoking behavior and attitudes and a moderate effect on smoking related knowledge.

Trial registration: Current Controlled Trials ISRCTN99442407

Word count abstract: 299 words

ARTICLE SUMMARY

Article focus

- School-based prevention programs show inconsistent results concerning efficacy and most of evaluation studies were conducted in the US.

- This study investigates the effects of a prevention program implemented in grade 5 and 6 in German schools on different outcomes six months after end of program using rigorous evaluation methodology.

Key messages

- Program participation seems to reduce prevalence and incidence of lifetime smoking, to increase smoking related knowledge, and to influence attitudes towards a more critical perception of smoking.

Strengths and limitations of this study

- Findings were retrieved from a cluster randomized controlled trial with a well-powered sample and under usage of sophisticated statistical methods controlling for confounders and taking clustering of data into account.

- Drop out, reliance on self-reports and lack of control for treatment integrity may be limiting factors to this study.

BACKGROUND

Smoking remains to be the single greatest preventable cause of mortality worldwide, being a major risk factor for a number of life-threatening diseases, including various cancers, cardio-vascular diseases and lung diseases.[1] Though reductions in smoking rates in adolescents have been documented for many Western countries including Germany[2] over the last decade, smoking prevention is still a main issue for public health.

School programs are often one of the first approaches mentioned in efforts to denormalize tobacco use and to raise awareness of tobacco´s hazardous nature. Prominent approaches to prevent smoking in students are the development and improvement of general life skills, as well as the fostering of skills for resisting social influence and substance-specific skills in adolescence. General life skills are considered to empower adolescents in challenging situations and to help them to master life as competent as possible.[3] By enhancing these skills, it is assumed to prevent substance use and abuse, since substance use is considered as a dysfunctional strategy to cope with every day challenges and developmental tasks in adolescence. In line with the social influence approach,[4] smoking is conceptualized as a result of influences emerging from the adolescent's environment like peers, family, or media by normative processes and/or overt cigarette offers. Therefore, correction of inaccurate norms is one important component of these programs to adjust the often overestimated prevalence of smoking in adolescence towards more conservative and realistic norms.[5] Skill training following these approaches is considered to 'inoculate' students against influences encouraging them to smoke, to help them resist temptations from peers to smoke and to correct normative expectations towards smoking.

For more than 40 years prevention programs have been implemented and evaluated within the school setting. However, empirical evidence of the efficacy of these approaches is not yet uniquely convincing.[6-11] A recent Cochrane review on the effects of school-based smoking prevention trials[12] selected randomized controlled trials where students, classes, schools, or school districts were randomized to intervention arm(s) versus a control group, and followed-up for at least six months. One hundred and thirty-four studies involving 428,293 participants met the inclusion criteria of the review which revealed an overall significant intervention effect on the onset of smoking at longest follow-up, while there was no overall effect at follow-ups at one year or less. When analyzing intervention effects not only on smoking behavior, but also on further outcomes addressed directly or indirectly by school-based interventions like attitudes towards smoking, resistance skills or smoking related knowledge, findings might be condensed into a more or less consistent pattern with medium effects being found for knowledge and, if any, small effects for attitudes, skills and use.[13-15]

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Among altogether 37 trials on smoking prevention strategies from the time period 2001 to 2006 which were included in a Health Technology Assessment, only one study originated from Germany.[16] The Cochrane Review[12] which covers publications until 2012 included another five studies from Germany, three of them were trials being published until 2000, and two trials being published after 2006 (one of these was a multi-center study with one out of seven centers being located in Germany). Most of these studies had some methodological shortcomings like not adjusting for clustering of data which results from the specific characteristics of the setting with delivery of the intervention to complete classes, and schools or classes instead of individuals being the unit of randomization. Therefore, a lack of rigorous evaluation trials on smoking prevention programs can be inferred especially for Germany.

The present study aims to contribute to overcome shortcomings in evidence for efficacy of school-based smoking prevention by presenting results of cluster randomized trial from Germany. We report findings on 6-month follow-up effects of a school-based curriculum named "Eigenständig werden 5+6" ("Becoming independent 5+6") for students in grade five and six. The overall aim of "Eigenständig werden 5+6" is the prevention of substance use and abuse by increasing substance specific skills and general life skills of students. Findings presented herein refer to effects of program participation on smoking related knowledge, attitudes towards smoking, perceived norms of smoking, self-efficacy to resist cigarette offers and actual smoking behavior six months after end of program implementation.

METHODS

Intervention

"Eigenständig werden 5+6" is a school-based prevention program for students in grade five and six which takes quality criteria of effective prevention programs into account.[7;8;17;18] Based on the life skills approach and on the social influence model, "Eigenständig werden 5+6" aims primarily at the prevention of substance use (i.e. tobacco smoking and drinking alcohol) by increasing general life skills as well as substance specific skills (i.e. coping with emotions, stress, problems, pressures to smoke and drink alcohol, increase of refusal skills and decrease of susceptibility to pro-smoking and pro-alcohol social influences).

The program delivers the contents (life skills, students' ability to work in a group, substance specific skills) in 14 units (most of them lasting 90 minutes) and in two workshops (four to six class hours) that are evenly distributed over the grades five and six. Workshops include several activities about substance use such as smoking cigarettes and alcohol misuse. All

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components are realized by trained teachers within daily school-routine. Further details on the program have been described elsewhere.[19]

Design

A five-wave cluster randomized-controlled trial with two arms (intervention and control condition) is being conducted in four German federal states (Bremen, Hesse, North Rhine-Westphalia and Schleswig-Holstein) to evaluate effects of "Eigenständig werden 5+6". The randomization occurred at school level to avoid information exchange between conditions in the school. For randomization, schools were stratified according to the following criteria: (1) study region, (2) type of school, (3) number of fifth grade classes per school. According to these strata, schools were randomly assigned to the two arms of the study with a 50 per cent chance of being allocated to either group by using coin toss method. Intervention group took part in "Eigenständig werden 5+6" and is compared to control group receiving education as usual. Assessments took place prior to the intervention in October/November 2010, post-tests were realized in June/July 2011 and June/July 2012, a 6-month follow-up was being conducted in December 2012 and a 15-month follow-up will take place in September/October 2013. For further details, see Hansen et al.[19]

Study Sample

Complete lists of all secondary schools of selected regions were obtained from the Ministries of Education of each federal state. An overall of 450 secondary schools in the study regions were invited to participate in the study, of which 323 (71.5%) did neither express approval or disapproval (Figure 1). The decision to participate in the study was expressed by 48 schools (11%) with 191 classes and 4,772 students. Of these 48 schools agreeing to participate, 26 schools with 97 classes and 2,437 students were allocated to intervention group whereas 22 schools with 94 classes and 2,335 students were assigned to control condition. After randomization, three schools of intervention group withdrew their consent as well as four teachers of intervention classes refused to take part.

Consequently, baseline data comprises 45 schools, 172 classes and 3,444 students with a mean age of 10.37 years (SD=0.59), 47.9% girls, with 1,685 students in 81 classes in intervention and 1,759 students in 91 classes in control condition. In respect to different outcome and covariate characteristics, intervention and control students were extensively comparable with the exception of a higher proportion of students of Gymnasiums in control condition (for sample size determination and detailed baseline sample description see[19]). Data presented herein refer to baseline (October 2010) and 6-month follow-up survey (December 2012). It was possible to merge follow-up data of 1,255 students in intervention

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arm and 1,438 students in control arm (total N=2,693, 78.2% of N=3,444) to baseline data. For analysis, data sets with inconsistencies concerning age, gender, and smoking status were excluded (N=180). The final analysis sample consists of 2,513 data sets (intervention group: N=1,179, control group: N=1,334).

- Insert Figure 1 about here -

Measures

Data was collected through self-completed anonymous questionnaires by teachers and students. Development of questionnaire and a complete list of variables and constructs assessed in the trial have been documented.[19] Analysis presented herein, rely on the following outcome measures: *Lifetime smoking* experience was assessed by asking how many cigarettes have ever been smoked in life. Nine answering categories ('none', 'only a few puffs', '1 cigarette', '2 cigarettes', '3-4 cigarettes', '5-9 cigarettes', '10-19 cigarettes', '20-100 cigarettes', '>100 cigarettes') were provided. Students having smoked at least a few puffs were considered as ever smokers. *Smoking incidence* at follow-up among baseline never smokers was determined by combining answers to lifetime smoking at baseline and follow-up: those who had never smoked at baseline, and indicated any smoking by the follow-up survey, even just a few puffs, were considered as having initiated smoking during the observation period. *Current smoking* frequency was measured by asking how many cigarettes are currently smoked. 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 'daily'. Responses were dichotomized into students not smoking and students indicating any kind of current smoking.

To assess *attitudes towards smoking and risk perception*, respondents should rate eleven statements (e.g. 'Non-smokers are fitter', 'Non-smokers are cooler', 'If I smoke during the next month, I will get in trouble with my friends'). Answer categories comprise 0='not true', 1='somewhat true', 2='rather true', and 3= 'totally true', i.e. higher values represent a more negative attitude towards smoking and more sensitive perception of risk. Cronbach's Alpha of this scale was 0.80. Change in attitude from baseline to follow-up was determined by subtracting baseline value from follow-up value for each respondent. *Smoking related knowledge* was tested through seven statements (e.g. 'Cigarettes contain arsenic which is also found in rat poison.') to which respondents could either agree by answering 'true' or disagree by stating 'wrong' or state 'I don't know'. As indicator of knowledge, percentage of correct classification of statements was determined. Increase in knowledge from baseline to follow-up was determined by subtracting baseline value from follow-up value for each

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respondent. *Normative expectations* were measured on an 11-point scale ranging from 0='nobody' to 10='everybody' on which students had to estimate how many a) 'Adults in Germany' and b) 'Adolescents at their age' in Germany smoke. *Self-efficacy* to refuse cigarette offers were assessed by asking 'To what extent do you dare to refuse cigarettes, even if your friends laugh at you or suspend you on that account?' with answer categories ranging from 0='not at all' to 3='totally'. Normative expectations and self-efficacy were analyzed on single item level.

Covariate measures were derived from studies that focused on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to the smoking measures.[20-22] Sociodemographics include age, gender, type of school (Gymnasium vs. other type of school), migration background (mother and/or father were born outside Germany) and socio-economic status (SES, Family Affluence Scale[23]). As personal characteristics, rebelliousness and sensation-seeking were assessed with two items in each case.[24;25] Parent, sibling and peer smoking were assessed as factors from social environment (no vs. any parent/sibling/peer smoking). Finally, students were asked whether they had participated in a comprehensive prevention program in elementary school with examples of most broadly disseminated programs given.

Procedure

In schools having agreed to participate, teachers of the respective 5th grade collected the parental informed consent. Students with refusal were excluded from all assessments. Data assessment was conducted in the class room and lasted 45 minutes. Research staff was responsible for the distribution, help in completion and collection of the questionnaire. To permit a linking of individual baseline and follow-up data while assuring anonymity, students generated a seven digit individual code. This procedure has been tested and used in several studies and therefore been inspected and approved by Ethics Committee, data protection and Ministries of Education repeatedly.[26] Teachers were not involved in data assessment. At the end of the assessment, all questionnaires were placed in an envelope which was sealed in front of the class. Therefore, every student was assured that neither teachers nor parents were able to see the completed questionnaire.

Ethical approval for the trial was gained from the Ethics Committee of Medical Faculty of the University of Kiel. Additional approvals (e.g., from ministries of education, and parents) were sought as required.

Analyses

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Predictors of attrition were examined by logistic regressions, χ^2- and t-tests. To test for selective attrition, interaction effects for group condition and dependent variable were tested. Descriptive statistics (percentages, means, standard deviations) are crude values. To analyze effects of the intervention on smoking behavior as well as on attitudes and knowledge, multilevel mixed effect regression models using Stata *mixed* and *meqrlogit* command were conducted, adjusting for covariates. In case of dichotomous outcomes, effect sizes (Cohen's d) were determined by using the converting formula proposed by Borenstein et al.[27] Effect sizes for metric outcomes were calculated as proposed by Feingold.[28] All data analyses were conducted with Stata V.13.[29]

RESULTS

Attrition analysis

Among the 3,444 students assessed at baseline, there was no data available in the analysis sample for 931 students (27.0%). Drop-out was higher in intervention group (N=506, 30.0%) compared to control group (N=425, 24.2%; $\chi^2(1)$=15.02, p<0.001). Overall, significantly higher attrition was also found for male students (31.2%; p<0.001), students attending other schools than *Gymnasium* (32.1%; p<0.001), students with a migration background (36.5%; p<0.001), students indicating current smoking (45.7%; p=0.004) or current use of alcohol (39.8%; p<0.001) at baseline. Furthermore, students dropping out of the study were older ($M_{attrition}$=10.5 vs. $M_{retention}$=10.3 years of age at baseline; p<0.001) and had a lower SES ($M_{attrition}$=17.1 vs. $M_{retention}$=17.9; p<0.001) than students in the retention sample. Besides these overall effects, no hints for selective attrition were found, i.e. the associations between variables listed above and attrition did not differ systematically between intervention and control group.

Effects on smoking behavior

Students in intervention and control group did not differ in rates for lifetime and current smoking at baseline. At follow-up, 16.0% of intervention students indicated that they had ever smoked in their lives compared to 20.2% in the control students (Figure 2). This difference was statistically significant also after controlling for confounding factors (adjusted Odds Ratio [OR]=0.63; 95% confidence interval [CI]=[0.41; 0.96]; p=0.026).

While about 1% of intervention and control students reported current smoking at baseline, these rates increased to more than 5% at follow-up both in intervention and control group. Therefore, no group differences could be found in frequency of current smoking.

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At baseline, 95.6% of the sample were never-smokers (N=2,403; IG: 96.4%, CG: 94.9%). Among these baseline never-smokers, 15.5% initiated smoking during the observation period. Incidence rate was significantly lower in intervention students, among whom 13.7% reported first use of cigarettes between baseline and follow-up, compared to control group with an incidence rate of 17.1% (adjusted OR=0.66, 95% CI=[0.43; 1.00], p=0.047).

- insert Figure 2 about here -

Effects on smoking related knowledge and attitudes

Students of both groups showed about the same level of smoking related knowledge at baseline with correct answering rates of about 30% (Table 1). At follow-up, students in both groups scored better in the knowledge test: intervention students had a mean percentage of correct answers of 46.75, while intervention students rated on average 37.74% of the statements correctly. The increase in knowledge was significantly higher in intervention students (adjusted β=9.38; 95% CI=[6.73; 12.04]; p<0.001).

- insert Table 1 about here -

A comparable pattern was found for attitudes towards smoking: At baseline, both groups did not differ in their attitudes and showed a rather critical perception of smoking with a mean score of 2.04 on the scale ranging from 0 to 3 (Table 1). At follow-up, students rated smoking even more negatively with a mean score of 2.24 in intervention and 2.16 in control group. Compared to control group, this change in attitudes was more pronounced in intervention group (adjusted β=0.10; 95% CI=[0.03; 0.16]; p=0.002).

Normative expectations were hardly influenced by the intervention: While intervention students estimated smoking prevalence in adults marginally lower at follow-up compared to their estimation at baseline, a small increase in this estimate could be observed in control students (Table 1). For peer smoking, both groups showed a small increase in perceived frequency of smoking. None of these changes turned out to be statistically significant after covariates and baseline estimates were controlled for.

Already at baseline, students in both groups considered themselves rather capable to refuse cigarette offers (Table 1). During observation period, self-efficacy even grew with a slightly higher – but statistically insignificant – increase in intervention students compared to control students.

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Table 1.
Descriptive statistics and multilevel mixed effects linear regressions for smoking related knowledge, attitudes, perceived norms and self-efficacy to refuse cigarette offers

| | Baseline Beginning of grade 5 | | Follow-up Mid of grade 7 | | Change | | | | |
	Intervention M (SD)	Control M (SD)	Intervention M (SD)	Control M (SD)	Intervention M (SD)	Control M (SD)	adj. β[1]	Difference in change 95% CI	p
Knowledge[2]	30.34 (19.47)	30.11 (19.14)	46.75 (21.59)	37.74 (20.45)	16.53 (26.46)	7.53 (24.13)	9.38	6.73; 12.04	<0.001
Attitudes/risk perception[3]	2.04 (0.51)	2.04 (0.51)	2.24 (0.51)	2.16 (0.54)	0.20 (0.61)	0.12 (0.61)	0.10	0.03; 0.16	0.002
Norms adult smoking[4]	6.08 (1.62)	5.97 (1.59)	6.04 (1.62)	6.09 (1.55)	-0.03 (2.09)	0.12 (1.95)	-0.08	-0.24; 0.07	0.265
Norms peer smoking[4]	3.08 (2.64)	2.93 (2.56)	4.24 (2.28)	4.02 (2.18)	1.16 (3.10)	1.10 (2.93)	0.15	-0.13; 0.43	0.283
Self-efficacy to refuse cigarettes[5]	2.38 (1.04)	2.36 (1.03)	2.53 (0.80)	2.49 (0.85)	0.15 (1.20)	0.11 (1.22)	0.07	-0.03; 0.17	0.140

M = Mean, SD = Standard deviation, CI = Confidence interval
[1] Adjusted for age, gender, type of school, socio-economic status, immigration background, peer / parent / sibling smoking, sensation seeking, rebelliousness, earlier participation in prevention program, baseline value of the respective variable
[2] Mean percentage of correct answers in a 7-item quiz
[3] Range 0 to 3, higher values representing more negative attitude
[4] Range 0 = nobody smokes to 10 = everybody smokes
[5] Range 0-3, higher values representing higher self-efficacy

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Effect sizes for significant program effects were small to medium with d=0.26 (lifetime smoking), d=0.23 (incidence of smoking), d=0.45 (smoking related knowledge), and d=0.15 (attitudes/risk perception).

DISCUSSION

The current study aimed to investigate effects of a school-based prevention program on smoking related knowledge, attitudes and behavior six months after end of program implementation. Using a cluster randomized controlled design, findings revealed that program participation seems to reduce prevalence and incidence of lifetime smoking, to increase smoking related knowledge, and to influence attitudes and perceived risks of smoking towards a more critical perception. Program effects on prevalence of current smoking, normative expectations or refusal skills could not be determined. Using Cohen's classification of effect sizes,[30] effect size was small for smoking behavior and attitudes, while there was a medium effect on smoking related knowledge.

The pattern found for effects on smoking behavior with significant small effects on smoking incidence (d=0.23) and lifetime smoking (d=0.26), and no effect on current smoking can be aligned quite well with results presented in former meta-analyses: The pooled odds ratio of 0.88 for smoking onset at longest follow-up revealed by the overall analysis of Thomas et al.[12] corresponds to an effect size of d=0.07, while their subgroup analyses for different intervention approaches provided even moderate effect sizes (odds ratios between 0.49 and 0.52 corresponding to d's between 0.36 and 0.39). Earlier meta-analyses on school-based drug prevention programs,[13] psychosocial smoking prevention programs[14] or studies on Project DARE (Drug Abuse Resistance Education),[15] the most widely used school-based drug prevention program in the United States and focusing on teaching skills to recognize and resist social pressure, also determined small program effects on substance use with d's ranging between 0.08 and 0.18. Finding no effect on current smoking might also be explained to some extent by the young age of the sample with only very few students smoking already on a regular basis.

Participation in "Eigenständig werden 5+6" significantly increased smoking related knowledge with an effect size of d=0.45 – the highest effect found in our analyses. This medium effect is in line with effect sizes ranging from 0.36 to 0.42 determined in meta-analyses referred to above.[13-15] Attitudes were influenced also significantly by the intervention, the small effect (d=0.15) compares well with small effects in a range from 0.11 to 0.26 having been reported.[13-15]

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We were not able to show an effect of the intervention in correcting perceived norms of smoking or self-efficacy to refuse offered cigarettes. Students of both intervention and control group consider themselves to be rather highly self-efficacious to resist to cigarette offers already at the outset of the study and this rating even increases in both groups at follow-up, i.e. a ceiling effect might decrease discriminative power of the group comparisons. As far as perceived norms of smoking are concerned, a possible explanation of the null-effect is the fact that only a minor part of the intervention (one subtask among nine tasks of the smoking workshop at the end of grade 5) deals with the topic of norms. Most tasks in the workshop address facts about and visualization of short- and long-term consequences of smoking, others aim to scrutinize strategies of tobacco industry or to foster resistance skills.

Some limitations of the current study have to be considered: There has been some drop-out from the study from baseline to follow-up; the analysis sample (N=2,513) amounted to 73.0% of the baseline sample (N=3,444). Nevertheless, we did not find any hints for selective attrition which could restrict the validity of findings. The curriculum "Eigenständig werden 5+6" comprises of 14 lessons à on average 90 minutes and two workshops with 4 to 6 hours of duration which are implemented by teachers in addition to usual education, i.e. the program is quite time-consuming, it requires some dedication by teachers and it seems unreasonable to assume that the intervention is delivered to all classes exactly in the way and to the extent foreseen by the manual. Analyses in this report were not controlled for treatment integrity,[31;32] i.e. classes with low treatment fidelity and having been exposed only to parts of the intervention contribute to the same extent to the results of the intervention group as classes with complete program implementation and results can be considered as rather conservative. Another limitation is the reliance on self-reports in the assessment of outcomes. Especially for outcomes assessing smoking behavior, but also for attitudes towards smoking, answers might be biased by social desirability. These influences might occur more likely in the intervention group since students might be primed by the intervention that smoking is an "unwanted" behavior. Nevertheless, since purchase of cigarettes and smoking in public is forbidden by law for minors in Germany, also the students in the control condition are not free of a social desirability bias. For other outcomes like the assessment of refusal skills, validity of self-report data might be limited by restricted accessibility, i.e. whether adolescents are really able to judge their own competence to resist cigarette offers. Finally, the study was run in four federal states of Germany, i.e. generalizability might be limited due to these regional constraints.

On the other hand, some strengths of the current studies should be born in mind: Results were derived from a cluster randomized controlled trial, applying sophisticated statistical methods, comprising a range of several outcomes and following students up for six months after the end of intervention. Therefore, we implemented rather rigorous evaluation methods, which are in line with recommendations like those of the Society for Prevention Research.[33]

Perspectives and open questions for future research might be the following: In the current trial, a further follow-up at 15 months after end of intervention is being conducted to explore stability of effects in the longer term. Furthermore, exploring effects on other outcomes than smoking, e.g. alcohol use or life skills, is owing for the current study. Finally, besides stating whether an intervention is effective or not, mechanisms by which shown effects can be explained theoretically and empirically are to be explored. These mediation analyses may contribute to investigate causal models for preventive intervention, e.g. to explore whether knowledge or change in attitude are necessary preconditions for behavior change.[13]

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Figure legends

Figure 1. Participation flowchart

Figure 2. Percentage of lifetime smoking, current smoking at baseline and 6-month follow-up, percentage of smoking incidence at 6-month follow-up among baseline never-smokers, and multilevel mixed effects logistic regressions; OR = odds ratio, CI = confidence interval; logistic regressions were adjusted for age, gender, type of school, socio-economic status, immigration background, peer / parent / sibling smoking, sensation seeking, rebelliousness, earlier participation in prevention program

Competing interests

None.

Ethics approval

Ethics approval was provided by the Ethics Committee of the Medical Faculty of the University of Kiel (Ref.: D 419/10).

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Contributors

BI performed the statistical analysis and interpretation of data and drafted the manuscript. JH contributed to acquisition of data and participated in drafting the manuscript. KM contributed to acquisition and management of data. RH as principle investigator is responsible for study concept, design and supervision and helped in drafting the manuscript.

All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors conducted a critical revision of the article and granted final approval of the article for important intellectual content.

Data sharing statement

No additional data available.

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19

Assessed for eligibility: 450 schools

Denial:
79 schools (17,5%)
No statement:
323 schools (71,5%)

Randomisation: 48 schools (11%)

Allocated to intervention group
26 schools/ 97 classes
2,437 students

Allocated to control group
22 schools/ 94 classes
2,335 students

Withdrawal of consent:
schools:
3 schools, 12 classes, 321 students
teachers:
4 classes, 102 students

Withdrawal of consent:
teachers:
3 classes, 84 students

No parental permission:
231 students
Absent:
98 students

No parental permission:
361 students
Absent:
131 students

Baseline Assessment
23 schools/ 81 classes
1,685 students

Baseline Assessment
22 schools/ 91 classes
1,759 students

Drop-out of 14 classes with 316 students

Drop-out of 7 classes with 150 students

Follow-up Assessment
Available data:
21 schools/ 67 classes/ 1,407 students
Matched to baseline: 1,255 students

Follow-up Assessment
Available data:
21 schools/ 84 classes/ 1,678 students
Matched to baseline: 1,438 students

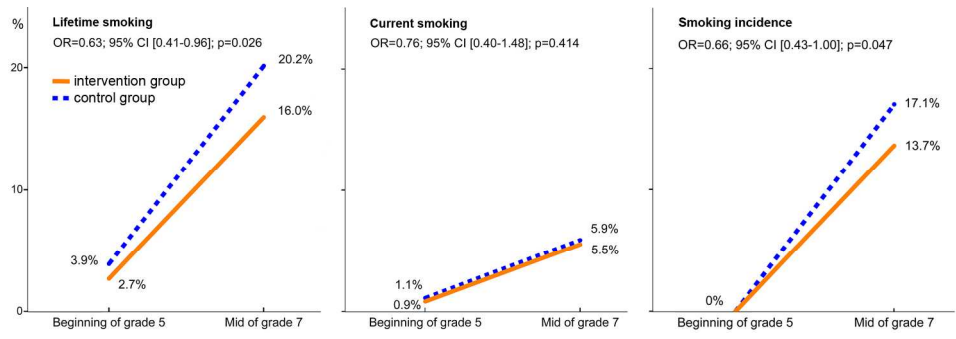Excluded due to inconsistent data: 76 students

Excluded due to inconsistent data: 104 students

Analysis Sample
1,179 students

Analysis Sample
1,334 students

202x65mm (300 x 300 DPI)

Table 1: CONSORT 2010 checklist of information to include when reporting a cluster randomised trial

Section/Topic	Item No	Standard Checklist item	Extension for cluster designs	Page No *
Title and abstract				
	1a	Identification as a randomised trial in the title	Identification as a cluster randomised trial in the title	p. 1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	See table 2	p. 2
Introduction				
Background and objectives	2a	Scientific background and explanation of rationale	Rationale for using a cluster design	p. 5
	2b	Specific objectives or hypotheses	Whether objectives pertain to the the cluster level, the individual participant level or both	p. 5
Methods				
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Definition of cluster and description of how the design features apply to the clusters	p. 6
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons		p. 6
Participants	4a	Eligibility criteria for participants	Eligibility criteria for clusters	p. 6
	4b	Settings and locations where the data were collected		p. 6
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Whether interventions pertain to the cluster level, the individual participant level or both	p. 5
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and	Whether outcome measures pertain to the cluster level, the individual participant level or both	p. 7

		when they were assessed		
	6b	Any changes to trial outcomes after the trial commenced, with reasons		**n.a.**
Sample size	7a	How sample size was determined	Method of calculation, number of clusters(s) (and whether equal or unequal cluster sizes are assumed), cluster size, a coefficient of intracluster correlation (ICC or k), and an indication of its uncertainty	p. 6
	7b	When applicable, explanation of any interim analyses and stopping guidelines		n.a.
Randomisation:				
Sequence generation	8a	Method used to generate the random allocation sequence		p. 6
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Details of stratification or matching if used	p. 6
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Specification that allocation was based on clusters rather than individuals and whether allocation concealment (if any) was at the cluster level, the individual participant level or both	p. 6
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Replace by 10a, 10b and 10c	
	10a		Who generated the random allocation sequence, who enrolled clusters, and who assigned clusters to interventions	p. 6
	10b		Mechanism by which individual participants were included in clusters for the purposes of the trial (such as complete	p. 6

			enumeration, random sampling)	
	10c		From whom consent was sought (representatives of the cluster, or individual cluster members, or both), and whether consent was sought before or after randomisation	p. 8
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how		n.a.
	11b	If relevant, description of the similarity of interventions		n.a.
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	How clustering was taken into account	p. 9
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses		p. 9
Results				
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	For each group, the numbers of clusters that were randomly assigned, received intended treatment, and were analysed for the primary outcome	p. 6 Figure 1
	13b	For each group, losses and exclusions after randomisation, together with reasons	For each group, losses and exclusions for both clusters and individual cluster members	p.6
Recruitment	14a	Dates defining the periods of recruitment and follow-up		p. 6
	14b	Why the trial ended or was stopped		n.a.
Baseline data	15	A table showing baseline demographic and clinical	Baseline characteristics for the individual and cluster levels as	

		characteristics for each group	applicable for each group	
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	For each group, number of clusters included in each analysis	p. 6
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Results at the individual or cluster level as applicable and a coefficient of intracluster correlation (ICC or k) for each primary outcome	p. 9-
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended		p. 9-
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory		p. 9-
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)		
Discussion				
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses		p. 13
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Generalisability to clusters and/or individual participants (as relevant)	p. 13
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence		p. 12-
Other information				
Registration	23	Registration number and		p. 2

		name of trial registry		
Protocol	24	Where the full trial protocol can be accessed, if available		p. 6
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders		p. 15

* Note: page numbers optional depending on journal requirements

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Effects of a School-Based Prevention Program on Smoking
in early Adolescence: Six-Month Follow-up of the
'Eigenständig werden' Cluster Randomized Trial

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Effects of a School-Based Prevention Program on Smoking in early Adolescence: Six-Month Follow-up of the 'Eigenständig werden' Cluster Randomized Trial

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Key words: smoking; school-based prevention; cluster randomized controlled trial; efficacy

Word count main text: 4,398

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ABSTRACT

Objectives: To test the effects of a school-based prevention program on students' smoking related behavior, attitudes and knowledge six months after implementation over two school-years has ended.

Design: Two-arm prospective cluster randomized controlled trial with a follow-up survey six months after end of program implementation, i.e. 26 months after baseline.

Setting: Forty-five public secondary schools from four federal states in Germany (Bremen, Hesse, North Rhine-Westphalia, Schleswig-Holstein).

Participants: A total of 3,444 students from 172 classes with a mean age of 10.37 years (SD=0.59) and 47.9% girls at baseline. Analysis sample with follow-up up data merged to baseline data comprises 2,513 data sets (73.0%).

Intervention: "Eigenständig werden 5+6", a school-based prevention program for grade five and six to enhance substance specific and general life skills, consisting of 14 units (à 90 minutes) and two workshops (4-6 hours) being taught over a time period of two school-years by trained teachers.

Outcome measures: Lifetime and current smoking, incidence of smoking in baseline never smokers, smoking related knowledge, attitudes, perceived norms of smoking, self-efficacy to refuse cigarette offers were assessed in students.

Results: Six months after end of program implementation, students of intervention classes showed significantly lower rates for lifetime smoking (adjusted odds ratio [OR]=0.63;95% confidence interval [CI]=[0.41; 0.96];p=0.026) and incidence of smoking (adjusted OR=0.66; 95%CI=[0.43; 1.00];p=0.047), a higher increase of smoking related knowledge (adjusted β=9.38; 95%CI=[6.73; 12.04];p<0.001) and a greater change in attitudes towards a more critical perception of risks and disadvantages of smoking (adjusted β=0.10; 95%CI=[0.03; 0.16];p=0.002). No group differences were found for current smoking, perceived norms of smoking and self-efficacy to refuse cigarette offers.

Conclusions: Participation in the school-based prevention program "Eigenständig werden 5+6" may have small effects on smoking behavior and attitudes and a moderate effect on smoking related knowledge.

Trial registration: Current Controlled Trials ISRCTN99442407

Word count abstract: 298 words

ARTICLE SUMMARY

Article focus

- School-based prevention programs show inconsistent results concerning efficacy and most of evaluation studies were conducted in the US.

- This study investigates the effects of a prevention program implemented in young adolescents in German schools on different outcomes six months after the end of the two school-years lasting program implementation using rigorous evaluation methodology.

Key messages

- Program participation seems to reduce the prevalence and incidence of lifetime smoking, to increase smoking related knowledge, and to influence attitudes towards a more critical perception of smoking.

Strengths and limitations of this study

- Findings were retrieved from a cluster randomized controlled trial with a well-powered sample and under usage of sophisticated statistical methods controlling for confounders and taking clustering of data into account.

- Drop out, reliance on self-reports and lack of control for treatment integrity may be limiting factors to this study.

BACKGROUND

Smoking remains to be the single greatest preventable cause of mortality worldwide, being a major risk factor for a number of life-threatening diseases, including various cancers, cardio-vascular diseases and lung diseases.[1] Though reductions in smoking rates in adolescents have been documented for many Western countries including Germany[2] over the last decade, smoking prevention is still a main issue for public health. Most recent data from Germany reveal smoking rates of about 12% for both female and male adolescents aged 12 to 17 years and 6.6% for young adolescents aged 12 to 15 years.[2;3]

School programs are often one of the first approaches mentioned in efforts to denormalize tobacco use and to raise awareness of tobacco´s hazardous nature. Prominent approaches to prevent smoking in students are the development and improvement of general life skills, as well as the fostering of skills for resisting social influence and substance-specific skills in adolescence. General life skills are considered to empower adolescents in challenging situations and to help them to master life as competent as possible.[4] By enhancing these skills, it is assumed to prevent substance use and abuse, since substance use is considered as a dysfunctional strategy to cope with every day challenges and developmental tasks in adolescence. In line with the social influence approach,[5] smoking is conceptualized as a result of influences emerging from the adolescent's environment like peers, family, or media by normative processes and/or overt cigarette offers. Therefore, correction of inaccurate norms is one important component of these programs to adjust the often overestimated prevalence of smoking in adolescence towards more conservative and realistic norms.[6] Skill training following these approaches is considered to 'inoculate' students against influences encouraging them to smoke, to help them resist temptations from peers to smoke and to correct normative expectations towards smoking.

For more than 40 years prevention programs have been implemented and evaluated within the school setting. However, the empirical evidence of the efficacy of these approaches is not yet uniquely convincing.[7-12] A recent Cochrane review on the effects of school-based smoking prevention trials[13] selected randomized controlled trials where students, classes, schools, or school districts were randomized to intervention arm(s) versus a control group, and followed-up for at least six months. One hundred and thirty-four studies involving 428,293 participants met the inclusion criteria of the review which revealed an overall significant intervention effect on the onset of smoking at longest follow-up, while there was no overall effect at follow-ups at one year or less. When analyzing intervention effects not only on smoking behavior, but also on further outcomes addressed directly or indirectly by school-based interventions like attitudes towards smoking, resistance skills or smoking

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related knowledge, findings might be condensed into a more or less consistent pattern with medium effects being found for knowledge and, if any, small effects for attitudes, skills and use.[14-16]

Among altogether 37 trials on smoking prevention strategies from the time period 2001 to 2006 which were included in a Health Technology Assessment, only one study originated from Germany.[17] The Cochrane Review[13] which covers publications until 2012 included another five studies from Germany, three of them were trials being published until 2000, and two trials being published after 2006 (one of these was a multi-center study with one out of seven centers being located in Germany). Most of these studies had some methodological shortcomings like not adjusting for the clustering of data which results from the specific characteristics of the setting with delivery of the intervention to complete classes, and schools or classes instead of individuals being the unit of randomization. Therefore, a lack of rigorous evaluation trials on smoking prevention programs can be inferred especially for Germany.

The present study aims to contribute to overcome shortcomings in the evidence for the efficacy of school-based smoking prevention by presenting results of a cluster randomized trial from Germany. We report findings on the 6-month follow-up effects of a school-based curriculum named "Eigenständig werden 5+6" ("Becoming independent 5+6") for students in grade five and six when they are about 10 to 12 years old. The overall aim of "Eigenständig werden 5+6" is the prevention of substance use and abuse by increasing substance specific skills and general life skills of students. Findings presented herein refer to effects of program participation on smoking related knowledge, attitudes towards smoking, perceived norms of smoking, self-efficacy to resist cigarette offers and actual smoking behavior six months after the implementation over two school-years has ended, i.e. on average 26 months after baseline.

METHODS

Intervention

"Eigenständig werden 5+6" is a school-based prevention program for students in grade five and six which takes quality criteria of effective prevention programs into account.[8;9;18;19] Based on the life skills approach and on the social influence model, "Eigenständig werden 5+6" aims primarily at the prevention of substance use (i.e. tobacco smoking and drinking alcohol) by increasing general life skills as well as substance specific skills (i.e. coping with

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emotions, stress, problems, pressures to smoke and drink alcohol, increase of refusal skills and decrease of susceptibility to pro-smoking and pro-alcohol social influences).

The program delivers the contents in 14 units (most of them lasting 90 minutes) and in two workshops (four to six class hours) that are evenly distributed over the grades five and six. In detail, each lesson covers a specific topic, for instance problem solving, critical thinking, effective communication skills, decision-making, interpersonal relationship skills, self-awareness building skills, empathy, coping with stress, and emotions as well as the student's ability to work in a group. The two workshops include several activities about smoking cigarettes and alcohol misuse, and are designed as a student's course with nine challenging stations that either address different aspects of smoking cigarettes or aspects of alcohol misuse. Stations concerning the first workshop, smoking cigarettes, cover risks and disadvantages of smoking, smoking related knowledge, perceived norms, and self-efficacy to refuse a cigarette offers as well as strategies of advertisement and industry. The stations of the second workshop deal with the same issues, but tailored to the topic of alcohol misuse. All components are realized by trained teachers within daily school-routine. Further details on the program have been described elsewhere.[20]

Design

A five-wave cluster randomized-controlled trial with two arms (intervention and control condition) is being conducted in four German federal states (Bremen, Hesse, North Rhine-Westphalia and Schleswig-Holstein) to evaluate the effects of "Eigenständig werden 5+6". The randomization occurred at school level to avoid information exchange between conditions in the school. For randomization, schools were stratified according to the following criteria: (1) study region, (2) type of school, (3) number of fifth grade classes per school. According to these strata, schools were randomly assigned to the two arms of the study with a 50 per cent chance of being allocated to either group by using coin toss method. Intervention group took part in "Eigenständig werden 5+6" and is compared to control group receiving education as usual, i.e. lessons and subjects following the standard school curriculum without specific interventions to foster life skills or to prevent smoking. Baseline assessment took place prior to the intervention in October/November 2010, post-tests were realized in June/July 2011 and June/July 2012, a 6-month follow-up was being conducted in December 2012 and a 15-month follow-up will take place in September/October 2013. For further details, see Hansen et al.[20]

Study Sample

A priori sample size determination assuming a significance level of α=0.05, power=0.80, a 15% prevention effect, an average cluster size of 20 students per class, an intra class

correlation of 0.02 and a drop-out rate of 25% revealed a recommended sample size of 158 classes and 3,160 students at baseline (for detailed description of sample size determination see[20]). To recruit the sample, complete lists of all secondary schools of selected regions were obtained from the Ministries of Education of each federal state. An overall of 450 secondary schools in the study regions were invited to participate in the study, of which 323 (71.5%) did neither express approval or disapproval (Figure 1). The decision to participate in the study was expressed by 48 schools (11%) with 191 classes and 4,772 students. Of these 48 schools agreeing to participate, 26 schools with 97 classes and 2,437 students were allocated to the intervention group whereas 22 schools with 94 classes and 2,335 students were assigned to the control condition. After randomization, three schools of the intervention group withdrew their consent as well as four teachers of intervention classes refused to take part.

Consequently, baseline data comprise 45 schools, 172 classes and 3,444 students with a mean age of 10.37 years (SD=0.59), 47.9% girls; with 1,685 students in 81 classes in the intervention and 1,759 students in 91 classes in the control condition. In respect to different outcome and covariate characteristics, intervention and control students were extensively comparable with the exception of a higher proportion of students of Gymnasiums in the control condition (for detailed baseline sample description see[20]). Data presented herein refer to the baseline (October 2010) and 6-month follow-up survey (December 2012). It was possible to merge follow-up data of 1,255 students in the intervention arm and 1,438 students in the control arm (total N=2,693, 78.2% of N=3,444) to baseline data. For analysis, data sets with inconsistencies concerning age, gender, and smoking status were excluded (N=180). The final analysis sample consists of 2,513 data sets (intervention group: N=1,179, control group: N=1,334). Mean age at follow-up was 12.50 years (SD=0.58).

- Insert Figure 1 about here -

Measures

Data were collected through self-completed anonymous questionnaires by teachers and students. The development of the questionnaire and a complete list of variables and constructs assessed in the trial have been documented.[20] Analyses presented herein, rely on the following outcome measures: *Lifetime tobacco smoking* experience was assessed by asking how many cigarettes have ever been smoked in life. Nine answering categories ('none', 'only a few puffs', '1 cigarette', '2 cigarettes', '3-4 cigarettes', '5-9 cigarettes', '10-19 cigarettes', '20-100 cigarettes', '>100 cigarettes') were provided. Students having smoked at least a few puffs were considered as ever smokers. *Smoking incidence* at follow-up among

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baseline never smokers was determined by combining the answers to lifetime smoking at baseline and follow-up: those who had never smoked at baseline, and indicated any smoking by the follow-up survey, even just a few puffs, were considered as having initiated smoking during the observation period. *Current smoking* frequency was measured by asking how many cigarettes are currently smoked. 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 'daily'. Responses were dichotomized into students not smoking and students indicating any kind of current smoking.

To assess *attitudes towards smoking and risk perception*, respondents should rate eleven statements (e.g. 'Non-smokers are fitter', 'Non-smokers are cooler', 'If I smoke during the next month, I will get in trouble with my friends'). Answer categories comprise 0='not true', 1='somewhat true', 2='rather true', and 3= 'totally true', i.e. higher values represent a more negative attitude towards smoking and more sensitive perception of risk. Cronbach's Alpha of this scale was 0.80. A change in attitude from baseline to follow-up was determined by subtracting the baseline value from the follow-up value for each respondent. *Smoking related knowledge* was tested through seven statements (e.g. 'Cigarettes contain arsenic which is also found in rat poison.') to which respondents could either agree by answering 'true' or disagree by stating 'wrong' or state 'I don't know'. As indicator of knowledge, the percentage of correct classifications of statements was determined. An increase in knowledge from baseline to follow-up was determined by subtracting the baseline value from the follow-up value for each respondent. *Normative expectations* were measured on an 11-point scale ranging from 0='nobody' to 10='everybody' on which students had to estimate how many a) 'Adults in Germany' and b) 'Adolescents at their age' in Germany smoke. *Self-efficacy* to refuse cigarette offers were assessed by asking 'To what extent do you dare to refuse cigarettes, even if your friends laugh at you or suspend you on that account?' with answer categories ranging from 0='not at all' to 3='totally'. Normative expectations and self-efficacy were analyzed on single item level.

Covariate measures were derived from studies that focused on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to the smoking measures.[21-23] Sociodemographics include age, gender, type of school (Gymnasium vs. other type of school), migration background (mother and/or father were born outside Germany) and socio-economic status (SES, Family Affluence Scale[24]). As personal characteristics, rebelliousness and sensation-seeking were assessed with two items in each case.[25;26] Parent, sibling and peer smoking were assessed as factors from social environment (no vs. any parent/sibling/peer smoking). Finally, students were asked whether

they had participated in a comprehensive prevention program in elementary school with examples of most broadly disseminated programs given.

Procedure

In schools having agreed to participate, teachers of the respective fifth grade collected the parental informed consent. Students with refusal were excluded from all assessments. Data assessment was conducted in the class room and lasted 45 minutes. Research staff was responsible for the distribution, help in completion and collection of the questionnaire. To permit a linking of individual baseline and follow-up data while assuring anonymity, students generated a seven digit individual code. This procedure has been tested and used in several studies and therefore been inspected and approved by Ethics Committee, data protection and Ministries of Education repeatedly.[27] Teachers were not involved in the data assessment. At the end of the assessment, all questionnaires were placed in an envelope which was sealed in front of the class. Therefore, every student was assured that neither teachers nor parents were able to see the completed questionnaire.

Ethical approval for the trial was gained from the Ethics Committee of Medical Faculty of the University of Kiel. Additional approvals (e.g., from ministries of education, and parents) were sought as required.

Analyses

Predictors of attrition were examined by multilevel mixed effect logistic regressions. To test for selective attrition, interaction effects for group condition and dependent variable were tested. Descriptive statistics (percentages, means, standard deviations) are crude values. To analyze the effects of the intervention on smoking behavior as well as on attitudes and knowledge, multilevel mixed effect regression models using Stata *mixed* and *meqrlogit* command were conducted, adjusting for covariates. In case of dichotomous outcomes, effect sizes (Cohen's d) were determined by using the converting formula proposed by Borenstein et al.[28] Effect sizes for metric outcomes were calculated as proposed by Feingold.[29] All data analyses were conducted with Stata V.13.[30]

RESULTS

Attrition analysis

Among the 3,444 students assessed at baseline, there were no data available in the analysis sample for 931 students (27.0%). Overall, significantly higher attrition was found for male students (31.2%; p<0.001), students with a migration background (36.5%; p<0.001), students indicating current smoking (45.7%; p=0.047) or current use of alcohol (39.8%; p<0.001) at

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baseline. Furthermore, students dropping out of the study were older than students in the retention sample ($M_{attrition}$=10.5 vs. $M_{retention}$=10.3 years of age at baseline; p=0.003). Besides these overall effects, no hints for selective attrition were found, i.e. the associations between variables listed above and attrition did not differ systematically between the intervention and control group.

Effects on smoking behavior

Students in the intervention and control group did not differ in rates for lifetime and current smoking at baseline. At follow-up, 16.0% of intervention students indicated that they had ever smoked in their lives compared to 20.2% in the control students (Figure 2). This difference was statistically significant also after controlling for confounding factors (adjusted Odds Ratio [OR]=0.63; 95% confidence interval [CI]=[0.41; 0.96]; p=0.026).

While about 1% of intervention and control students reported current smoking at baseline, these rates increased to more than 5% at follow-up both in intervention and control group. Therefore, no group differences could be found in the frequency of current smoking.

At baseline, 95.6% of the sample were never-smokers (N=2,403; intervention group: 96.4%, control group: 94.9%). Among these baseline never-smokers, 15.5% initiated smoking during the observation period. The incidence rate was significantly lower in intervention students, among whom 13.7% reported the first use of cigarettes between baseline and follow-up, compared to the control group with an incidence rate of 17.1% (adjusted OR=0.66, 95% CI=[0.43; 1.00], p=0.047).

- insert Figure 2 about here -

Effects on smoking related knowledge and attitudes

Students of both groups showed about the same level of smoking related knowledge at baseline with correct answering rates of about 30% (Table 1). At follow-up, students in both groups scored better in the knowledge test: intervention students had a mean percentage of correct answers of 46.75, while the control students rated on average 37.74% of the statements correctly. The increase in knowledge was significantly higher in the intervention group (adjusted β=9.38; 95% CI=[6.73; 12.04]; p<0.001).

- insert Table 1 about here -

A comparable pattern was found for attitudes towards smoking: At baseline, both groups did not differ in their attitudes and showed a rather critical perception of smoking with a mean score of 2.04 on the scale ranging from 0 to 3 (Table 1). At follow-up, students rated smoking even more negatively with a mean score of 2.24 in the intervention and 2.16 in the control group. Compared to the control group, this change in attitudes was more pronounced in the intervention group (adjusted β=0.10; 95% CI=[0.03; 0.16]; p=0.002).

Normative expectations were hardly influenced by the intervention: While intervention students estimated smoking prevalence in adults marginally lower at follow-up compared to their estimation at baseline, a small increase in this estimate could be observed in control students (Table 1). For peer smoking, both groups showed a small increase in perceived frequency of smoking. None of these changes turned out to be statistically significant after covariates and baseline estimates were controlled for.

Already at baseline, students in both groups considered themselves rather capable to refuse cigarette offers (Table 1). During the observation period, self-efficacy even grew with a slightly higher – but statistically insignificant – increase in intervention students compared to control students.

Table 1.
Descriptive statistics and multilevel mixed effects linear regressions for smoking related knowledge, attitudes, perceived norms and self-efficacy to refuse cigarette offers

	Baseline Beginning of grade 5		Follow-up Mid of grade 7		Change				
	Intervention	Control	Intervention	Control	Intervention	Control		Difference in change	
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	adj. β[1]	95% CI	p
Knowledge[2]	30.34 (19.47)	30.11 (19.14)	46.75 (21.59)	37.74 (20.45)	16.53 (26.46)	7.53 (24.13)	9.38	6.73; 12.04	<0.001
Attitudes/risk perception[3]	2.04 (0.51)	2.04 (0.51)	2.24 (0.51)	2.16 (0.54)	0.20 (0.61)	0.12 (0.61)	0.10	0.03; 0.16	0.002
Norms adult smoking[4]	6.08 (1.62)	5.97 (1.59)	6.04 (1.62)	6.09 (1.55)	-0.03 (2.09)	0.12 (1.95)	-0.08	-0.24; 0.07	0.265
Norms peer smoking[4]	3.08 (2.64)	2.93 (2.56)	4.24 (2.28)	4.02 (2.18)	1.16 (3.10)	1.10 (2.93)	0.15	-0.13; 0.43	0.283
Self-efficacy to refuse cigarettes[5]	2.38 (1.04)	2.36 (1.03)	2.53 (0.80)	2.49 (0.85)	0.15 (1.20)	0.11 (1.22)	0.07	-0.03; 0.17	0.140

M = Mean, SD = Standard deviation, CI = Confidence interval
[1] Adjusted for age, gender, type of school, socio-economic status, immigration background, peer / parent / sibling smoking, sensation seeking, rebelliousness, earlier participation in a prevention program, baseline value of the respective variable
[2] Mean percentage of correct answers in a 7-item quiz
[3] Range 0 to 3, higher values representing more negative attitude
[4] Range 0 = nobody smokes to 10 = everybody smokes
[5] Range 0-3, higher values representing higher self-efficacy

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Effect sizes for significant program effects were small to medium with d=0.26 (lifetime smoking), d=0.23 (incidence of smoking), d=0.45 (smoking related knowledge), and d=0.15 (attitudes/risk perception).

Sensitivity analyses

Since a substantial proportion of cases was excluded from the analysis sample due to inconsistent data (N=180) or as they were lost to follow-up (N=931), we conducted some sensitivity analyses to estimate the risk that the findings might be biased by these exclusions. First, we reran the analyses with inconsistent cases left in the dataset. This re-inclusion of inconsistent cases hardly changed the results for metric outcomes with significant effects for knowledge and attitudes and slightly changed results for smoking behavior with marginally significant associations for lifetime smoking (p=0.086) and incidence (p=0.083). To address the restriction of sample to complete cases, predictors for higher attrition were used as guide to create subsamples. As the attrition rate was highest in baseline current smokers and therefore this (small) subgroup of students smoking already very early might differ substantially from the majority of non-smoking students, we excluded baseline current smokers (N=25) completely. For this subsample, we found the same significant effects for lifetime smoking (p=0.030), knowledge (p<0.001) and attitudes (p=0.002) and no effects on current smoking, norms and self-efficacy. Further factors being associated with a higher risk of attrition (male gender, higher age, migration background) were explored by analyzing subsamples of male students, students aged ≥11 years at baseline and students with migration background. In these subsamples, incidence rates in control students exceeded those of intervention by 4 to 7 percent points (reaching significance for older students, p=0.026, marginal significance for students with migration background, p=0.061, and failing to reach significance for male students, p=0.225).

DISCUSSION

The current study aimed to investigate the effects of a school-based prevention program on smoking related knowledge, attitudes and behavior six months after the end of program implementation. Using a cluster randomized controlled design, findings revealed that the program participation seems to reduce the prevalence and incidence of lifetime smoking, to increase smoking related knowledge, and to influence attitudes and perceived risks of smoking towards a more critical perception. Program effects on the prevalence of current smoking, normative expectations or refusal skills could not be determined. Using Cohen's classification of effect sizes,[31] effect size was small for smoking behavior and attitudes, while there was a medium effect on smoking related knowledge.

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The pattern found for effects on smoking behavior with significant small effects on smoking incidence (d=0.23) and lifetime smoking (d=0.26), and no effect on current smoking can be aligned quite well with the results presented in former meta-analyses: The pooled odds ratio of 0.88 for smoking onset at the longest follow-up revealed by the overall analysis of Thomas et al.[13] corresponds to an effect size of d=0.07, while their subgroup analyses for different intervention approaches provided even moderate effect sizes (odds ratios between 0.49 and 0.52 corresponding to d's between 0.36 and 0.39). Earlier meta-analyses on school-based drug prevention programs,[14] psychosocial smoking prevention programs[15] or studies on Project DARE (Drug Abuse Resistance Education),[16] the most widely used school-based drug prevention program in the United States and focusing on teaching skills to recognize and resist social pressure, also determined small program effects on substance use with d's ranging between 0.08 and 0.18. Finding no effect on current smoking might also be explained to some extent by the young age of the sample with only very few students smoking already on a regular basis.

The participation in "Eigenständig werden 5+6" significantly increased smoking related knowledge with an effect size of d=0.45 – the highest effect found in our analyses. This medium effect is in line with effect sizes ranging from 0.36 to 0.42 determined in meta-analyses referred to above.[14-16] Attitudes were influenced also significantly by the intervention, the small effect (d=0.15) compares well with the small effects in a range from 0.11 to 0.26 having been reported.[14-16]

We were not able to show an effect of the intervention in correcting perceived norms of smoking or in enhancing self-efficacy to refuse offered cigarettes. Students of both intervention and control group consider themselves to be rather highly self-efficacious to resist to cigarette offers already at the outset of the study and this rating even increases in both groups at follow-up, i.e. a ceiling effect might decrease the discriminative power of the group comparisons. As far as perceived norms of smoking are concerned, a possible explanation of the null-effect is the fact that only a minor part of the intervention (one subtask among nine tasks of the smoking workshop at the end of grade 5) deals with the topic of norms. Most tasks in the workshop address facts about and visualization of the short- and long-term consequences of smoking, others aim to scrutinize strategies of the tobacco industry or to foster resistance skills.

Some limitations of the current study have to be considered: During the 26 month period from baseline to follow-up, there has been some drop-out from the study. The analysis sample (N=2,513) amounted to 73.0% of the baseline sample (N=3,444). This drop-out was

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slightly higher than expected in the a priori power calculation (25%), but since the baseline sample was somewhat larger than calculated (N=3,444 instead of N=3,160), the analysis sample still exceeds the estimated sample at follow-up (75% of 3,160 = 2,370). Therefore, the power of the analyses should be adequate. Furthermore, we did not find any hints for selective attrition which could restrict the validity of findings and sensitivity analyses revealed very comparable patterns of results in subsamples with higher risk for attrition and smoking. The curriculum "Eigenständig werden 5+6" comprises of 14 lessons à on average 90 minutes and two workshops with 4 to 6 hours of duration which are implemented by teachers in addition to usual education, i.e. the program is quite time-consuming, it requires some dedication by teachers and it seems unreasonable to assume that the intervention is delivered to all classes exactly in the way and to the extent foreseen by the manual. The analyses in this report were not controlled for treatment integrity,[32;33] i.e. classes with low treatment fidelity that have only been exposed to parts of the intervention contribute to the same extent to the results of the intervention group as classes with complete program implementation. Therefore, results can be considered as rather conservative. Another limitation is the reliance on self-reports in the assessment of outcomes. Especially for outcomes assessing smoking behavior, but also for attitudes towards smoking, answers might be biased by social desirability. These influences might occur more likely in the intervention group since students might be primed by the intervention that smoking is an "unwanted" behavior. Nevertheless, since purchase of cigarettes and smoking in public is forbidden by law for minors in Germany, students in the control condition are not free of a social desirability bias as well.For other outcomes like the assessment of refusal skills, validity of self-report data might be limited by restricted accessibility, i.e. whether adolescents are really able to judge their own competence to resist cigarette offers. Finally, the study was run in regular public schools of four federal states of Germany, i.e. the generalizability might be limited due to these regional constraints and restricted to adolescents visiting regular schools.

On the other hand, some strengths of the current study should be born in mind: Results were derived from a cluster randomized controlled trial, applying sophisticated statistical methods, comprising a range of several outcomes and following students up for six months after the end of intervention. Therefore, we implemented rather rigorous evaluation methods, which are in line with recommendations like those of the Society for Prevention Research.[34]

Perspectives and open questions for future research might be the following: In the current trial, a further follow-up at 15 months after end of intervention is being conducted to explore stability of effects in the longer term. Furthermore, exploring effects on other outcomes than

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smoking, e.g. alcohol use or life skills, is owing for the current study. On the basis of findings for efficacy, effectiveness in relation to costs as well as generalizability to other populations should be investigated. Finally, besides stating whether an intervention is effective or not, mechanisms by which shown effects can be explained theoretically and empirically are to be explored. These mediation analyses may contribute to investigate causal models for preventive intervention, e.g. to explore whether knowledge or change in attitude are necessary preconditions for behavior change.[14]

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3   **Figure legends**
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5   Figure 1. Participation flowchart
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9   Figure 2. Percentage of lifetime smoking, current smoking at baseline and 6-month follow-up,
10   percentage of smoking incidence at 6-month follow-up among baseline never-smokers, and
11   multilevel mixed effects logistic regressions; OR = odds ratio, CI = confidence interval;
12   logistic regressions were adjusted for age, gender, type of school, socio-economic status,
13   immigration background, peer / parent / sibling smoking, sensation seeking, rebelliousness,
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15   earlier participation in a prevention program
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Competing interests

None.

Ethics approval

Ethics approval was provided by the Ethics Committee of the Medical Faculty of the University of Kiel (Ref.: D 419/10).

Contributors

BI performed the statistical analysis and interpretation of the data and drafted the manuscript. JH contributed to the acquisition of the data and participated in drafting the manuscript. KM contributed to the acquisition and management of the data. RH as principle investigator is responsible for the study concept, design and supervision and helped in drafting the manuscript.

All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors conducted a critical revision of the article and granted final approval of the article for important intellectual content.

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Data sharing statement

No additional data available.

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Effects of a School-Based Prevention Program on Smoking in early Adolescence: Six-Month

Follow-up of the 'Eigenständig werden' Cluster Randomized Trial

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ABSTRACT

Objectives: To test the effects of a school-based prevention program on students' smoking related behavior, attitudes and knowledge six months after ~~program~~ implementation over two school-years has ended.

Design: Two-arm prospective cluster randomized controlled trial with a follow-up survey six months after end of program implementation, i.e. 26 months after baseline.

Setting: Forty-five public secondary schools from four federal states in Germany (Bremen, Hesse, North Rhine-Westphalia, Schleswig-Holstein).

Participants: A total of 3,444 students from 172 classes ~~at baseline~~ with a mean age of 10.37 years (SD=0.59) and 47.9% girls at baseline. Analysis sample with follow-up up data merged to baseline data comprises 2,513 data sets (73.0%).

Intervention: "Eigenständig werden 5+6", a school-based prevention program for grade five and six to enhance substance specific and general life skills, consisting of 14 units (à 90 minutes) and two workshops (4 ~~resp.~~ 6 hours) being taught over a time period of two school-years by trained teachers.

Outcome measures: Lifetime and current smoking, incidence of smoking in baseline never smokers, smoking related knowledge, attitudes, perceived norms of smoking, self-efficacy to refuse cigarette offers were assessed in students.

Results: Six months after end of program implementation, students of intervention classes showed significantly lower rates for lifetime smoking (adjusted odds ratio [OR]=0.63;95% confidence interval [CI]=[0.41; 0.96];p=0.026) and incidence of smoking (adjusted OR=0.66; 95%CI=[0.43; 1.00];p=0.047), a higher increase of smoking related knowledge (adjusted β=9.38; 95%CI=[6.73; 12.04];p<0.001) and a greater change in attitudes towards a more critical perception of risks and disadvantages of smoking (adjusted β=0.10; 95%CI=[0.03; 0.16];p=0.002). No group differences were found for current smoking, perceived norms of smoking and self-efficacy to refuse cigarette offers.

Conclusions: Participation in the school-based prevention program "Eigenständig werden 5+6" may have small effects on smoking behavior and attitudes and a moderate effect on smoking related knowledge.

Trial registration: Current Controlled Trials ISRCTN99442407

Word count abstract: 298 words

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ARTICLE SUMMARY

Article focus

- School-based prevention programs show inconsistent results concerning efficacy and most of evaluation studies were conducted in the US.
- This study investigates the effects of a prevention program implemented in ~~grade 5 and 6~~young adolescents in German schools on different outcomes six months after the end of the two school-years lasting program implementation using rigorous evaluation methodology.

Key messages

- Program participation seems to reduce the prevalence and incidence of lifetime smoking, to increase smoking related knowledge, and to influence attitudes towards a more critical perception of smoking.

Strengths and limitations of this study

- Findings were retrieved from a cluster randomized controlled trial with a well-powered sample and under usage of sophisticated statistical methods controlling for confounders and taking clustering of data into account.
- Drop out, reliance on self-reports and lack of control for treatment integrity may be limiting factors to this study.

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BACKGROUND

Smoking remains to be the single greatest preventable cause of mortality worldwide, being a major risk factor for a number of life-threatening diseases, including various cancers, cardio-vascular diseases and lung diseases.[1] Though reductions in smoking rates in adolescents have been documented for many Western countries including Germany[2] over the last decade, smoking prevention is still a main issue for public health. Most recent data from Germany reveal smoking rates of about 12% for both female and male adolescents aged 12 to 17 years and 6.6% for young adolescents aged 12 to 15 years.[2;3]

School programs are often one of the first approaches mentioned in efforts to denormalize tobacco use and to raise awareness of tobacco´s hazardous nature. Prominent approaches to prevent smoking in students are the development and improvement of general life skills, as well as the fostering of skills for resisting social influence and substance-specific skills in adolescence. General life skills are considered to empower adolescents in challenging situations and to help them to master life as competent as possible.[4] By enhancing these skills, it is assumed to prevent substance use and abuse, since substance use is considered as a dysfunctional strategy to cope with every day challenges and developmental tasks in adolescence. In line with the social influence approach,[5] smoking is conceptualized as a result of influences emerging from the adolescent's environment like peers, family, or media by normative processes and/or overt cigarette offers. Therefore, correction of inaccurate norms is one important component of these programs to adjust the often overestimated prevalence of smoking in adolescence towards more conservative and realistic norms.[6] Skill training following these approaches is considered to 'inoculate' students against influences encouraging them to smoke, to help them resist temptations from peers to smoke and to correct normative expectations towards smoking.

For more than 40 years prevention programs have been implemented and evaluated within the school setting. However, the empirical evidence of the efficacy of these approaches is not yet uniquely convincing.[7-12] A recent Cochrane review on the effects of school-based smoking prevention trials[13] selected randomized controlled trials where students, classes, schools, or school districts were randomized to intervention arm(s) versus a control group, and followed-up for at least six months. One hundred and thirty-four studies involving 428,293 participants met the inclusion criteria of the review which revealed an overall significant intervention effect on the onset of smoking at longest follow-up, while there was no overall effect at follow-ups at one year or less. When analyzing intervention effects not only on smoking behavior, but also on further outcomes addressed directly or indirectly by school-based interventions like attitudes towards smoking, resistance skills or smoking

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related knowledge, findings might be condensed into a more or less consistent pattern with medium effects being found for knowledge and, if any, small effects for attitudes, skills and use.[14-16][13-15]

Among altogether 37 trials on smoking prevention strategies from the time period 2001 to 2006 which were included in a Health Technology Assessment, only one study originated from Germany.[17][16] The Cochrane Review[13][12] which covers publications until 2012 included another five studies from Germany, three of them were trials being published until 2000, and two trials being published after 2006 (one of these was a multi-center study with one out of seven centers being located in Germany). Most of these studies had some methodological shortcomings like not adjusting for the clustering of data which results from the specific characteristics of the setting with delivery of the intervention to complete classes, and schools or classes instead of individuals being the unit of randomization. Therefore, a lack of rigorous evaluation trials on smoking prevention programs can be inferred especially for Germany.

The present study aims to contribute to overcome shortcomings in the evidence for the efficacy of school-based smoking prevention by presenting results of a cluster randomized trial from Germany. We report findings on the 6-month follow-up effects of a school-based curriculum named "Eigenständig werden 5+6" ("Becoming independent 5+6") for students in grade five and six when they are about 10 to 12 years old. The overall aim of "Eigenständig werden 5+6" is the prevention of substance use and abuse by increasing substance specific skills and general life skills of students. Findings presented herein refer to effects of program participation on smoking related knowledge, attitudes towards smoking, perceived norms of smoking, self-efficacy to resist cigarette offers and actual smoking behavior six months after end of the program implementation over two school-years has ended, i.e. on average 26 months after baseline.

METHODS

Intervention

"Eigenständig werden 5+6" is a school-based prevention program for students in grade five and six which takes quality criteria of effective prevention programs into account.[8,9,18,19][7,8,17,18] Based on the life skills approach and on the social influence model, "Eigenständig werden 5+6" aims primarily at the prevention of substance use (i.e. tobacco smoking and drinking alcohol) by increasing general life skills as well as substance specific skills (i.e. coping with

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emotions, stress, problems, pressures to smoke and drink alcohol, increase of refusal skills and decrease of susceptibility to pro-smoking and pro-alcohol social influences).

The program delivers the contents in 14 units (most of them lasting 90 minutes) and in two workshops (four to six class hours) that are evenly distributed over the grades five and six. In detail, each lesson covers a specific topic, for instance problem solving, critical thinking, effective communication skills, decision-making, interpersonal relationship skills, self-awareness building skills, empathy, coping with stress, and emotions as well as the student's ability to work in a group. The two workshops include several activities about smoking cigarettes and alcohol misuse, and are designed as a student's course with nine challenging stations that either address different aspects of smoking cigarettes or aspects of alcohol misuse. Stations concerning the first workshop, smoking cigarettes, cover risks and disadvantages of smoking, smoking related knowledge, perceived norms, and self-efficacy to refuse a cigarette offers as well as strategies of advertisement and industry. The stations of the second workshop deal with the same issues, but tailored to the topic of alcohol misuse. The program delivers the contents (life skills, students' ability to work in a group, substance specific skills) in 14 units (most of them lasting 90 minutes) and in two workshops (four to six class hours) that are evenly distributed over the grades five and six. Workshops include several activities about substance use such as smoking cigarettes and alcohol misuse. All components are realized by trained teachers within daily school-routine. Further details on the program have been described elsewhere.[20][19]

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Design

A five-wave cluster randomized-controlled trial with two arms (intervention and control condition) is being conducted in four German federal states (Bremen, Hesse, North Rhine-Westphalia and Schleswig-Holstein) to evaluate the effects of "Eigenständig werden 5+6". The randomization occurred at school level to avoid information exchange between conditions in the school. For randomization, schools were stratified according to the following criteria: (1) study region, (2) type of school, (3) number of fifth grade classes per school. According to these strata, schools were randomly assigned to the two arms of the study with a 50 per cent chance of being allocated to either group by using coin toss method. Intervention group took part in "Eigenständig werden 5+6" and is compared to control group receiving education as usual, i.e. lessons and subjects following the standard school curriculum without specific interventions to foster life skills or to prevent smoking. Baseline aAssessments took place prior to the intervention in October/November 2010, post-tests were realized in June/July 2011 and June/July 2012, a 6-month follow-up was being

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conducted in December 2012 and a 15-month follow-up will take place in September/October 2013. For further details, see Hansen et al.[2019]

Study Sample

A priori sample size determination assuming a significance level of $α=0.05$, power=0.80, a 15% prevention effect, an average cluster size of 20 students per class, an intra class correlation of 0.02 and a drop-out rate of 25% revealed a recommended sample size of 158 classes and 3,160 students at baseline (for detailed description of sample size determination see[20]). To recruit the sample, cComplete lists of all secondary schools of selected regions were obtained from the Ministries of Education of each federal state. An overall of 450 secondary schools in the study regions were invited to participate in the study, of which 323 (71.5%) did neither express approval or disapproval (Figure 1). The decision to participate in the study was expressed by 48 schools (11%) with 191 classes and 4,772 students. Of these 48 schools agreeing to participate, 26 schools with 97 classes and 2,437 students were allocated to the intervention group whereas 22 schools with 94 classes and 2,335 students were assigned to the control condition. After randomization, three schools of the intervention group withdrew their consent as well as four teachers of intervention classes refused to take part.

Consequently, baseline data comprises 45 schools, 172 classes and 3,444 students with a mean age of 10.37 years (SD=0.59), 47.9% girls, : with 1,685 students in 81 classes in the intervention and 1,759 students in 91 classes in the control condition. In respect to different outcome and covariate characteristics, intervention and control students were extensively comparable with the exception of a higher proportion of students of Gymnasiums in the control condition (for sample size determination and detailed baseline sample description see[2019]). Data presented herein refer to the baseline (October 2010) and 6-month follow-up survey (December 2012). It was possible to merge follow-up data of 1,255 students in the intervention arm and 1,438 students in the control arm (total N=2,693, 78.2% of N=3,444) to baseline data. For analysis, data sets with inconsistencies concerning age, gender, and smoking status were excluded (N=180). The final analysis sample consists of 2,513 data sets (intervention group: N=1,179, control group: N=1,334). Mean age at follow-up was 12.50 years (SD=0.58).

- Insert Figure 1 about here -

Measures

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Data ~~was~~ were collected through self-completed anonymous questionnaires by teachers and students. The d~~D~~evelopment of the questionnaire and a complete list of variables and constructs assessed in the trial have been documented.~~20~~19 ~~Analysis~~ Analyses presented herein, rely on the following outcome measures: *Lifetime tobacco smoking* experience was assessed by asking how many cigarettes have ever been smoked in life. Nine answering categories ('none', 'only a few puffs', '1 cigarette', '2 cigarettes', '3-4 cigarettes', '5-9 cigarettes', '10-19 cigarettes', '20-100 cigarettes', '>100 cigarettes') were provided. Students having smoked at least a few puffs were considered as ever smokers. *Smoking incidence* at follow-up among baseline never smokers was determined by combining the answers to lifetime smoking at baseline and follow-up: those who had never smoked at baseline, and indicated any smoking by the follow-up survey, even just a few puffs, were considered as having initiated smoking during the observation period. *Current smoking* frequency was measured by asking how many cigarettes are currently smoked. 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 'daily'. Responses were dichotomized into students not smoking and students indicating any kind of current smoking.

To assess *attitudes towards smoking and risk perception*, respondents should rate eleven statements (e.g. 'Non-smokers are fitter', 'Non-smokers are cooler', 'If I smoke during the next month, I will get in trouble with my friends'). Answer categories comprise 0='not true', 1='somewhat true', 2='rather true', and 3= 'totally true', i.e. higher values represent a more negative attitude towards smoking and more sensitive perception of risk. Cronbach's Alpha of this scale was 0.80. A c~~C~~hange in attitude from baseline to follow-up was determined by subtracting the baseline value from the follow-up value for each respondent. *Smoking related knowledge* was tested through seven statements (e.g. 'Cigarettes contain arsenic which is also found in rat poison.') to which respondents could either agree by answering 'true' or disagree by stating 'wrong' or state 'I don't know'. As indicator of knowledge, the percentage of correct classifications of statements was determined. An i~~I~~ncrease in knowledge from baseline to follow-up was determined by subtracting the baseline value from the follow-up value for each respondent. *Normative expectations* were measured on an 11-point scale ranging from 0='nobody' to 10='everybody' on which students had to estimate how many a) 'Adults in Germany' and b) 'Adolescents at their age' in Germany smoke. *Self-efficacy* to refuse cigarette offers were assessed by asking 'To what extent do you dare to refuse cigarettes, even if your friends laugh at you or suspend you on that account?' with answer categories ranging from 0='not at all' to 3='totally'. Normative expectations and self-efficacy were analyzed on single item level.

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Covariate measures were derived from studies that focused on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to the smoking measures.[21-2320-22] Sociodemographics include age, gender, type of school (Gymnasium vs. other type of school), migration background (mother and/or father were born outside Germany) and socio-economic status (SES, Family Affluence Scale[2423]). As personal characteristics, rebelliousness and sensation-seeking were assessed with two items in each case.[25;2624;25] Parent, sibling and peer smoking were assessed as factors from social environment (no vs. any parent/sibling/peer smoking). Finally, students were asked whether they had participated in a comprehensive prevention program in elementary school with examples of most broadly disseminated programs given.

Procedure

In schools having agreed to participate, teachers of the respective 5th fifth grade collected the parental informed consent. Students with refusal were excluded from all assessments. Data assessment was conducted in the class room and lasted 45 minutes. Research staff was responsible for the distribution, help in completion and collection of the questionnaire. To permit a linking of individual baseline and follow-up data while assuring anonymity, students generated a seven digit individual code. This procedure has been tested and used in several studies and therefore been inspected and approved by Ethics Committee, data protection and Ministries of Education repeatedly.[2726] Teachers were not involved in the data assessment. At the end of the assessment, all questionnaires were placed in an envelope which was sealed in front of the class. Therefore, every student was assured that neither teachers nor parents were able to see the completed questionnaire.

Ethical approval for the trial was gained from the Ethics Committee of Medical Faculty of the University of Kiel. Additional approvals (e.g., from ministries of education, and parents) were sought as required.

Analyses

Predictors of attrition were examined by multilevel mixed effect logistic regressions, x^2 and t tests. To test for selective attrition, interaction effects for group condition and dependent variable were tested. Descriptive statistics (percentages, means, standard deviations) are crude values. To analyze the effects of the intervention on smoking behavior as well as on attitudes and knowledge, multilevel mixed effect regression models using Stata *mixed* and *meqrlogit* command were conducted, adjusting for covariates. In case of dichotomous outcomes, effect sizes (Cohen's d) were determined by using the converting formula

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proposed by Borenstein et al.[2827] Effect sizes for metric outcomes were calculated as

proposed by Feingold.[2928] All data analyses were conducted with Stata V.13.[3029]

RESULTS

Attrition analysis

Among the 3,444 students assessed at baseline, there ~~was~~ were no data available in the analysis sample for 931 students (27.0%). ~~Drop-out was higher in intervention group (N=506, 30.0%) compared to control group (N=425, 24.2%; χ²(1)=15.02, p<0.001).~~ Overall, significantly higher attrition was ~~also~~ found for male students (31.2%; p<0.001), ~~students attending other schools than *Gymnasium* (32.1%; p<0.001),~~ students with a migration background (36.5%; p<0.001), students indicating current smoking (45.7%; p=0.~~004~~047) or current use of alcohol (39.8%; p<0.001) at baseline. Furthermore, students dropping out of the study were older than students in the retention sample ($M_{attrition}$=10.5 vs. $M_{retention}$=10.3 years of age at baseline; p~~<~~=0.~~001~~003) ~~and had a lower SES ($M_{attrition}$=17.1 vs. $M_{retention}$=17.9; p<0.001) than students in the retention sample~~. Besides these overall effects, no hints for selective attrition were found, i.e. the associations between variables listed above and attrition did not differ systematically between the intervention and control group.

Effects on smoking behavior

Students in the intervention and control group did not differ in rates for lifetime and current smoking at baseline. At follow-up, 16.0% of intervention students indicated that they had ever smoked in their lives compared to 20.2% in the control students (Figure 2). This difference was statistically significant also after controlling for confounding factors (adjusted Odds Ratio [OR]=0.63; 95% confidence interval [CI]=[0.41; 0.96]; p=0.026).

While about 1% of intervention and control students reported current smoking at baseline, these rates increased to more than 5% at follow-up both in intervention and control group. Therefore, no group differences could be found in the frequency of current smoking.

At baseline, 95.6% of the sample were never-smokers (N=2,403; ~~IG~~intervention group: 96.4%, ~~CG~~control group: 94.9%). Among these baseline never-smokers, 15.5% initiated smoking during the observation period. The i~~I~~ncidence rate was significantly lower in intervention students, among whom 13.7% reported the first use of cigarettes between baseline and follow-up, compared to the control group with an incidence rate of 17.1% (adjusted OR=0.66, 95% CI=[0.43; 1.00], p=0.047).

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Effects on smoking related knowledge and attitudes
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Students of both groups showed about the same level of smoking related knowledge at
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baseline with correct answering rates of about 30% (Table 1). At follow-up, students in both
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groups scored better in the knowledge test: intervention students had a mean percentage of
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correct answers of 46.75, while the ~~intervention~~ control students rated on average 37.74% of
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the statements correctly. The increase in knowledge was significantly higher in the
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intervention ~~students~~ group (adjusted β=9.38; 95% CI=[6.73; 12.04]; p<0.001).
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A comparable pattern was found for attitudes towards smoking: At baseline, both groups did
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not differ in their attitudes and showed a rather critical perception of smoking with a mean
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score of 2.04 on the scale ranging from 0 to 3 (Table 1). At follow-up, students rated smoking
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even more negatively with a mean score of 2.24 in the intervention and 2.16 in the control
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group. Compared to the control group, this change in attitudes was more pronounced in the
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intervention group (adjusted β=0.10; 95% CI=[0.03; 0.16]; p=0.002).
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Normative expectations were hardly influenced by the intervention: While intervention
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students estimated smoking prevalence in adults marginally lower at follow-up compared to
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their estimation at baseline, a small increase in this estimate could be observed in control
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students (Table 1). For peer smoking, both groups showed a small increase in perceived
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frequency of smoking. None of these changes turned out to be statistically significant after
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covariates and baseline estimates were controlled for.
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Already at baseline, students in both groups considered themselves rather capable to refuse
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cigarette offers (Table 1). During the observation period, self-efficacy even grew with a
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slightly higher – but statistically insignificant – increase in intervention students compared to
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control students.
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Table 1.
Descriptive statistics and multilevel mixed effects linear regressions for smoking related knowledge, attitudes, perceived norms and self-efficacy to refuse cigarette offers

	Baseline Beginning of grade 5		Follow-up Mid of grade 7		Change				
	Intervention M (SD)	Control M (SD)	Intervention M (SD)	Control M (SD)	Intervention M (SD)	Control M (SD)	adj. β[1]	Difference in change 95% CI	p
Knowledge[2]	30.34 (19.47)	30.11 (19.14)	46.75 (21.59)	37.74 (20.45)	16.53 (26.46)	7.53 (24.13)	9.38	6.73; 12.04	<0.001
Attitudes/risk perception[3]	2.04 (0.51)	2.04 (0.51)	2.24 (0.51)	2.16 (0.54)	0.20 (0.61)	0.12 (0.61)	0.10	0.03; 0.16	0.002
Norms adult smoking[4]	6.08 (1.62)	5.97 (1.59)	6.04 (1.62)	6.09 (1.55)	-0.03 (2.09)	0.12 (1.95)	-0.08	-0.24; 0.07	0.265
Norms peer smoking[4]	3.08 (2.64)	2.93 (2.56)	4.24 (2.28)	4.02 (2.18)	1.16 (3.10)	1.10 (2.93)	0.15	-0.13; 0.43	0.283
Self-efficacy to refuse cigarettes[5]	2.38 (1.04)	2.36 (1.03)	2.53 (0.80)	2.49 (0.85)	0.15 (1.20)	0.11 (1.22)	0.07	-0.03; 0.17	0.140

M = Mean, SD = Standard deviation, CI = Confidence interval
[1] Adjusted for age, gender, type of school, socio-economic status, immigration background, peer / parent / sibling smoking, sensation seeking, rebelliousness, earlier participation in a prevention program, baseline value of the respective variable
[2] Mean percentage of correct answers in a 7-item quiz
[3] Range 0 to 3, higher values representing more negative attitude
[4] Range 0 = nobody smokes to 10 = everybody smokes
[5] Range 0-3, higher values representing higher self-efficacy

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Effect sizes for significant program effects were small to medium with d=0.26 (lifetime smoking), d=0.23 (incidence of smoking), d=0.45 (smoking related knowledge), and d=0.15 (attitudes/risk perception).

Sensitivity analyses

Since a substantial proportion of cases was excluded from the analysis sample due to inconsistent data (N=180) or as they were lost to follow-up (N=931), we conducted some sensitivity analyses to estimate the risk that the findings might be biased by these exclusions. First, we reran the analyses with inconsistent cases left in the dataset. This re-inclusion of inconsistent cases hardly changed the results for metric outcomes with significant effects for knowledge and attitudes and slightly changed results for smoking behavior with marginally significant associations for lifetime smoking (p=0.086) and incidence (p=0.083). To address the restriction of sample to complete cases, predictors for higher attrition were used as guide to create subsamples. As the attrition rate was highest in baseline current smokers and therefore this (small) subgroup of students smoking already very early might differ substantially from the majority of non-smoking students, we excluded baseline current smokers (N=25) completely. For this subsample, we found the same significant effects for lifetime smoking (p=0.030), knowledge (p<0.001) and attitudes (p=0.002) and no effects on current smoking, norms and self-efficacy. Further factors being associated with a higher risk of attrition (male gender, higher age, migration background) were explored by analyzing subsamples of male students, students aged ≥11 years at baseline and students with migration background. In these subsamples, incidence rates in control students exceeded those of intervention by 4 to 7 percent points (reaching significance for older students, p=0.026, marginal significance for students with migration background, p=0.061, and failing to reach significance for male students, p=0.225).

DISCUSSION

The current study aimed to investigate the effects of a school-based prevention program on smoking related knowledge, attitudes and behavior six months after the end of program implementation. Using a cluster randomized controlled design, findings revealed that the program participation seems to reduce the prevalence and incidence of lifetime smoking, to increase smoking related knowledge, and to influence attitudes and perceived risks of smoking towards a more critical perception. Program effects on the prevalence of current smoking, normative expectations or refusal skills could not be determined. Using Cohen's classification of effect sizes,[3130] effect size was small for smoking behavior and attitudes, while there was a medium effect on smoking related knowledge.

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The pattern found for effects on smoking behavior with significant small effects on smoking incidence (d=0.23) and lifetime smoking (d=0.26), and no effect on current smoking can be aligned quite well with the results presented in former meta-analyses: The pooled odds ratio of 0.88 for smoking onset at the longest follow-up revealed by the overall analysis of Thomas et al.[13][12] corresponds to an effect size of d=0.07, while their subgroup analyses for different intervention approaches provided even moderate effect sizes (odds ratios between 0.49 and 0.52 corresponding to d's between 0.36 and 0.39). Earlier meta-analyses on school-based drug prevention programs,[14][13] psychosocial smoking prevention programs[15][14] or studies on Project DARE (Drug Abuse Resistance Education),[16][15] the most widely used school-based drug prevention program in the United States and focusing on teaching skills to recognize and resist social pressure, also determined small program effects on substance use with d's ranging between 0.08 and 0.18. Finding no effect on current smoking might also be explained to some extent by the young age of the sample with only very few students smoking already on a regular basis.

The pParticipation in "Eigenständig werden 5+6" significantly increased smoking related knowledge with an effect size of d=0.45 – the highest effect found in our analyses. This medium effect is in line with effect sizes ranging from 0.36 to 0.42 determined in meta-analyses referred to above.[14-16][13-15] Attitudes were influenced also significantly by the intervention, the small effect (d=0.15) compares well with the small effects in a range from 0.11 to 0.26 having been reported.[14-16][13-15]

We were not able to show an effect of the intervention in correcting perceived norms of smoking or in enhancing self-efficacy to refuse offered cigarettes. Students of both intervention and control group consider themselves to be rather highly self-efficacious to resist to cigarette offers already at the outset of the study and this rating even increases in both groups at follow-up, i.e. a ceiling effect might decrease the discriminative power of the group comparisons. As far as perceived norms of smoking are concerned, a possible explanation of the null-effect is the fact that only a minor part of the intervention (one subtask among nine tasks of the smoking workshop at the end of grade 5) deals with the topic of norms. Most tasks in the workshop address facts about and visualization of the short- and long-term consequences of smoking, others aim to scrutinize strategies of the tobacco industry or to foster resistance skills.

Some limitations of the current study have to be considered: During the 26 month period from baseline to follow-up, tThere has been some drop-out from the study. from baseline to follow-up; tThe analysis sample (N=2,513) amounted to 73.0% of the baseline sample

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(N=3,444). This drop-out was slightly higher than expected in the a priori power calculation (25%), but since the baseline sample was somewhat larger than calculated (N=3,444 instead of N=3,160), the analysis sample still exceeds the estimated sample at follow-up (75% of 3,160 = 2,370). Therefore, the power of the analyses should be adequate. NeverthelessFurthermore, we did not find any hints for selective attrition which could restrict the validity of findings and sensitivity analyses revealed very comparable patterns of results in subsamples with higher risk for attrition and smoking. The curriculum "Eigenständig werden 5+6" comprises of 14 lessons à on average 90 minutes and two workshops with 4 to 6 hours of duration which are implemented by teachers in addition to usual education, i.e. the program is quite time-consuming, it requires some dedication by teachers and it seems unreasonable to assume that the intervention is delivered to all classes exactly in the way and to the extent foreseen by the manual. The aAnalyses in this report were not controlled for treatment integrity,[32;3331;32] i.e. classes with low treatment fidelity that and having have only been exposed only to parts of the intervention contribute to the same extent to the results of the intervention group as classes with complete program implementation. Therefore, and results can be considered as rather conservative. Another limitation is the reliance on self-reports in the assessment of outcomes. Especially for outcomes assessing smoking behavior, but also for attitudes towards smoking, answers might be biased by social desirability. These influences might occur more likely in the intervention group since students might be primed by the intervention that smoking is an "unwanted" behavior. Nevertheless, since purchase of cigarettes and smoking in public is forbidden by law for minors in Germany, also the students in the control condition are not free of a social desirability bias as well. For other outcomes like the assessment of refusal skills, validity of self-report data might be limited by restricted accessibility, i.e. whether adolescents are really able to judge their own competence to resist cigarette offers. Finally, the study was run in regular public schools of four federal states of Germany, i.e. the generalizability might be limited due to these regional constraints and restricted to adolescents visiting regular schools.

On the other hand, some strengths of the current studiesy should be born in mind: Results were derived from a cluster randomized controlled trial, applying sophisticated statistical methods, comprising a range of several outcomes and following students up for six months after the end of intervention. Therefore, we implemented rather rigorous evaluation methods, which are in line with recommendations like those of the Society for Prevention Research.[3433]

Perspectives and open questions for future research might be the following: In the current trial, a further follow-up at 15 months after end of intervention is being conducted to explore stability of effects in the longer term. Furthermore, exploring effects on other outcomes than

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smoking, e.g. alcohol use or life skills, is owing for the current study. On the basis of findings for efficacy, effectiveness in relation to costs as well as generalizability to other populations should be investigated. Finally, besides stating whether an intervention is effective or not, mechanisms by which shown effects can be explained theoretically and empirically are to be explored. These mediation analyses may contribute to investigate causal models for preventive intervention, e.g. to explore whether knowledge or change in attitude are necessary preconditions for behavior change.[14][13]

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Figure legends

Figure 1. Participation flowchart

Figure 2. Percentage of lifetime smoking, current smoking at baseline and 6-month follow-up, percentage of smoking incidence at 6-month follow-up among baseline never-smokers, and multilevel mixed effects logistic regressions; OR = odds ratio, CI = confidence interval; logistic regressions were adjusted for age, gender, type of school, socio-economic status, immigration background, peer / parent / sibling smoking, sensation seeking, rebelliousness, earlier participation in a prevention program

Competing interests

None.

Ethics approval

Ethics approval was provided by the Ethics Committee of the Medical Faculty of the University of Kiel (Ref.: D 419/10).

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Contributors

BI performed the statistical analysis and interpretation of the data and drafted the manuscript. JH contributed to the acquisition of the data and participated in drafting the manuscript. KM contributed to the acquisition and management of the data. RH as principle investigator is responsible for the study concept, design and supervision and helped in drafting the manuscript.

All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors conducted a critical revision of the article and granted final approval of the article for important intellectual content.

Data sharing statement

No additional data available.

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Assessed for eligibility: 450 schools

Denial:
79 schools (17,5%)
No statement:
323 schools (71,5%)

Randomisation: 48 schools (11%)

Allocated to intervention group
26 schools/ 97 classes
2,437 students

Allocated to control group
22 schools/ 94 classes
2,335 students

Withdrawal of consent:
schools:
3 schools, 12 classes, 321 students
teachers:
4 classes, 102 students

Withdrawal of consent:
teachers:
3 classes, 84 students

No parental permission:
231 students
Absent:
98 students

No parental permission:
361 students
Absent:
131 students

Baseline Assessment
23 schools/ 81 classes
1,685 students

Baseline Assessment
22 schools/ 91 classes
1,759 students

Drop-out of 14 classes with 316 students

Drop-out of 7 classes with 150 students

Follow-up Assessment
Available data:
21 schools/ 67 classes/ 1,407 students
Matched to baseline: 1,255 students

Follow-up Assessment
Available data:
21 schools/ 84 classes/ 1,678 students
Matched to baseline: 1,438 students

Excluded due to inconsistent data: 76 students

Excluded due to inconsistent data: 104 students

Analysis Sample
1,179 students

Analysis Sample
1,334 students
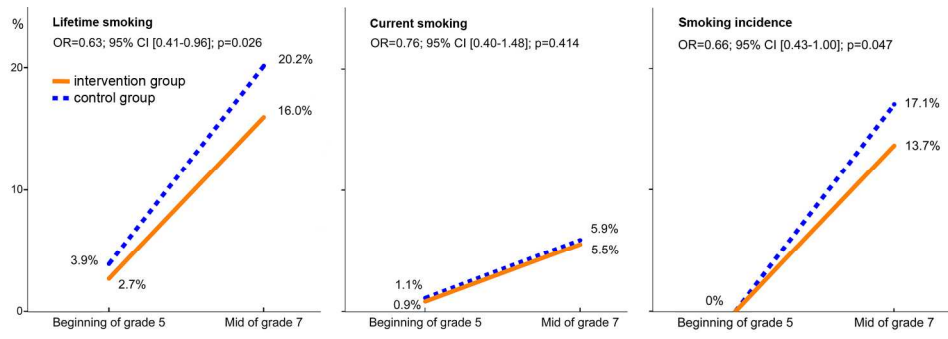
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Table 1: CONSORT 2010 checklist of information to include when reporting a cluster randomised trial

Section/Topic	Item No	Standard Checklist item	Extension for cluster designs	Page No *
Title and abstract				
	1a	Identification as a randomised trial in the title	Identification as a cluster randomised trial in the title	p. 1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	See table 2	p. 2
Introduction				
Background and objectives	2a	Scientific background and explanation of rationale	Rationale for using a cluster design	p. 5
	2b	Specific objectives or hypotheses	Whether objectives pertain to the the cluster level, the individual participant level or both	p. 5
Methods				
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Definition of cluster and description of how the design features apply to the clusters	p. 6
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons		p. 6
Participants	4a	Eligibility criteria for participants	Eligibility criteria for clusters	p. 6
	4b	Settings and locations where the data were collected		p. 6
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Whether interventions pertain to the cluster level, the individual participant level or both	p. 5
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and	Whether outcome measures pertain to the cluster level, the individual participant level or both	p. 7

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		when they were assessed		
	6b	Any changes to trial outcomes after the trial commenced, with reasons		**n.a.**
Sample size	7a	How sample size was determined	Method of calculation, number of clusters(s) (and whether equal or unequal cluster sizes are assumed), cluster size, a coefficient of intracluster correlation (ICC or *k*), and an indication of its uncertainty	p. 6
	7b	When applicable, explanation of any interim analyses and stopping guidelines		n.a.
Randomisation:				
Sequence generation	8a	Method used to generate the random allocation sequence		p. 6
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Details of stratification or matching if used	p. 6
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Specification that allocation was based on clusters rather than individuals and whether allocation concealment (if any) was at the cluster level, the individual participant level or both	p. 6
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Replace by 10a, 10b and 10c	
	10a		Who generated the random allocation sequence, who enrolled clusters, and who assigned clusters to interventions	p. 6
	10b		Mechanism by which individual participants were included in clusters for the purposes of the trial (such as complete	p. 6

			enumeration, random sampling)	
	10c		From whom consent was sought (representatives of the cluster, or individual cluster members, or both), and whether consent was sought before or after randomisation	p. 8
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how		n.a.
	11b	If relevant, description of the similarity of interventions		n.a.
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	How clustering was taken into account	p. 9
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses		p. 9
Results				
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	For each group, the numbers of clusters that were randomly assigned, received intended treatment, and were analysed for the primary outcome	p. 6 Figure 1
	13b	For each group, losses and exclusions after randomisation, together with reasons	For each group, losses and exclusions for both clusters and individual cluster members	p.6
Recruitment	14a	Dates defining the periods of recruitment and follow-up		p. 6
	14b	Why the trial ended or was stopped		n.a.
Baseline data	15	A table showing baseline demographic and clinical	Baseline characteristics for the individual and cluster levels as	

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		characteristics for each group	applicable for each group	
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	For each group, number of clusters included in each analysis	p. 6
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Results at the individual or cluster level as applicable and a coefficient of intracluster correlation (ICC or k) for each primary outcome	p. 9-
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended		p. 9-
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory		p. 9-
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)		
Discussion				
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses		p. 13
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Generalisability to clusters and/or individual participants (as relevant)	p. 13
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence		p. 12-
Other information				
Registration	23	Registration number and		p. 2

		name of trial registry		
Protocol	24	Where the full trial protocol can be accessed, if available		p. 6
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders		p. 15

* Note: page numbers optional depending on journal requirements