From never to daily smoking in 30 months: The predictive value of tobacco and non-tobacco advertising exposure

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From never to daily smoking in 30 months:

The predictive value of tobacco and non-tobacco advertising exposure

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ABSTRACT

Objective: To test the specificity of the association between tobacco advertising and youth smoking initiation.

Design: Longitudinal survey with a 30-months interval.

Setting: Twenty-one public schools in 3 German states.

Participants: A total of 1320 sixth- to eighth-grade students who were never-smokers at baseline (age range at baseline, 10-15 years; mean, 12.3 years).

Exposures: Exposure to tobacco and non-tobacco advertisements was measured at baseline with images of 6 tobacco and 8 non-tobacco advertisements; students indicated the number of times they had seen each ad and the sum score over all advertisements was used to represent inter-individual differences in the amount of advertising exposure.

Primary and secondary outcome measures: Established smoking, defined as smoked >100 cigarettes during the observational period, and daily smoking at follow-up. Secondary outcome measures were any smoking and smoking in the last 30 days.

Results: During the observation period 5% of the never smokers at baseline smoked more than 100 cigarettes and 4.4% were classified as daily smokers. After controlling for age, gender, socio-economic status, school performance, television screen time, personality characteristics, and smoking status of peers and parents, each additional 10 tobacco advertising contacts increased the adjusted relative risk for established smoking by 38% (95% confidence interval: 16% - 63%; $p<0.001$) and for daily smoking by 30% (95% confidence interval: 3% - 64%; $p<0.05$). No significant association was found for non-tobacco advertising contact.

Conclusions: The study confirms a content-specific effect of tobacco advertising and underlines that tobacco advertising exposure is not simply a marker for adolescents that are generally more receptive or attentive towards marketing.

ARTICLE SUMMARY

Article focus

- High exposure to tobacco advertising might just be an indicator of high advertising exposure in general.
- In this study we compare the potential of tobacco advertising vs. non-tobacco advertising exposure in predicting established and daily smoking of formerly never-smoking German adolescents.

Key messages

- Exposure to tobacco advertisements predicted established smoking and daily smoking, exposure to non-tobacco advertising did not.
- The study also shows that advertising allowed under partial bans continues to drive adolescents to smoke.

Strengths and limitations of this study

- One of few studies that tests the specificity of the association between tobacco advertising and smoking.
- Long follow-up period with smoking outcomes that are strongly predictive of becoming an addicted smoker.
- A high drop-out rate and attrition bias are limiting factors of this study.

INTRODUCTION

Tobacco companies were among the first companies to use integrated marketing strategies, and their products have long been among the most heavily marketed products in the United States and worldwide.[1] The tobacco industry still denies that their marketing is targeted at young people. According to the industry the purpose of tobacco advertising is to maintain and increase market shares of adult consumers.[2] In contrast, empirical research indicates that adolescents are aware of, recognize, and are influenced by tobacco marketing strategies. The U.S. Surgeon General's 2012 comprehensive review of the tobacco marketing literature concluded that advertising and promotional activities by tobacco companies are key risk factors for the uptake to smoking in adolescents.[3]

A 2011 Cochrane review identified 19 longitudinal studies that followed up a total of over 29,000 subjects, who were adolescents aged 18 or younger, and were not regular smokers at baseline. In 18 of the 19 studies the nonsmoking adolescents who were more aware of tobacco advertising or receptive to it, were more likely to experiment with cigarettes or become smokers at follow up.[4]

Based on these research results, article 13 of the World Health Organization's (WHO) Framework Convention on Tobacco Control stipulates a comprehensive ban on tobacco advertising, promotion, and sponsorship.[5] A number of countries all over the world follow these recommendations, and have banned tobacco advertisings. However, other countries, such as the United States and Germany, have implemented considerably weaker tobacco marketing policies. Germany has banned tobacco advertisements in television, radio, newspapers, and magazines, but there are still opportunities for the industry to promote their products: Tobacco marketing is allowed at point of sale, on billboards, and in cinemas before movies that show after 6:00 pm. Brand extension, i.e. the use of tobacco brand names for other products, is also allowed.

From a scientific point of view, the best way to study the effects of tobacco marketing would be a randomized controlled trial. But this kind of study design would be both unethical and

impractical. Since experimental studies cannot be conducted, we have to rely on observational studies. Sir Austin Bradford Hill identified several criteria for evaluating causality in epidemiological studies.[6] According to these criteria the risk factor (e.g. tobacco marketing) must clearly precede the hypothesized effect (e.g. smoking uptake in young people). In addition, the association should be strong, consistent, expected from theory, and specific.

The Cochrane review on the effects of tobacco advertising on young people[4] listed our previous study[7;8] as the only one that tested the specificity of tobacco advertising compared to advertisements of other consumer goods. According to the review, limitations of this study included (a) the short nine months follow-up period, and (b) the outcome measure which defined smoking initiation during the observational period as any smoking including a few puffs. Clearly, not all adolescents who try smoking will go on to become addicted smokers. With the current study we present findings from the same cohort, only for a much longer follow-up period (30 months). The longer follow-up period enables us to study established and daily smoking as outcomes in young people, outcomes that are more strongly predictive of becoming an addicted smoker.[9]

METHODS

Study sample

In May 2008 we invited 120 randomly selected schools from three states of Germany (Brandenburg, Hamburg, and Schleswig-Holstein) to participate in a school-based survey. The German school system has different types of schools (*Grundschule, Hauptschule, Realschule, Oberschule, Gemeinschaftsschule, Gymnasium)* that mainly differ with regard to the academic skills of their students and graduation level. The selection was stratified by state and type of school, assuring a balanced representation of all school types of the respective states. Twenty-nine schools with 176 classes and 4195 sixth to eighth grade students agreed to participate after a four week recruitment interval. In September and October 2008 we surveyed a total of 174 classes with 3415 students (81.4% of the sampled students). Reasons for exclusion were either absence (2 classes, 134 students) or missing parental consent (646 students). From the 3415 students surveyed at baseline, 2346 were classified as never smokers. Of these, 1320 (56.3%) could be reached again at the follow-up assessment in May/June 2011. Reasons for study drop-out were loss of whole schools due to school changes after sixth grade (7 schools, 14 classes, 194 students), refusal to participate at the follow-up assessment (1 school, 8 classes, 59 students) or class absence (24 classes, 291 students). Other reasons were unexplained absence on the day of data assessment or unmatchable student codes (482 students). The number of analyzed never smokers per school ranged from 3 to 232, class-sizes ranged from 1 to 26.

Survey implementation

Data were collected through self-completed anonymous questionnaires during one school hour (45 min. period), administered by trained research staff. Only students with written parental consent were qualified for participation, parent consent forms were disseminated by class teachers three weeks prior to the baseline assessment. Students did not receive incentives for participation and irrespective of parental consent all students were free to

refuse participation (none refused). Class teachers assigned tasks for students that did not participate. After completion of the survey, questionnaires were placed in an envelope and sealed in front of the class. Students were assured that their individual information would not be seen by parents or teachers. To permit a linking of the baseline and follow-up questionnaires, students generated an anonymous seven-digit individual code, a procedure that had been tested in previous studies, slightly modified for this study. [10] Implementation was approved by all Ministries of Cultural Affairs of the three involved states, and ethical approval was obtained from the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Measures

Advertising exposure

Advertising exposure has been operationalized in numerous ways across studies.[4] It has been measured both in terms of the physical presence of advertisements in individuals' environments and in terms of the psychological processes underlying individuals' memories for these advertisements.[11] In the present study we approximated the individual advertising contact frequency by providing masked colored images of billboard ads for cigarettes and fixed-images of TV commercials for non-tobacco ads, asking the students to rate how often they have ever seen each ad extract (on a 4-point scale with scale points 0="Never,",1="1 to 4 times," 2="5 to 10 times" and 3="More than 10 times"). The answers were post-coded as 0=0, 1=2.5, 2=7.5, and 3=11 and summed up to create the tobacco and non-tobacco ad scales, respectively.

The images included six cigarette brands, and eight "control" ads for products that included sweets, clothes, mobile phones, and cars. The following cigarette brands were included in the survey (with ad theme or cue in parentheses): (1) Marlboro (cowboy; horses); (2) F6 (sunrise); (3) Gauloises (couple); (4) Pall Mall (Empire State Building); (5) L&M (couple); (6) Lucky Strike (cigarette packs). These six cigarette brands are among the eight most popular

cigarette brands in Germany.[12] For other commercial products, the following ads were included in the survey (with product type and ad theme or cue in parentheses): (1) Jack Wolfskin (trekking-clothing; climber); (2) Volkswagen (car; the performer Seal); (3) Tic Tac (candy; elevator); (4) Dr. Best (tooth brush; tomato); (5) Kinder Pingui (chocolate bar; penguins); (6) T-Mobile (mobile phone; dog); (7) Spee (detergent; fox); (8) Toyota (car). Advertising selection was based on a pilot study on 28 tobacco and non-tobacco ads (110 students aged 11 to 16 years, mean age 13.6 years), selecting the half of ads that revealed neither ceiling nor floor effects and had corrected item-test correlations above r_{it}=0.40.

We assessed ad exposure to non-tobacco products to control for the propensity to be receptive or attentive to advertising in general, which could confound the relation between tobacco-specific advertising exposure and smoking behavior.

Smoking behavior

We assessed lifetime smoking experience by asking "How many cigarettes have you smoked in your life?" (never smoked, just a few puffs, 1-19 cigarettes, 20-100 cigarettes, >100 cigarettes).[13] Students that indicated any smoking at baseline, even just a few puffs, were excluded from the analysis. Having smoked more than 100 cigarettes at the follow-up assessment was defined as being an established smoker. Current smoking frequency was measured by asking, “How often do you smoke at present?” to which respondents could answer, “I don’t smoke,” “less than once a month,” “at least once a month, but not weekly,” “at least once a week, but not daily,” or “daily.” For the present analysis, this variable was dichotomized into daily and non-daily smoking.

Covariates

Covariate measures were derived from studies that focus on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to ad exposure and the smoking measures. [14-16]

Potential confounders included: (1) Sociodemographics: age, gender, study region, and socioeconomic status (SES); SES of the students was approximated with a combination of student and class teacher ratings: Students answered three items of the PISA cultural and social capital assessment[17], asking for the number of books in the household (5-point scale from 0 = "None" to 4 = "More than 100") and parenting characteristics ("My parents always know where I am" and "My parents know other parents from my school"), class teachers filled out an 11-item school evaluation sheet related to SES of their students (examples: "Most students of the school live in families with financial problems", "Most students of the school come from underprivileged families", "Our school has a good reputation", scale range from 0 = "Not true at all" to 3 = "Totally true", Cronbach's alpha = 0.85); student and teacher ratings positively correlated r = 0.57, alpha = 0.72. (2) Personal characteristics: self-reported school performance ("How would you describe your grades last year?", scale points "excellent", "good", "average", "below average"); average TV screen time ("How many hours do you usually watch TV in your leisure time?", scale points: "none", "about half an hour", "about an hour", "about two hours", "about three hours", "about four hours", "more than four hours a day"); rebelliousness and sensation-seeking, assessed with four items combined into a single index, with higher scores indicating greater propensity for rebelliousness and sensation seeking[18] ("I get in trouble in school"; "I do things my parents wouldn't want me to do"; "I like scary things"; "I like to do dangerous things", scale points 0 = "not at all like me", 1 = "a little like me", 2 = "pretty much like me", and 3 = "exactly like me", Cronbach's alpha = 0.76). (3) Social environment: parent smoking (0 = "No", 1 = "Yes, 2) and peer smoking (0 = "None", 1 = "Some, 2 = "Most", 3 = "All"). As mentioned above, we also controlled for the adolescent's ability to recall advertising in general with the non-tobacco ad scale.

Statistical analysis

All data analyses were conducted with Stata version 12.0 (Stata Corp, College Station, TX). Chi-squared tests and T-tests were performed to check whether subjects included in the

analysis differed systematically from those not reached at the follow-up assessment. Bivariate associations between the study variables were analyzed using Spearman rank correlations. The multivariate associations between amount of advertising exposure and smoking initiation were analyzed with Poisson regressions. Poisson regression allows for the presentation of adjusted Incidence Rate Ratios (IRRs) and 95% confidence intervals (CIs) for the relationship between exposure to advertising and smoking at follow-up, having the advantage of not being influenced by the prevalence of the exposure. IRRs were calculated for every 10 advertising contacts, indicating the relative increase in smoking incidence (established smoking and daily smoking) for each additional 10 contacts. The dichotomized outcome variables were regressed on advertising exposure after inclusion of all covariates and with clustered robust standard errors to account for intra-class correlations within schools. In a subsequent analysis we repeated the Poisson regressions with advertising contact frequency being parsed into tertiles to account for the skewed distribution of tobacco advertising contact and to replicate the approach used in our previous analysis. [8] Missing data were handled by listwise deletion.

RESULTS

Descriptive statistics at baseline and attrition analysis

Table 1 gives descriptive statistics for all interviewed never smokers at baseline, for those lost to follow-up, and the final analyzed sample, allowing comparisons of differences due to attrition. Never smokers lost to follow-up were significantly younger of age, more often male, had lower scores on the SES scale, rated their school performance more poorly, had higher scores in sensation seeking/rebelliousness and more often reported at least one parent who smoked. No differences were found with regard to tobacco or non-tobacco advertising contact.

Table 1. Descriptive sample statistics at baseline and attrition analysis.

	Baseline never smokers (n=2346) %	Lost to follow-up (n=1026) %	Analyzed Sample (n=1320) %	p

Sociodemographics				
Age at baseline, mean (SD)	12.24 (1.01)	12.16 (1.09)	12.30 (0.93)	.001
Gender: Female	54.9	51.9	57.3	.008
SES: Below Median	51.1	60.6	43.8	<.001
State				
Schleswig-Holstein	41.6	39.8	43.0	.279
Hamburg	28.4	29.1	27.8	
Brandenburg	30.0	31.1	29.2	
Personal characteristics				
School performance				
Below average	2.5	3.7	1.5	<.001
Average	33.7	37.8	30.6	
Good	49.9	44.9	53.9	
Excellent	13.9	13.6	14.0	
TV screen time				
≤ 30 min	16.8	15.5	17.8	.051
1-2 h	59.5	58.8	60.1	
3-4 h	19.0	19.8	18.3	
> 4 h	4.7	5.9	3.8	
Sensation seeking and rebelliousness, mean (SD), range 0-3	0.53 (0.50)	0.56 (0.51)	0.50 (0.49)	.010
Social environment				
Peer smoking: None	71.7	71.5	71.9	.858
Parent smoking: No	53.3	49.3	56.4	.001
Advertising exposure				
Tobacco advertising				
Low	35.3	35.3	35.4	.600
Medium	38.7	39.7	38.0	
High	26.0	25.0	26.6	
Non-tobacco advertising				
Low	39.8	40.8	39.0	.469
Medium	32.1	32.4	32.0	
High	28.1	26.8	29.0	

Smoking initiation during the observational period

Thirty months after the baseline assessment 436 never smokers reported trying cigarette smoking including a few puffs (33% incidence rate), 138 reported smoking in the past 30 days (10.5% incidence rate), Sixty-six had smoked more than 100 cigarettes and were classified as established smokers (incidence rate 5%), and 58 reported daily smoking (incidence rate 4.4%). Daily smoking incidence was not significantly related to age (p=0.526) or sex (p=0.153), with 33% of the daily smokers at follow-up being 14 years of age or younger and 24% being 16 or older.

Exposure to advertisements at baseline

Table 2 gives contact frequencies (how often the students had seen the ad) for all advertised products at baseline. The cigarette ad with the highest contact frequency was Lucky Strike, for which about half of the sample reported at least one contact. The lowest tobacco ad contact frequency rate was found for F6, a regional German cigarette brand sold mainly in eastern Germany. Ad contact frequency for non-tobacco products was generally much higher than for tobacco products. For example, almost all students (98%) reported having seen the ad for Kinder Pingui, a chocolate bar. The range of the sum of contacts over all depicted advertisements was 0 to 55 (mean=7.9) for the tobacco ads, and 0 to 88 (mean=42.2) for the non-tobacco ads.

Table 2. Contact frequency for tobacco and non-tobacco advertisings (n = 1320 never smokers at baseline)

	Seen at least once	**Seen more than 10 times**
	%	%
Tobacco ads (product type)		
Lucky Strike (cigarettes)	49	13
Marlboro (cigarettes)	28	6
Pall Mall (cigarettes)	24	6
Gauloises (cigarettes)	19	2
L&M (cigarettes)	18	4

Table 2. Contact frequency for tobacco and non-tobacco advertisings (n = 1320 never smokers at baseline)

F6 (cigarettes)	12	1
Non-tobacco ads (product type)		
Kinder Pingui (sweet)	96	71
Tic Tac (candy)	87	44
Dr. Best (tooth brush)	83	36
T-Mobile (mobile phone)	85	35
Spee (detergent)	76	24
Volkswagen (car)	50	14
Toyota (car)	54	10
Jack Wolfskin (trekking-clothing)	45	9

Zero order associations

Table 3 shows pairwise Spearman rank correlations between the study variables, demonstrating significant crude associations between the assessed covariates and smoking behavior as well as between covariates and advertising contact, justifying their inclusion in the multivariate analyses. The highest correlations with all smoking outcomes was found for peer smoking, followed by tobacco advertising contact. There were some differences in the correlational pattern between tobacco and non-tobacco advertising contact. Compared to the amount of contact with tobacco ads, non-tobacco advertising exposure was stronger related to age and showed no association with gender, and also had a stronger correlation with SES, TV screen time, and parental smoking. The zero-order correlation between tobacco and non-tobacco advertising contact indicated a proportion of about 20% shared variance.

Table 3. Zero-order correlation matrix for all study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1.00													
2. Gender (0=female, 1=male)	0.02	1.00												
3. SES	**-0.07***	0.02	1.00											
4. Region (0=west, 1=east)	**0.25*****	-0.01	**-0.10***	1.00										
5. School performance	**0.11*****	0.03	**-0.16*****	-0.05	1.00									
6. TV screen time	**0.17*****	**0.07****	**-0.30*****	**0.25*****	**0.15*****	1.00								
7. Sensation seeking	**0.09*****	**0.24*****	-0.03	0.01	**0.16*****	**0.18*****	1.00							
8. Peer smoking	**0.28*****	0.02	**-0.22*****	**0.28*****	**0.15*****	**0.24*****	**0.24*****	1.00						
9. Parent smoking	0.04	-0.02	**-0.26*****	**0.09*****	**0.11****	**0.22*****	**0.08****	**0.17*****	1.00					
10. Tobacco ad exposure	**0.14*****	**0.13*****	0.02	**-0.06***	0.05	**0.11****	**0.24*****	**0.13*****	**0.08****	1.00				
11. Non-tobacco ad exposure	**0.20*****	0.05	**-0.08****	**0.11****	**0.06***	**0.36*****	**0.21*****	**0.18*****	**0.18*****	**0.44*****	1.00			
12. Ever smoking	**0.15*****	0.01	**-0.17*****	**0.14*****	**0.09****	**0.14*****	**0.18*****	**0.24*****	**0.13*****	**0.19*****	**0.15*****	1.00		
13. Past 30 days smoking	**0.09****	-0.02	**-0.12****	**0.08****	**0.06***	**0.12****	**0.15*****	**0.21*****	**0.14*****	**0.17*****	**0.12*****	**0.61*****	1.00	
14. Established smoking	**0.07***	**0.09****	**-0.07***	**0.08****	0.05	**0.10***	**0.12****	**0.16*****	**0.09*****	**0.13*****	**0.09****	**0.33*****	**0.51*****	1.00
15. Daily smoking	0.02	0.04	**-0.14*****	**0.08****	**0.07***	**0.10***	**0.09****	**0.14*****	**0.13*****	**0.08****	0.03	**0.30*****	**0.49*****	**0.75*****

Association between advertising contact and smoking initiation

Figures 1a and 1b show the adjusted predictions of established smoking and daily smoking based on the amount of tobacco and non-tobacco advertising contact. The curves illustrate an increasing risk for the two smoking outcomes dependent on the amount of tobacco ad contact, but not for non-tobacco advertising contact.

Insert Figures 1a and 1b about here

The Figures also report the adjusted incidence rate ratios associated with an increase in advertising exposure. There was an adjusted IRR for established smoking of 1.38 (95% CI 1.16, 1.63; p<.001) for each additional 10 tobacco ad contacts and 1.00 (95% CI 0.84, 1.19; p=0.996) for each additional 10 non-tobacco ad contacts. For daily smoking, the corresponding IRRs were 1.30 (95% CI 1.03, 1.64; p=0.029) for 10 tobacco ad contacts and 0.92 (95% CI 0.79, 1.08; p=0.296) for 10 non-tobacco ad contacts, respectively.

Due to the skewed distribution of tobacco ad contact frequency (more than half of the never-smoking students had fewer than 10 contacts), we repeated the analysis using contact frequency parsed into tertiles, representing relative low (0-2.5), medium (5-10), and high (11-55) advertising contact. For established smoking the adjusted IRRs were 1.52 for tobacco ads (95% CI 1.14, 2.03; p=0.004) and 1.05 for non-tobacco ads (95% CI 0.68, 1.62; p=0.819). Using daily smoking as outcome variable the IRRs were 1.43 (95% CI 1.08, 1.90; p=0.012) and 0.84 (95% CI 0.58, 1.22; p=0.363) for each additional tertile of tobacco and non-tobacco advertising contact. Theses IRRs relate to 3.1%, 4.8%, and 7.3% established smoking attributable incidence rate or 3.1%, 4.6%, and 6.4% daily smoking incidence for low, medium, and high tobacco advertising contact, respectively, assuming the adjusted analysis adequately controlled for third variable influence.

DISCUSSION

This longitudinal study is a further test of the relationship between tobacco advertising exposure and youth smoking behavior, confirming the specificity of the advertising-smoking link by comparing the effects of tobacco versus non-tobacco advertising. The study extends previous work by using two less prevalent outcome measures (established and daily smoking) and a longer follow-up period of 2.5 years, measures likely to indicate an addiction component to the smoking.[19] Specificity was shown by the finding that tobacco advertising at baseline predicted these outcomes independent of the amount of general advertising contact and after controlling for a number of well-known risk factors for smoking initiation. This result confirms the content-specific effect of tobacco advertising and underlines that tobacco advertising exposure is not simply a marker for adolescents that are generally more receptive or attentive towards marketing.

This longitudinal study also clearly points out the implications of partial tobacco advertising bans in countries like the United States and Germany. The one-third of adolescents in the highest tertile of advertising had rates of daily and established smoking that were double (3 percentage points higher) than adolescents in the first tertile. In reverse, assuming that the models were fully adjusted for other confounding influences, one might expect a significant further decrease in the rates of smoking in these countries after a total elimination of tobacco advertising.

Some limitations of the study have to be considered. There was a severe loss of students during the 30 months interval (44%). To a large degree the drop-out was due to organizational issues (e.g., school and class changes) that are unlikely systematically related to advertising exposure or smoking behavior on the individual level. However, the lost students differed on a couple of dimensions from the retained students, i.e., age, gender, socio-economic status, school performance, sensation seeking, and parental smoking. With

the exception of the lower age, the drop-out markers indicate that lower risk adolescents were more likely to be retained. This might have biased the results as the effect of specific risk factors (e.g., advertising exposure) might not be independent of other risk factors. Second, as with any observational study, the results may be biased by unmeasured confounding – that is, an unmeasured risk factor could alter the estimates reported for the association between tobacco advertising and smoking onset. Third, the memory-based measure of ad exposure could be biased by memory effects other than the ones we controlled for. The potential to memorize ads (in terms of contact frequency) should, however, not be completely independent of actual exposure. Finally, because the implemented method did not use a representative sample of all broadcasted ads, it does not allow for an accurate estimation of the total amount of tobacco and non-tobacco advertising exposure or the advertising pressure of specific brands.

The finding that exposure to tobacco advertising predicts smoking in youth could have important public health implications. A total ban of tobacco advertising and promotion around the world is one key policy measure of WHO Framework Convention on Tobacco Control (FCTC) [20]. Under Article 13.1 of the FCTC, 'Parties recognize that a comprehensive ban on advertising, promotion and sponsorship would reduce the consumption of tobacco products'. Data from this study support this measure, because only exposure to tobacco advertisements predicted smoking initiation, which cannot be attributed to a general receptiveness to marketing and because it shows that advertising allowed under partial bans continues to drive adolescents to smoke.

STATEMENTS

Licence

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None.

Contributors:

Conception and design of the study: All authors

Analysis and interpretation of data: MM, RH

Collection and assembly of data: MM, BI

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Critical revision of the article for important intellectual content: All authors

Final approval of the article: All authors

All authors have full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Study implementation was approved by the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Data sharing: No additional data available.

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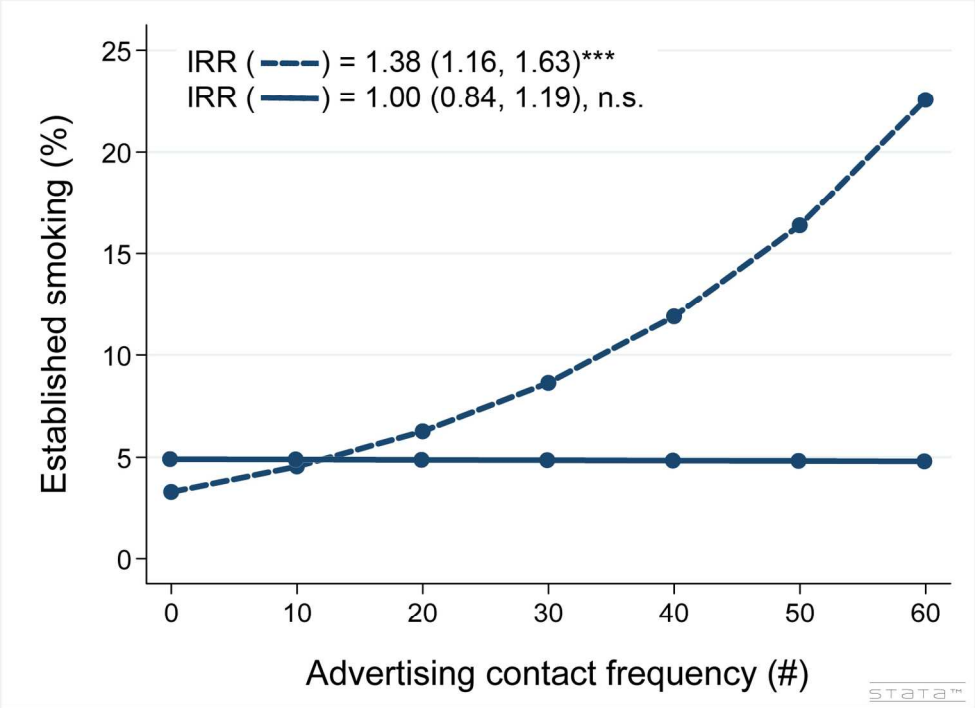
Figure legend

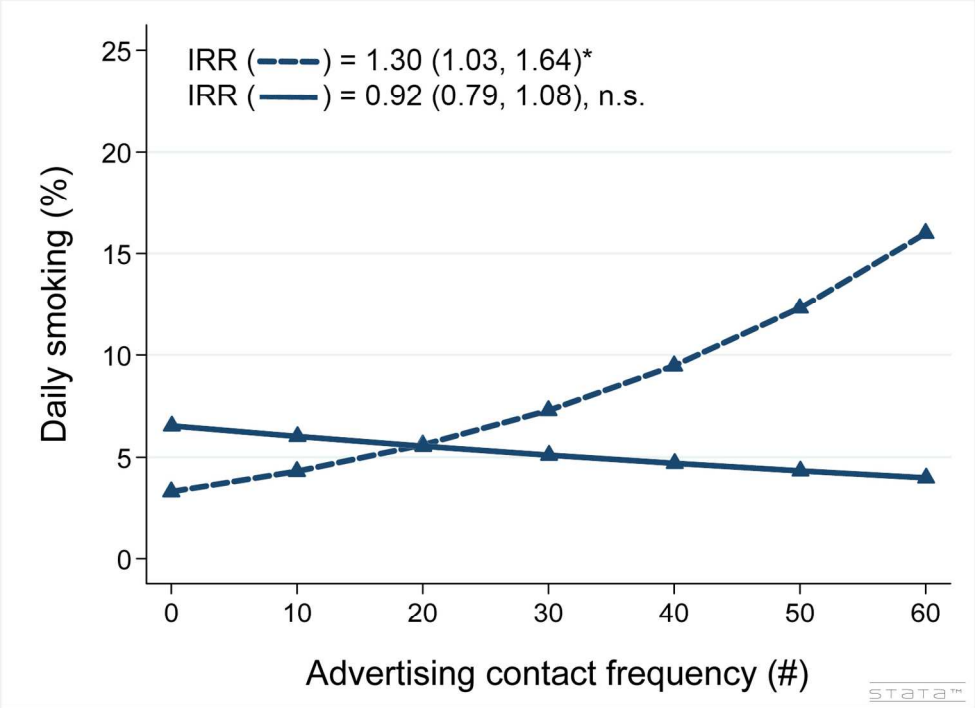
Figures 1a and 1b

----- Tobacco advertising —— Non-tobacco advertising

IRR = Incidence Rate Ratio for 10 additional advertising contacts
Figures in brackets = 95% Confidence Interval
n.s. = not significant; *=p<.05; ***=p<.001



143x104mm (300 x 300 DPI)



143x104mm (300 x 300 DPI)

STROBE statement
Manuscript entitled "From never to daily smoking in 30 months:
The predictive value of tobacco and non-tobacco advertising exposure"

	Item No	Recommendation	Manuscript page
Title and abstract			
	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8,9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8,9
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9, 10
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	10
		(d) If applicable, explain how loss to follow-up was addressed	10
		(*e*) Describe any sensitivity analyses	10

Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study? eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(*b*) Give reasons for non-participation at each stage	6
		(*c*) Consider use of a flow diagram	--
Descriptive data	14*	(*a*) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(*b*) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8, 13, 15 Figure 1
		(*b*) Report category boundaries when continuous variables were categorized	15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	--
Other analyses	17	Report other analyses done? eg analyses of subgroups and interactions, and sensitivity analyses	--
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16,17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

From never to daily smoking in 30 months: The predictive value of tobacco and non-tobacco advertising exposure

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From never to daily smoking in 30 months:

The predictive value of tobacco and non-tobacco advertising exposure

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Number of figures: 2

ABSTRACT

Objective: To test the specificity of the association between tobacco advertising and youth smoking initiation.

Design: Longitudinal survey with a 30-months interval.

Setting: Twenty-one public schools in 3 German states.

Participants: A total of 1320 sixth- to eighth-grade students who were never-smokers at baseline (age range at baseline, 10-15 years; mean, 12.3 years).

Exposures: Exposure to tobacco and non-tobacco advertisements was measured at baseline with images of 6 tobacco and 8 non-tobacco advertisements; students indicated the number of times they had seen each ad and the sum score over all advertisements was used to represent inter-individual differences in the amount of advertising exposure.

Primary and secondary outcome measures: Established smoking, defined as smoked >100 cigarettes during the observational period, and daily smoking at follow-up. Secondary outcome measures were any smoking and smoking in the last 30 days.

Results: During the observation period 5% of the never smokers at baseline smoked more than 100 cigarettes and 4.4% were classified as daily smokers. After controlling for age, gender, socio-economic status, school performance, television screen time, personality characteristics, and smoking status of peers and parents, each additional 10 tobacco advertising contacts increased the adjusted relative risk for established smoking by 38% (95% confidence interval: 16% - 63%; $p<0.001$) and for daily smoking by 30% (95% confidence interval: 3% - 64%; $p<0.05$). No significant association was found for non-tobacco advertising contact.

Conclusions: The study confirms a content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not

simply a marker for adolescents that are generally more receptive or attentive towards marketing.

ARTICLE SUMMARY

Article focus

- High exposure to tobacco advertising might just be an indicator of high advertising exposure in general.
- In this study we compare the potential of tobacco advertising vs. non-tobacco advertising exposure in predicting established and daily smoking of formerly never-smoking German adolescents.

Key messages

- Exposure to tobacco advertisements predicted established smoking and daily smoking, exposure to non-tobacco advertising did not.
- The study also shows that advertising allowed under partial bans still reaches adolescents.

Strengths and limitations of this study

- One of few studies that tests the specificity of the association between tobacco advertising and smoking.
- Long follow-up period with smoking outcomes that are strongly predictive of becoming an addicted smoker.
- A high drop-out rate and attrition bias are limiting factors of this study.

INTRODUCTION

Tobacco companies were among the first companies to use integrated marketing strategies, and their products have long been among the most heavily marketed products in the United States and worldwide.[1] The tobacco industry still denies that their marketing is targeted at young people. According to the industry the purpose of tobacco advertising is to maintain and increase market shares of adult consumers.[2] In contrast, empirical research indicates that adolescents are aware of, recognize, and are influenced by tobacco marketing strategies. The U.S. Surgeon General's 2012 comprehensive review of the tobacco marketing literature concluded that advertising and promotional activities by tobacco companies are key risk factors for the uptake to smoking in adolescents.[3]

A 2011 Cochrane review identified 19 longitudinal studies that followed up a total of over 29,000 subjects, who were adolescents aged 18 or younger, and were not regular smokers at baseline. In 18 of the 19 studies the nonsmoking adolescents who were more aware of tobacco advertising or receptive to it, were more likely to experiment with cigarettes or become smokers at follow up.[4]

Based on these research results, article 13 of the World Health Organization's (WHO) Framework Convention on Tobacco Control stipulates a comprehensive ban on tobacco advertising, promotion, and sponsorship.[5] A number of countries all over the world follow these recommendations, and have banned tobacco advertisings. However, other countries, such as the United States and Germany, have implemented considerably weaker tobacco marketing policies.[6] Germany has banned tobacco advertisements in television, radio, newspapers, and magazines, but there are still opportunities for the industry to promote their products: Tobacco marketing is allowed at point of sale, on billboards, and in cinemas before movies that show after 6:00 pm. Brand extension, i.e. the use of tobacco brand names for other products, is also allowed.

From a scientific point of view, the best way to study the effects of tobacco marketing would be a randomized controlled trial. But this kind of study design would be both unethical and

impractical. Since experimental studies cannot be conducted, we have to rely on observational studies. Sir Austin Bradford Hill identified several criteria for evaluating causality in epidemiological studies.[7] According to these criteria the risk factor (e.g. tobacco marketing) must clearly precede the hypothesized effect (e.g. smoking uptake in young people). In addition, the association should be strong, consistent, expected from theory, and specific.

The Cochrane review on the effects of tobacco advertising on young people[4] listed our previous study[8;9] as the only one that tested the specificity of tobacco advertising compared to advertisements of other consumer goods. Limitations of this study included (a) the short nine months follow-up period, and (b) the outcome measure which defined smoking initiation during the observational period as any smoking including a few puffs. Clearly, not all adolescents who try smoking will go on to become addicted smokers. With the current study we present findings from the same cohort, only for a much longer follow-up period (30 months). The longer follow-up period enables us to study established and daily smoking as outcomes in young people, outcomes that are more strongly predictive of becoming an addicted smoker.[10]

METHODS

Study sample

In May 2008 we invited 120 randomly selected schools from three states of Germany (Brandenburg, Hamburg, and Schleswig-Holstein) to participate in a school-based survey. The German school system has different types of schools (*Grundschule, Hauptschule, Realschule, Oberschule, Gemeinschaftsschule, Gymnasium)* that mainly differ with regard to the academic skills of their students and graduation level. The selection was stratified by state and type of school, assuring a balanced representation of all school types of the respective states. Twenty-nine schools with 176 classes and 4195 sixth to eighth grade students agreed to participate after a four week recruitment interval. In September and October 2008 we surveyed a total of 174 classes with 3415 students (81.4% of the sampled students). Reasons for exclusion were either absence (2 classes, 134 students) or missing parental consent (646 students). From the 3415 students surveyed at baseline, 2346 were classified as never smokers. Of these, 1320 (56.3%) could be reached again at the follow-up assessment in May/June 2011. Reasons for study drop-out were loss of primary schools that end after sixth grade (7 schools, 14 classes, 194 students), refusal to participate at the follow-up assessment (1 school, 8 classes, 59 students) or class absence (24 classes, 291 students). Other reasons were unexplained absence on the day of data assessment or unmatchable student codes (482 students). The number of analyzed never smokers per school ranged from 3 to 232, class-sizes ranged from 1 to 26.

Survey implementation

Data were collected through self-completed anonymous questionnaires during one school hour (45 min. period), administered by trained research staff. Only students with written parental consent were qualified for participation, parent consent forms were disseminated by class teachers three weeks prior to the baseline assessment. Students did not receive incentives for participation and irrespective of parental consent all students were free to

refuse participation (none refused). Class teachers assigned tasks for students that did not participate. After completion of the survey, questionnaires were placed in an envelope and sealed in front of the class. Students were assured that their individual information would not be seen by parents or teachers. To permit a linking of the baseline and follow-up questionnaires, students generated an anonymous seven-digit individual code, a procedure that had been tested in previous studies, slightly modified for this study.[11] Implementation was approved by all Ministries of Cultural Affairs of the three involved states, and ethical approval was obtained from the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Measures

Advertising exposure

Advertising exposure has been operationalized in numerous ways across studies.[4] It has been measured both in terms of the physical presence of advertisements in individuals' environments and in terms of the psychological processes underlying individuals' memories for these advertisements.[12] In the present study we approximated the individual advertising contact frequency by providing masked colored images of billboard ads for cigarettes and fixed-images of TV commercials for non-tobacco ads with all brand-identifying content digitally removed, asking the students to rate how often they have ever seen each ad extract (on a 4-point scale with scale points 0="Never,",1="1 to 4 times," 2="5 to 10 times" and 3="More than 10 times"). The answers were post-coded as 0=0, 1=2.5, 2=7.5, and 3=11 and summed up to create the tobacco and non-tobacco ad scales, respectively.

The images included six cigarette brands, and eight "control" ads for products that included sweets, clothes, mobile phones, and cars. The following cigarette brands were included in the survey (with ad theme or cue in parentheses): (1) Marlboro (cowboy; horses); (2) F6 (sunrise); (3) Gauloises (couple); (4) Pall Mall (Empire State Building); (5) L&M (couple); (6) Lucky Strike (cigarette packs). These six cigarette brands are among the eight most popular

cigarette brands in Germany.[13] For other commercial products, the following ads were included in the survey (with product type and ad theme or cue in parentheses): (1) Jack Wolfskin (trekking-clothing; climber); (2) Volkswagen (car; the performer Seal); (3) Tic Tac (candy; elevator); (4) Dr. Best (tooth brush; tomato); (5) Kinder Pingui (chocolate bar; penguins); (6) T-Mobile (mobile phone; dog); (7) Spee (detergent; fox); (8) Toyota (car). Advertising selection was based on a pilot study on 28 tobacco and non-tobacco ads (110 students aged 11 to 16 years, mean age 13.6 years), selecting the half of ads that revealed neither ceiling nor floor effects and had corrected item-test correlations above r_{it}=0.40.

We assessed ad exposure to non-tobacco products to control for the propensity to be receptive or attentive to advertising in general, which could confound the relation between tobacco-specific advertising exposure and smoking behavior.

Smoking behavior

We assessed lifetime smoking experience by asking "How many cigarettes have you smoked in your life?" (never smoked, just a few puffs, 1-19 cigarettes, 20-100 cigarettes, >100 cigarettes).[14] Students that indicated any smoking at baseline, even just a few puffs, were excluded from the analysis. Having smoked more than 100 cigarettes at the follow-up assessment was defined as being an established smoker. Current smoking frequency was measured by asking, “How often do you smoke at present?” to which respondents could answer, “I don’t smoke,” “less than once a month,” “at least once a month, but not weekly,” “at least once a week, but not daily,” or “daily.” For the present analysis, this variable was dichotomized into daily and non-daily smoking. To account for different smoking susceptibility in never-smokers at baseline we also assessed future use intentions (“Do you think you will ever smoke in the future?”) and refusal intentions (“If one of your friends offered you a cigarette, would you take it?”), with response categories “Definitely not”, “Probably not”, “Probably yes”, and “Definitely yes”.[15]

Covariates

Covariate measures were derived from studies that focus on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to ad exposure and the smoking measures.[16-18]

Sociodemographics: age, gender, study region, and socioeconomic status (SES); SES of the students was approximated with a combination of student and class teacher ratings: Students answered three items of the PISA cultural and social capital assessment,[19] asking for the number of books in the household (5-point scale from 0 = "None" to 4 = "More than 100") and parenting characteristics ("My parents always know where I am" and "My parents know other parents from my school"), class teachers filled out an 11-item school evaluation sheet related to SES of their students (examples: "Most students of the school live in families with financial problems", "Most students of the school come from underprivileged families", "Our school has a good reputation", scale range from 0 = "Not true at all" to 3 = "Totally true", Cronbach's alpha = 0.85); student and teacher ratings positively correlated r = 0.57, alpha = 0.72.

Personal characteristics: self-reported school performance ("How would you describe your grades last year?", scale points "excellent", "good", "average", "below average"); average TV screen time ("How many hours do you usually watch TV in your leisure time?", scale points: "none", "about half an hour", "about an hour", "about two hours", "about three hours", "about four hours", "more than four hours a day"); rebelliousness and sensation-seeking, assessed with four items combined into a single index, with higher scores indicating greater propensity for rebelliousness and sensation seeking[20] ("I get in trouble in school"; "I do things my parents wouldn't want me to do"; "I like scary things"; "I like to do dangerous things", scale points 0 = "not at all like me", 1 = "a little like me", 2 = "pretty much like me", and 3 = "exactly like me", Cronbach's alpha = 0.76).

Social environment: parent smoking (0 = “No”, 1 = “Yes, 2) and peer smoking (0 = “None”, 1 = “Some, 2 = “Most”, 3 = “All”). As mentioned above, we also controlled for the adolescent’s ability to recall advertising in general with the non-tobacco ad scale.

Statistical analysis

All data analyses were conducted with Stata version 12.0 (Stata Corp, College Station, TX). Chi-squared tests and T-tests were performed to check whether subjects included in the analysis differed systematically from those not reached at the follow-up assessment. Bivariate associations between the study variables were analyzed using Spearman rank correlations. The multivariate associations between amount of advertising exposure and smoking initiation were analyzed with Poisson regressions. Poisson regression allows for the presentation of adjusted Incidence Rate Ratios (IRRs) and 95% confidence intervals (CIs) for the relationship between exposure to advertising and smoking at follow-up, having the advantage of not being influenced by the prevalence of the exposure. IRRs were calculated for every 10 advertising contacts, indicating the relative increase in smoking incidence (established smoking and daily smoking) for each additional 10 contacts. The dichotomized outcome variables were regressed on advertising exposure after inclusion of all covariates and with clustered robust standard errors to account for intra-class correlations within schools. In a subsequent analysis we repeated the Poisson regressions with advertising contact frequency being parsed into tertiles to account for the skewed distribution of tobacco advertising contact and to replicate the approach used in our previous analysis.[9] Missing data were handled by listwise deletion.

RESULTS

Descriptive statistics at baseline and attrition analysis

Table 1 gives descriptive statistics for all interviewed never smokers at baseline, for those lost to follow-up, and the final analyzed sample, allowing comparisons of differences due to

attrition. Never smokers lost to follow-up were significantly younger of age, more often male, had lower scores on the SES scale, rated their school performance more poorly, had higher scores in sensation seeking/rebelliousness and more often reported at least one parent who smoked. No differences were found with regard to tobacco or non-tobacco advertising contact.

Table 1. Descriptive sample statistics at baseline and attrition analysis.

	Baseline never smokers (n=2346) %	Lost to follow-up (n=1026) %	Analyzed Sample (n=1320) %	p
Sociodemographics				
Age at baseline, mean (SD)	12.24 (1.01)	12.16 (1.09)	12.30 (0.93)	.001
Gender: Female	54.9	51.9	57.3	.008
SES: Below Median	51.1	60.6	43.8	<.001
State				
Schleswig-Holstein	41.6	39.8	43.0	.279
Hamburg	28.4	29.1	27.8	
Brandenburg	30.0	31.1	29.2	
Personal characteristics				
School performance				
Below average	2.5	3.7	1.5	<.001
Average	33.7	37.8	30.6	
Good	49.9	44.9	53.9	
Excellent	13.9	13.6	14.0	
TV screen time				
≤ 30 min	16.8	15.5	17.8	.051
1-2 h	59.5	58.8	60.1	
3-4 h	19.0	19.8	18.3	
> 4 h	4.7	5.9	3.8	
Sensation seeking and	0.53 (0.50)	0.56 (0.51)	0.50 (0.49)	.010
Social environment				
Peer smoking: None	71.7	71.5	71.9	.858
Parent smoking: No	53.3	49.3	56.4	.001
Advertising exposure				
Tobacco advertising, range 0-55				
Low (< 1)	35.3	35.3	35.4	.600
Medium (1 - 10)	38.7	39.7	38.0	
High (> 10)	26.0	25.0	26.6	
Non-tobacco advertising, range 0-88				
Low (< 35)	39.8	40.8	39.0	.469
Medium (35 – 54)	32.1	32.4	32.0	
High (> 54)	28.1	26.8	29.0	

Smoking initiation during the observational period

Thirty months after the baseline assessment 436 never smokers reported trying cigarette smoking including a few puffs (33% incidence rate), 138 reported smoking in the past 30 days (10.5% incidence rate), Sixty-six had smoked more than 100 cigarettes and were classified as established smokers (incidence rate 5%), and 58 reported daily smoking (incidence rate 4.4%). Daily smoking incidence was not significantly related to age (p=0.526) or sex (p=0.153), with 33% of the daily smokers at follow-up being 14 years of age or younger and 24% being 16 or older.

Exposure to advertisements at baseline

Table 2. Contact frequency for tobacco and non-tobacco advertisings (n = 1320 never smokers at baseline)

	Seen at least once	Seen more than 10 times
	%	%
Tobacco ads (product type)		
Lucky Strike (cigarettes)	49	13
Marlboro (cigarettes)	28	6
Pall Mall (cigarettes)	24	6
Gauloises (cigarettes)	19	2
L&M (cigarettes)	18	4
F6 (cigarettes)	12	1
Non-tobacco ads (product type)		
Kinder Pingui (sweet)	96	71
Tic Tac (candy)	87	44
Dr. Best (tooth brush)	83	36
T-Mobile (mobile phone)	85	35
Spee (detergent)	76	24
Volkswagen (car)	50	14
Toyota (car)	54	10
Jack Wolfskin (trekking-clothing)	45	9

Table 2 gives contact frequencies (how often the students had seen the ad) for all advertised products at baseline. The cigarette ad with the highest contact frequency was Lucky Strike, for which about half of the sample reported at least one contact. The lowest tobacco ad

contact frequency rate was found for F6, a regional German cigarette brand sold mainly in eastern Germany. Ad contact frequency for non-tobacco products was generally much higher than for tobacco products. For example, almost all students (96%) reported having seen the ad for Kinder Pingui, a chocolate bar. The range of the sum of contacts over all depicted advertisements was 0 to 55 (mean=7.9) for the tobacco ads, and 0 to 88 (mean=42.2) for the non-tobacco ads, also reflecting the lower number of tobacco ads (6 vs. 8).

Zero order associations

Table 3 shows pairwise Spearman rank correlations between the study variables, demonstrating significant crude associations between the assessed covariates and smoking behavior as well as between covariates and advertising contact, justifying their inclusion in the multivariate analyses. The highest correlations with all smoking outcomes was found for peer smoking, followed by tobacco advertising contact. There were some differences in the correlational pattern between tobacco and non-tobacco advertising contact. Compared to the amount of contact with tobacco ads, non-tobacco advertising exposure was stronger related to age and showed no association with gender, and also had a stronger correlation with SES, TV screen time, and parental smoking. The zero-order correlation between tobacco and non-tobacco advertising contact indicated a proportion of about 20% shared variance.

Association between advertising contact and smoking initiation

Figures 1a and 1b show the adjusted predictions of established smoking and daily smoking based on the amount of tobacco and non-tobacco advertising contact. The curves illustrate an increasing risk for the two smoking outcomes dependent on the amount of tobacco ad contact, but not for non-tobacco advertising contact.

Insert Figures 1a and 1b about here

Table 3. Zero-order correlation matrix for all study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1.00													
2. Gender (0=female, 1=male)	0.02	1.00												
3. SES	**-0.07***	0.02	1.00											
4. Region (0=west, 1=east)	**0.25*****	-0.01	**-0.10***	1.00										
5. School performance	**0.11*****	0.03	**-0.16*****	-0.05	1.00									
6. TV screen time	**0.17*****	**0.07****	**-0.30*****	**0.25*****	**0.15*****	1.00								
7. Sensation seeking	**0.09*****	**0.24*****	-0.03	0.01	**0.16*****	**0.18*****	1.00							
8. Peer smoking	**0.28*****	0.02	**-0.22*****	**0.28*****	**0.15*****	**0.24*****	**0.24*****	1.00						
9. Parent smoking	0.04	-0.02	**-0.26*****	**0.09*****	**0.11****	**0.22*****	**0.08****	**0.17*****	1.00					
10. Tobacco ad exposure	**0.14*****	**0.13*****	0.02	**-0.06***	0.05	**0.11****	**0.24*****	**0.13*****	**0.08****	1.00				
11. Non-tobacco ad exposure	**0.20*****	0.05	**-0.08****	**0.11****	**0.06***	**0.36*****	**0.21*****	**0.18*****	**0.18*****	**0.44*****	1.00			
12. Ever smoking	**0.15*****	0.01	**-0.17*****	**0.14*****	**0.09****	**0.14*****	**0.18*****	**0.24*****	**0.13*****	**0.19*****	**0.15*****	1.00		
13. Past 30 days smoking	**0.09****	-0.02	**-0.12****	**0.08****	**0.06***	**0.12****	**0.15*****	**0.21*****	**0.14*****	**0.17*****	**0.12*****	**0.61*****	1.00	
14. Established smoking (>100 cig.)	**0.07***	**0.09****	**-0.07***	**0.08****	0.05	**0.10***	**0.12****	**0.16*****	**0.09*****	**0.13*****	**0.09****	**0.33*****	**0.51*****	1.00
15. Daily smoking	0.02	0.04	**-0.14*****	**0.08****	**0.07***	**0.10***	**0.09****	**0.14*****	**0.13*****	**0.08****	0.03	**0.30*****	**0.49*****	**0.75*****

Bold figures == significant associations
*p<0.05; **p<0.01; ***p<0.001

The Figures also report the adjusted incidence rate ratios associated with an increase in advertising exposure. There was an adjusted IRR for established smoking of 1.38 (95% CI 1.16, 1.63; p<0.001) for each additional 10 tobacco ad contacts and 1.00 (95% CI 0.84, 1.19; p=0.996) for each additional 10 non-tobacco ad contacts. For daily smoking, the corresponding IRRs were 1.30 (95% CI 1.03, 1.64; p=0.029) for 10 tobacco ad contacts and 0.92 (95% CI 0.79, 1.08; p=0.296) for 10 non-tobacco ad contacts, respectively.

Due to the skewed distribution of tobacco ad contact frequency (more than half of the never-smoking students had fewer than 10 contacts), we repeated the analysis using contact frequency parsed into tertiles, representing relative low (0-2.5), medium (5-10), and high (11-55) advertising contact. For established smoking the adjusted IRRs were 1.52 for tobacco ads (95% CI 1.14, 2.03; p=0.004) and 1.05 for non-tobacco ads (95% CI 0.68, 1.62; p=0.819). Using daily smoking as outcome variable the IRRs were 1.43 (95% CI 1.08, 1.90; p=0.012) and 0.84 (95% CI 0.58, 1.22; p=0.363) for each additional tertile of tobacco and non-tobacco advertising contact. These IRRs relate to 3.1%, 4.8%, and 7.3% established smoking attributable incidence rate or 3.1%, 4.6%, and 6.4% daily smoking incidence for low, medium, and high tobacco advertising contact, respectively, assuming the adjusted analysis adequately controlled for third variable influence.

To address the question if some never smokers had higher tobacco advertising contact because they were already more susceptible towards smoking at baseline, we conducted a sensitivity analysis with only never smokers with low susceptibility. These students reported that they will definitely never smoke in the future and will definitely not try cigarettes if a friend offered one (n = 803). In this restricted sub-sample the adjusted IRR for each additional 10 tobacco ad contacts was 1.37 for established smoking (95% CI 1.07, 1.76; p=0.012) and 1.33 for daily smoking (95% CI 1.02, 1.75; p=0.038). Again, no significant associations were found for non-tobacco advertisings.

DISCUSSION

This longitudinal study is a further test of the relationship between tobacco advertising exposure and youth smoking behavior, confirming the specificity of the advertising-smoking link by comparing the effects of tobacco versus non-tobacco advertising. The study extends previous work by using two less prevalent outcome measures (established and daily smoking) and a longer follow-up period of 2.5 years, measures likely to indicate an addiction component to the smoking.[21] Compared to the results reported on smoking initiation in terms of ever smoking (even a few puffs),[9] the increase in the adjusted relative risk for daily smoking dependent on tobacco advertising exposure was even more pronounced. Specificity was shown by the finding that tobacco advertising at baseline predicted these outcomes independent of the amount of general advertising contact and after controlling for a number of well-known risk factors for smoking initiation. This result confirms the content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not simply a marker for adolescents that are generally more receptive or attentive towards marketing.

This longitudinal study also clearly points out the implications of partial tobacco advertising bans in countries like the United States and Germany. The one-third of adolescents in the highest tertile of advertising had rates of daily and established smoking that were double (3 percentage points higher) than adolescents in the first tertile. In reverse, assuming that the models were fully adjusted for other confounding influences, one might expect a significant further decrease in the rates of smoking in these countries after a total elimination of tobacco advertising.

Some limitations of the study have to be considered. There was a severe loss of students during the 30 months interval (44%). To a large degree the drop-out was due to organizational issues (e.g., school and class changes) that are unlikely systematically related to advertising exposure or smoking behavior on the individual level. However, the lost students differed on a couple of dimensions from the retained students, i.e., age, gender,

socio-economic status, school performance, sensation seeking, and parental smoking. With the exception of the lower age, the drop-out markers indicate that lower risk adolescents were more likely to be retained. This might have biased the results as the effect of one risk factor might not be independent of other risk factors. Generally, one would assume that the associations get more conservative if higher risk adolescents are excluded, because this group has a higher likelihood of starting to smoke. However, in the context of media effects on smoking initiation there is also evidence that lower risk adolescents have a higher responsiveness towards media effects[22;23], indicating that the present results might not be generalised to the whole population of adolescents. Second, as with any observational study, the results may be biased by unmeasured confounding – that is, an unmeasured risk factor could alter the estimates reported for the association between tobacco advertising and smoking onset. Third, the memory-based measure of ad exposure could be biased by memory effects other than the ones we controlled for. The potential to remember ads (in terms of contact frequency) should, however, not be completely independent of actual exposure. Finally, because the implemented method did not use a representative sample of all broadcasted ads, it does not allow for an accurate estimation of the total amount of tobacco and non-tobacco advertising exposure or the advertising pressure of specific brands. This is amplified by the modification of the stimulus material which did not contain any brand information.

The finding that exposure to tobacco advertising predicts smoking in youth could have important public health implications. A total ban of tobacco advertising and promotion around the world is one key policy measure of the WHO Framework Convention on Tobacco Control (FCTC) [24]. Under Article 13.1 of the FCTC, 'Parties recognize that a comprehensive ban on advertising, promotion and sponsorship would reduce the consumption of tobacco products'. Data from this study support this measure, because only exposure to tobacco advertisements predicted smoking initiation, which cannot be attributed to a general receptiveness to marketing and because it shows that advertising allowed under partial bans is still reaching adolescents.

STATEMENTS

Licence

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None.

Contributors:

Conception and design of the study: All authors

Analysis and interpretation of data: MM, RH

Collection and assembly of data: MM, BI

Drafting of the article: MM, JS, RH

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Final approval of the article: All authors

All authors have full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Study implementation was approved by the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

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Figure legend

Figures 1a and 1b

----- Tobacco advertising —— Non-tobacco advertising

IRR = Incidence Rate Ratio for 10 additional advertising contacts
Figures in brackets = 95% Confidence Interval
n.s. = not significant; *=p<.05; ***=p<.001

From never to daily smoking in 30 months:

The predictive value of tobacco and non-tobacco advertising exposure

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ABSTRACT

Objective: To test the specificity of the association between tobacco advertising and youth smoking initiation.

Design: Longitudinal survey with a 30-months interval.

Setting: Twenty-one public schools in 3 German states.

Participants: A total of 1320 sixth- to eighth-grade students who were never-smokers at baseline (age range at baseline, 10-15 years; mean, 12.3 years).

Exposures: Exposure to tobacco and non-tobacco advertisements was measured at baseline with images of 6 tobacco and 8 non-tobacco advertisements; students indicated the number of times they had seen each ad and the sum score over all advertisements was used to represent inter-individual differences in the amount of advertising exposure.

Primary and secondary outcome measures: Established smoking, defined as smoked >100 cigarettes during the observational period, and daily smoking at follow-up. Secondary outcome measures were any smoking and smoking in the last 30 days.

Results: During the observation period 5% of the never smokers at baseline smoked more than 100 cigarettes and 4.4% were classified as daily smokers. After controlling for age, gender, socio-economic status, school performance, television screen time, personality characteristics, and smoking status of peers and parents, each additional 10 tobacco advertising contacts increased the adjusted relative risk for established smoking by 38% (95% confidence interval: 16% - 63%; $p<0.001$) and for daily smoking by 30% (95% confidence interval: 3% - 64%; $p<0.05$). No significant association was found for non-tobacco advertising contact.

Conclusions: The study confirms a content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not

simply a marker for adolescents that are generally more receptive or attentive towards marketing.

ARTICLE SUMMARY

Article focus

- High exposure to tobacco advertising might just be an indicator of high advertising exposure in general.
- In this study we compare the potential of tobacco advertising vs. non-tobacco advertising exposure in predicting established and daily smoking of formerly never-smoking German adolescents.

Key messages

- Exposure to tobacco advertisements predicted established smoking and daily smoking, exposure to non-tobacco advertising did not.
- The study also shows that advertising allowed under partial bans still reaches adolescents.

Strengths and limitations of this study

- One of few studies that tests the specificity of the association between tobacco advertising and smoking.
- Long follow-up period with smoking outcomes that are strongly predictive of becoming an addicted smoker.
- A high drop-out rate and attrition bias are limiting factors of this study.

INTRODUCTION

Tobacco companies were among the first companies to use integrated marketing strategies, and their products have long been among the most heavily marketed products in the United States and worldwide.[1] The tobacco industry still denies that their marketing is targeted at young people. According to the industry the purpose of tobacco advertising is to maintain and increase market shares of adult consumers.[2] In contrast, empirical research indicates that adolescents are aware of, recognize, and are influenced by tobacco marketing strategies. The U.S. Surgeon General's 2012 comprehensive review of the tobacco marketing literature concluded that advertising and promotional activities by tobacco companies are key risk factors for the uptake to smoking in adolescents.[3]

A 2011 Cochrane review identified 19 longitudinal studies that followed up a total of over 29,000 subjects, who were adolescents aged 18 or younger, and were not regular smokers at baseline. In 18 of the 19 studies the nonsmoking adolescents who were more aware of tobacco advertising or receptive to it, were more likely to experiment with cigarettes or become smokers at follow up.[4]

Based on these research results, article 13 of the World Health Organization's (WHO) Framework Convention on Tobacco Control stipulates a comprehensive ban on tobacco advertising, promotion, and sponsorship.[5] A number of countries all over the world follow these recommendations, and have banned tobacco advertisings. However, other countries, such as the United States and Germany, have implemented considerably weaker tobacco marketing policies.[6] Germany has banned tobacco advertisements in television, radio, newspapers, and magazines, but there are still opportunities for the industry to promote their products: Tobacco marketing is allowed at point of sale, on billboards, and in cinemas before movies that show after 6:00 pm. Brand extension, i.e. the use of tobacco brand names for other products, is also allowed.

From a scientific point of view, the best way to study the effects of tobacco marketing would be a randomized controlled trial. But this kind of study design would be both unethical and

impractical. Since experimental studies cannot be conducted, we have to rely on observational studies. Sir Austin Bradford Hill identified several criteria for evaluating causality in epidemiological studies.[7] According to these criteria the risk factor (e.g. tobacco marketing) must clearly precede the hypothesized effect (e.g. smoking uptake in young people). In addition, the association should be strong, consistent, expected from theory, and specific.

The Cochrane review on the effects of tobacco advertising on young people[4] listed our previous study[8;9] as the only one that tested the specificity of tobacco advertising compared to advertisements of other consumer goods. Limitations of this study included (a) the short nine months follow-up period, and (b) the outcome measure which defined smoking initiation during the observational period as any smoking including a few puffs. Clearly, not all adolescents who try smoking will go on to become addicted smokers. With the current study we present findings from the same cohort, only for a much longer follow-up period (30 months). The longer follow-up period enables us to study established and daily smoking as outcomes in young people, outcomes that are more strongly predictive of becoming an addicted smoker.[10]

METHODS

Study sample

In May 2008 we invited 120 randomly selected schools from three states of Germany (Brandenburg, Hamburg, and Schleswig-Holstein) to participate in a school-based survey. The German school system has different types of schools (*Grundschule, Hauptschule, Realschule, Oberschule, Gemeinschaftsschule, Gymnasium)* that mainly differ with regard to the academic skills of their students and graduation level. The selection was stratified by state and type of school, assuring a balanced representation of all school types of the respective states. Twenty-nine schools with 176 classes and 4195 sixth to eighth grade students agreed to participate after a four week recruitment interval. In September and October 2008 we surveyed a total of 174 classes with 3415 students (81.4% of the sampled students). Reasons for exclusion were either absence (2 classes, 134 students) or missing parental consent (646 students). From the 3415 students surveyed at baseline, 2346 were classified as never smokers. Of these, 1320 (56.3%) could be reached again at the follow-up assessment in May/June 2011. Reasons for study drop-out were loss of primary schools that end after sixth grade (7 schools, 14 classes, 194 students), refusal to participate at the follow-up assessment (1 school, 8 classes, 59 students) or class absence (24 classes, 291 students). Other reasons were unexplained absence on the day of data assessment or unmatchable student codes (482 students). The number of analyzed never smokers per school ranged from 3 to 232, class-sizes ranged from 1 to 26.

Survey implementation

Data were collected through self-completed anonymous questionnaires during one school hour (45 min. period), administered by trained research staff. Only students with written parental consent were qualified for participation, parent consent forms were disseminated by class teachers three weeks prior to the baseline assessment. Students did not receive incentives for participation and irrespective of parental consent all students were free to

refuse participation (none refused). Class teachers assigned tasks for students that did not participate. After completion of the survey, questionnaires were placed in an envelope and sealed in front of the class. Students were assured that their individual information would not be seen by parents or teachers. To permit a linking of the baseline and follow-up questionnaires, students generated an anonymous seven-digit individual code, a procedure that had been tested in previous studies, slightly modified for this study.[11] Implementation was approved by all Ministries of Cultural Affairs of the three involved states, and ethical approval was obtained from the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Measures

Advertising exposure

Advertising exposure has been operationalized in numerous ways across studies.[4] It has been measured both in terms of the physical presence of advertisements in individuals' environments and in terms of the psychological processes underlying individuals' memories for these advertisements.[12] In the present study we approximated the individual advertising contact frequency by providing masked colored images of billboard ads for cigarettes and fixed-images of TV commercials for non-tobacco ads with all brand-identifying content digitally removed, asking the students to rate how often they have ever seen each ad extract (on a 4-point scale with scale points 0="Never,",1="1 to 4 times," 2="5 to 10 times" and 3="More than 10 times"). The answers were post-coded as 0=0, 1=2.5, 2=7.5, and 3=11 and summed up to create the tobacco and non-tobacco ad scales, respectively.

The images included six cigarette brands, and eight "control" ads for products that included sweets, clothes, mobile phones, and cars. The following cigarette brands were included in the survey (with ad theme or cue in parentheses): (1) Marlboro (cowboy; horses); (2) F6 (sunrise); (3) Gauloises (couple); (4) Pall Mall (Empire State Building); (5) L&M (couple); (6) Lucky Strike (cigarette packs). These six cigarette brands are among the eight most popular

cigarette brands in Germany.[13] For other commercial products, the following ads were included in the survey (with product type and ad theme or cue in parentheses): (1) Jack Wolfskin (trekking-clothing; climber); (2) Volkswagen (car; the performer Seal); (3) Tic Tac (candy; elevator); (4) Dr. Best (tooth brush; tomato); (5) Kinder Pingui (chocolate bar; penguins); (6) T-Mobile (mobile phone; dog); (7) Spee (detergent; fox); (8) Toyota (car). Advertising selection was based on a pilot study on 28 tobacco and non-tobacco ads (110 students aged 11 to 16 years, mean age 13.6 years), selecting the half of ads that revealed neither ceiling nor floor effects and had corrected item-test correlations above r_{it}=0.40.

We assessed ad exposure to non-tobacco products to control for the propensity to be receptive or attentive to advertising in general, which could confound the relation between tobacco-specific advertising exposure and smoking behavior.

Smoking behavior

We assessed lifetime smoking experience by asking "How many cigarettes have you smoked in your life?" (never smoked, just a few puffs, 1-19 cigarettes, 20-100 cigarettes, >100 cigarettes).[14] Students that indicated any smoking at baseline, even just a few puffs, were excluded from the analysis. Having smoked more than 100 cigarettes at the follow-up assessment was defined as being an established smoker. Current smoking frequency was measured by asking, “How often do you smoke at present?” to which respondents could answer, “I don’t smoke,” “less than once a month,” “at least once a month, but not weekly,” “at least once a week, but not daily,” or “daily.” For the present analysis, this variable was dichotomized into daily and non-daily smoking. To account for different smoking susceptibility in never-smokers at baseline we also assessed future use intentions (“Do you think you will ever smoke in the future?”) and refusal intentions (“If one of your friends offered you a cigarette, would you take it?”), with response categories “Definitely not”, “Probably not”, “Probably yes”, and “Definitely yes”.[15]

Covariates

Covariate measures were derived from studies that focus on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to ad exposure and the smoking measures.[16-18]

Sociodemographics: age, gender, study region, and socioeconomic status (SES); SES of the students was approximated with a combination of student and class teacher ratings: Students answered three items of the PISA cultural and social capital assessment,[19] asking for the number of books in the household (5-point scale from 0 = "None" to 4 = "More than 100") and parenting characteristics ("My parents always know where I am" and "My parents know other parents from my school"), class teachers filled out an 11-item school evaluation sheet related to SES of their students (examples: "Most students of the school live in families with financial problems", "Most students of the school come from underprivileged families", "Our school has a good reputation", scale range from 0 = "Not true at all" to 3 = "Totally true", Cronbach's alpha = 0.85); student and teacher ratings positively correlated r = 0.57, alpha = 0.72.

Personal characteristics: self-reported school performance ("How would you describe your grades last year?", scale points "excellent", "good", "average", "below average"); average TV screen time ("How many hours do you usually watch TV in your leisure time?", scale points: "none", "about half an hour", "about an hour", "about two hours", "about three hours", "about four hours", "more than four hours a day"); rebelliousness and sensation-seeking, assessed with four items combined into a single index, with higher scores indicating greater propensity for rebelliousness and sensation seeking[20] ("I get in trouble in school"; "I do things my parents wouldn't want me to do"; "I like scary things"; "I like to do dangerous things", scale points 0 = "not at all like me", 1 = "a little like me", 2 = "pretty much like me", and 3 = "exactly like me", Cronbach's alpha = 0.76).

Social environment: parent smoking (0 = “No”, 1 = “Yes, 2) and peer smoking (0 = “None”, 1 = “Some, 2 = “Most”, 3 = “All”). As mentioned above, we also controlled for the adolescent’s ability to recall advertising in general with the non-tobacco ad scale.

Statistical analysis

All data analyses were conducted with Stata version 12.0 (Stata Corp, College Station, TX). Chi-squared tests and T-tests were performed to check whether subjects included in the analysis differed systematically from those not reached at the follow-up assessment. Bivariate associations between the study variables were analyzed using Spearman rank correlations. The multivariate associations between amount of advertising exposure and smoking initiation were analyzed with Poisson regressions. Poisson regression allows for the presentation of adjusted Incidence Rate Ratios (IRRs) and 95% confidence intervals (CIs) for the relationship between exposure to advertising and smoking at follow-up, having the advantage of not being influenced by the prevalence of the exposure. IRRs were calculated for every 10 advertising contacts, indicating the relative increase in smoking incidence (established smoking and daily smoking) for each additional 10 contacts. The dichotomized outcome variables were regressed on advertising exposure after inclusion of all covariates and with clustered robust standard errors to account for intra-class correlations within schools. In a subsequent analysis we repeated the Poisson regressions with advertising contact frequency being parsed into tertiles to account for the skewed distribution of tobacco advertising contact and to replicate the approach used in our previous analysis.[9] Missing data were handled by listwise deletion.

RESULTS

Descriptive statistics at baseline and attrition analysis

Table 1 gives descriptive statistics for all interviewed never smokers at baseline, for those lost to follow-up, and the final analyzed sample, allowing comparisons of differences due to

attrition. Never smokers lost to follow-up were significantly younger of age, more often male, had lower scores on the SES scale, rated their school performance more poorly, had higher scores in sensation seeking/rebelliousness and more often reported at least one parent who smoked. No differences were found with regard to tobacco or non-tobacco advertising contact.

Table 1. Descriptive sample statistics at baseline and attrition analysis.

	Baseline never smokers (n=2346) %	Lost to follow-up (n=1026) %	Analyzed Sample (n=1320) %	p
Sociodemographics				
Age at baseline, mean (SD)	12.24 (1.01)	12.16 (1.09)	12.30 (0.93)	.001
Gender: Female	54.9	51.9	57.3	.008
SES: Below Median	51.1	60.6	43.8	<.001
State				
Schleswig-Holstein	41.6	39.8	43.0	.279
Hamburg	28.4	29.1	27.8	
Brandenburg	30.0	31.1	29.2	
Personal characteristics				
School performance				
Below average	2.5	3.7	1.5	<.001
Average	33.7	37.8	30.6	
Good	49.9	44.9	53.9	
Excellent	13.9	13.6	14.0	
TV screen time				
≤ 30 min	16.8	15.5	17.8	.051
1-2 h	59.5	58.8	60.1	
3-4 h	19.0	19.8	18.3	
> 4 h	4.7	5.9	3.8	
Sensation seeking and	0.53 (0.50)	0.56 (0.51)	0.50 (0.49)	.010
Social environment				
Peer smoking: None	71.7	71.5	71.9	.858
Parent smoking: No	53.3	49.3	56.4	.001
Advertising exposure				
Tobacco advertising, range 0-55				
Low (< 1)	35.3	35.3	35.4	.600
Medium (1 - 10)	38.7	39.7	38.0	
High (> 10)	26.0	25.0	26.6	
Non-tobacco advertising, range 0-88				
Low (< 35)	39.8	40.8	39.0	.469
Medium (35 – 54)	32.1	32.4	32.0	
High (> 54)	28.1	26.8	29.0	

Smoking initiation during the observational period

Thirty months after the baseline assessment 436 never smokers reported trying cigarette smoking including a few puffs (33% incidence rate), 138 reported smoking in the past 30 days (10.5% incidence rate), Sixty-six had smoked more than 100 cigarettes and were classified as established smokers (incidence rate 5%), and 58 reported daily smoking (incidence rate 4.4%). Daily smoking incidence was not significantly related to age (p=0.526) or sex (p=0.153), with 33% of the daily smokers at follow-up being 14 years of age or younger and 24% being 16 or older.

Exposure to advertisements at baseline

Table 2. Contact frequency for tobacco and non-tobacco advertisings (n = 1320 never smokers at baseline)

	Seen at least once	Seen more than 10 times
	%	%
Tobacco ads (product type)		
Lucky Strike (cigarettes)	49	13
Marlboro (cigarettes)	28	6
Pall Mall (cigarettes)	24	6
Gauloises (cigarettes)	19	2
L&M (cigarettes)	18	4
F6 (cigarettes)	12	1
Non-tobacco ads (product type)		
Kinder Pingui (sweet)	96	71
Tic Tac (candy)	87	44
Dr. Best (tooth brush)	83	36
T-Mobile (mobile phone)	85	35
Spee (detergent)	76	24
Volkswagen (car)	50	14
Toyota (car)	54	10
Jack Wolfskin (trekking-clothing)	45	9

Table 2 gives contact frequencies (how often the students had seen the ad) for all advertised products at baseline. The cigarette ad with the highest contact frequency was Lucky Strike, for which about half of the sample reported at least one contact. The lowest tobacco ad

contact frequency rate was found for F6, a regional German cigarette brand sold mainly in eastern Germany. Ad contact frequency for non-tobacco products was generally much higher than for tobacco products. For example, almost all students (96%) reported having seen the ad for Kinder Pingui, a chocolate bar. The range of the sum of contacts over all depicted advertisements was 0 to 55 (mean=7.9) for the tobacco ads, and 0 to 88 (mean=42.2) for the non-tobacco ads, also reflecting the lower number of tobacco ads (6 vs. 8).

Zero order associations

Table 3 shows pairwise Spearman rank correlations between the study variables, demonstrating significant crude associations between the assessed covariates and smoking behavior as well as between covariates and advertising contact, justifying their inclusion in the multivariate analyses. The highest correlations with all smoking outcomes was found for peer smoking, followed by tobacco advertising contact. There were some differences in the correlational pattern between tobacco and non-tobacco advertising contact. Compared to the amount of contact with tobacco ads, non-tobacco advertising exposure was stronger related to age and showed no association with gender, and also had a stronger correlation with SES, TV screen time, and parental smoking. The zero-order correlation between tobacco and non-tobacco advertising contact indicated a proportion of about 20% shared variance.

Association between advertising contact and smoking initiation

Figures 1a and 1b show the adjusted predictions of established smoking and daily smoking based on the amount of tobacco and non-tobacco advertising contact. The curves illustrate an increasing risk for the two smoking outcomes dependent on the amount of tobacco ad contact, but not for non-tobacco advertising contact.

Insert Figures 1a and 1b about here

Table 3. Zero-order correlation matrix for all study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1.00													
2. Gender (0=female, 1=male)	0.02	1.00												
3. SES	**-0.07***	0.02	1.00											
4. Region (0=west, 1=east)	**0.25*****	-0.01	**-0.10***	1.00										
5. School performance	**0.11*****	0.03	**-0.16*****	-0.05	1.00									
6. TV screen time	**0.17*****	**0.07****	**-0.30*****	**0.25*****	**0.15*****	1.00								
7. Sensation seeking	**0.09*****	**0.24*****	-0.03	0.01	**0.16*****	**0.18*****	1.00							
8. Peer smoking	**0.28*****	0.02	**-0.22*****	**0.28*****	**0.15*****	**0.24*****	**0.24*****	1.00						
9. Parent smoking	0.04	-0.02	**-0.26*****	**0.09*****	**0.11****	**0.22*****	**0.08****	**0.17*****	1.00					
10. Tobacco ad exposure	**0.14*****	**0.13*****	0.02	**-0.06***	0.05	**0.11****	**0.24*****	**0.13*****	**0.08****	1.00				
11. Non-tobacco ad exposure	**0.20*****	0.05	**-0.08****	**0.11****	**0.06***	**0.36*****	**0.21*****	**0.18*****	**0.18*****	**0.44*****	1.00			
12. Ever smoking	**0.15*****	0.01	**-0.17*****	**0.14*****	**0.09****	**0.14*****	**0.18*****	**0.24*****	**0.13*****	**0.19*****	**0.15*****	1.00		
13. Past 30 days smoking	**0.09****	-0.02	**-0.12****	**0.08****	**0.06***	**0.12****	**0.15*****	**0.21*****	**0.14*****	**0.17*****	**0.12*****	**0.61*****	1.00	
14. Established smoking (>100 cig.)	**0.07***	**0.09****	**-0.07***	**0.08****	0.05	**0.10***	**0.12****	**0.16*****	**0.09*****	**0.13*****	**0.09****	**0.33*****	**0.51*****	1.00
15. Daily smoking	0.02	0.04	**-0.14*****	**0.08****	**0.07***	**0.10***	**0.09****	**0.14*****	**0.13*****	**0.08****	0.03	**0.30*****	**0.49*****	**0.75*****

Bold figures == significant associations
*p<0.05; **p<0.01; ***p<0.001

The Figures also report the adjusted incidence rate ratios associated with an increase in advertising exposure. There was an adjusted IRR for established smoking of 1.38 (95% CI 1.16, 1.63; p<0.001) for each additional 10 tobacco ad contacts and 1.00 (95% CI 0.84, 1.19; p=0.996) for each additional 10 non-tobacco ad contacts. For daily smoking, the corresponding IRRs were 1.30 (95% CI 1.03, 1.64; p=0.029) for 10 tobacco ad contacts and 0.92 (95% CI 0.79, 1.08; p=0.296) for 10 non-tobacco ad contacts, respectively.

Due to the skewed distribution of tobacco ad contact frequency (more than half of the never-smoking students had fewer than 10 contacts), we repeated the analysis using contact frequency parsed into tertiles, representing relative low (0-2.5), medium (5-10), and high (11-55) advertising contact. For established smoking the adjusted IRRs were 1.52 for tobacco ads (95% CI 1.14, 2.03; p=0.004) and 1.05 for non-tobacco ads (95% CI 0.68, 1.62; p=0.819). Using daily smoking as outcome variable the IRRs were 1.43 (95% CI 1.08, 1.90; p=0.012) and 0.84 (95% CI 0.58, 1.22; p=0.363) for each additional tertile of tobacco and non-tobacco advertising contact. These IRRs relate to 3.1%, 4.8%, and 7.3% established smoking attributable incidence rate or 3.1%, 4.6%, and 6.4% daily smoking incidence for low, medium, and high tobacco advertising contact, respectively, assuming the adjusted analysis adequately controlled for third variable influence.

To address the question if some never smokers had higher tobacco advertising contact because they were already more susceptible towards smoking at baseline, we conducted a sensitivity analysis with only never smokers with low susceptibility. These students reported that they will definitely never smoke in the future and will definitely not try cigarettes if a friend offered one (n = 803). In this restricted sub-sample the adjusted IRR for each additional 10 tobacco ad contacts was 1.37 for established smoking (95% CI 1.07, 1.76; p=0.012) and 1.33 for daily smoking (95% CI 1.02, 1.75; p=0.038). Again, no significant associations were found for non-tobacco advertisings.

DISCUSSION

This longitudinal study is a further test of the relationship between tobacco advertising exposure and youth smoking behavior, confirming the specificity of the advertising-smoking link by comparing the effects of tobacco versus non-tobacco advertising. The study extends previous work by using two less prevalent outcome measures (established and daily smoking) and a longer follow-up period of 2.5 years, measures likely to indicate an addiction component to the smoking.[21] Compared to the results reported on smoking initiation in terms of ever smoking (even a few puffs),[9] the increase in the adjusted relative risk for daily smoking dependent on tobacco advertising exposure was even more pronounced. Specificity was shown by the finding that tobacco advertising at baseline predicted these outcomes independent of the amount of general advertising contact and after controlling for a number of well-known risk factors for smoking initiation. This result confirms the content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not simply a marker for adolescents that are generally more receptive or attentive towards marketing.

This longitudinal study also clearly points out the implications of partial tobacco advertising bans in countries like the United States and Germany. The one-third of adolescents in the highest tertile of advertising had rates of daily and established smoking that were double (3 percentage points higher) than adolescents in the first tertile. In reverse, assuming that the models were fully adjusted for other confounding influences, one might expect a significant further decrease in the rates of smoking in these countries after a total elimination of tobacco advertising.

Some limitations of the study have to be considered. There was a severe loss of students during the 30 months interval (44%). To a large degree the drop-out was due to organizational issues (e.g., school and class changes) that are unlikely systematically related to advertising exposure or smoking behavior on the individual level. However, the lost students differed on a couple of dimensions from the retained students, i.e., age, gender,

socio-economic status, school performance, sensation seeking, and parental smoking. With the exception of the lower age, the drop-out markers indicate that lower risk adolescents were more likely to be retained. This might have biased the results as the effect of one risk factor might not be independent of other risk factors. Generally, one would assume that the associations get more conservative if higher risk adolescents are excluded, because this group has a higher likelihood of starting to smoke. However, in the context of media effects on smoking initiation there is also evidence that lower risk adolescents have a higher responsiveness towards media effects[22;23], indicating that the present results might not be generalised to the whole population of adolescents. Second, as with any observational study, the results may be biased by unmeasured confounding – that is, an unmeasured risk factor could alter the estimates reported for the association between tobacco advertising and smoking onset. Third, the memory-based measure of ad exposure could be biased by memory effects other than the ones we controlled for. The potential to remember ads (in terms of contact frequency) should, however, not be completely independent of actual exposure. Finally, because the implemented method did not use a representative sample of all broadcasted ads, it does not allow for an accurate estimation of the total amount of tobacco and non-tobacco advertising exposure or the advertising pressure of specific brands. This is amplified by the modification of the stimulus material which did not contain any brand information.

The finding that exposure to tobacco advertising predicts smoking in youth could have important public health implications. A total ban of tobacco advertising and promotion around the world is one key policy measure of the WHO Framework Convention on Tobacco Control (FCTC) [24]. Under Article 13.1 of the FCTC, 'Parties recognize that a comprehensive ban on advertising, promotion and sponsorship would reduce the consumption of tobacco products'. Data from this study support this measure, because only exposure to tobacco advertisements predicted smoking initiation, which cannot be attributed to a general receptiveness to marketing and because it shows that advertising allowed under partial bans is still reaching adolescents.

STATEMENTS

Licence

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Competing interests:

None.

Contributors:

Conception and design of the study: All authors

Analysis and interpretation of data: MM, RH

Collection and assembly of data: MM, BI

Drafting of the article: MM, JS, RH

Critical revision of the article for important intellectual content: All authors

Final approval of the article: All authors

All authors have full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Study implementation was approved by the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Data sharing: No additional data available.

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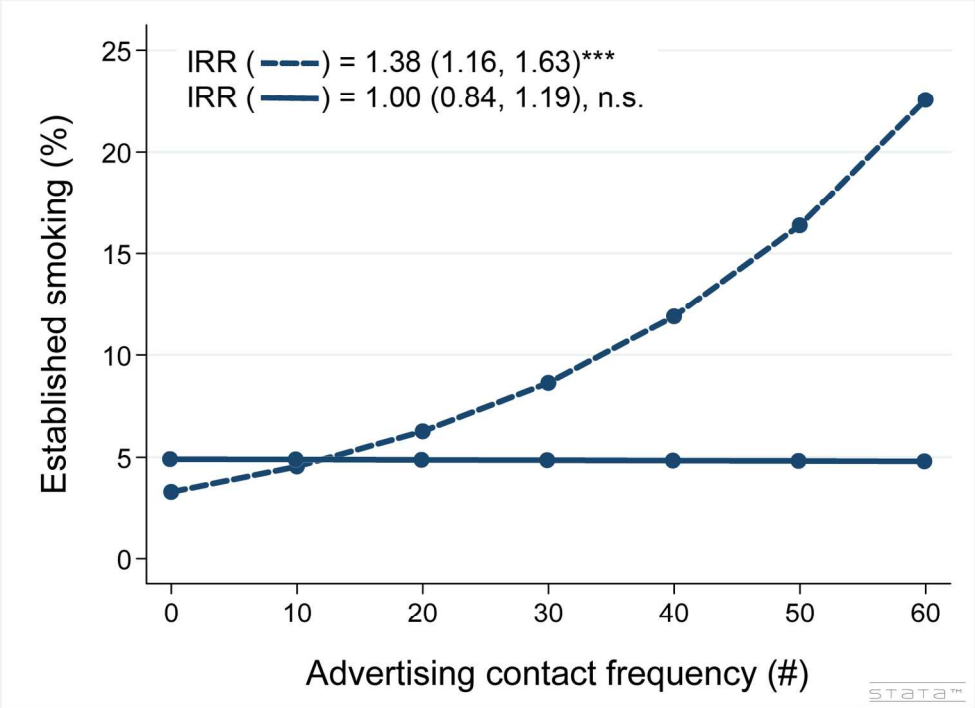
Figure legend

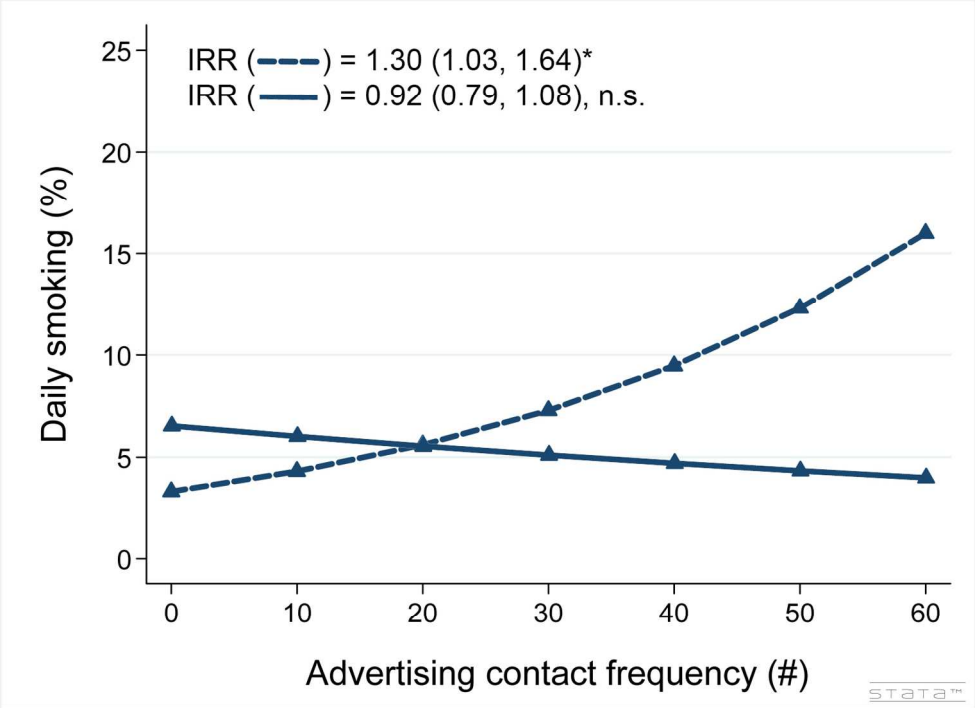
Figures 1a and 1b

----- Tobacco advertising —— Non-tobacco advertising

IRR = Incidence Rate Ratio for 10 additional advertising contacts
Figures in brackets = 95% Confidence Interval
n.s. = not significant; *=p<.05; ***=p<.001



143x104mm (300 x 300 DPI)



143x104mm (300 x 300 DPI)

STROBE statement
Manuscript entitled "From never to daily smoking in 30 months:
The predictive value of tobacco and non-tobacco advertising exposure"

	Item No	Recommendation	Manuscript page
Title and abstract			
	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8,9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8,9
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9, 10
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	10
		(d) If applicable, explain how loss to follow-up was addressed	10
		(*e*) Describe any sensitivity analyses	10

Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study? eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(*b*) Give reasons for non-participation at each stage	6
		(*c*) Consider use of a flow diagram	--
Descriptive data	14*	(*a*) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(*b*) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8, 13, 15 Figure 1
		(*b*) Report category boundaries when continuous variables were categorized	15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	--
Other analyses	17	Report other analyses done? eg analyses of subgroups and interactions, and sensitivity analyses	--
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16,17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

From never to daily smoking in 30 months: The predictive value of tobacco and non-tobacco advertising exposure

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Keywords:	EPIDEMIOLOGY, PREVENTIVE MEDICINE, PUBLIC HEALTH

From never to daily smoking in 30 months:

The predictive value of tobacco and non-tobacco advertising exposure

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Number of tables: 3

Number of figures: 2

ABSTRACT

Objective: To test the specificity of the association between tobacco advertising and youth smoking initiation.

Design: Longitudinal survey with a 30-months interval.

Setting: Twenty-one public schools in 3 German states.

Participants: A total of 1320 sixth- to eighth-grade students who were never-smokers at baseline (age range at baseline, 10-15 years; mean, 12.3 years).

Exposures: Exposure to tobacco and non-tobacco advertisements was measured at baseline with images of 6 tobacco and 8 non-tobacco advertisements; students indicated the number of times they had seen each ad and the sum score over all advertisements was used to represent inter-individual differences in the amount of advertising exposure.

Primary and secondary outcome measures: Established smoking, defined as smoked >100 cigarettes during the observational period, and daily smoking at follow-up. Secondary outcome measures were any smoking and smoking in the last 30 days.

Results: During the observation period 5% of the never smokers at baseline smoked more than 100 cigarettes and 4.4% were classified as daily smokers. After controlling for age, gender, socio-economic status, school performance, television screen time, personality characteristics, and smoking status of peers and parents, each additional 10 tobacco advertising contacts increased the adjusted relative risk for established smoking by 38% (95% confidence interval: 16% - 63%; $p<0.001$) and for daily smoking by 30% (95% confidence interval: 3% - 64%; $p<0.05$). No significant association was found for non-tobacco advertising contact.

Conclusions: The study confirms a content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not

simply a marker for adolescents that are generally more receptive or attentive towards marketing.

ARTICLE SUMMARY

Article focus

- High exposure to tobacco advertising might just be an indicator of high advertising exposure in general.
- In this study we compare the potential of tobacco advertising vs. non-tobacco advertising exposure in predicting established and daily smoking of formerly never-smoking German adolescents.

Key messages

- Exposure to tobacco advertisements predicted established smoking and daily smoking, exposure to non-tobacco advertising did not.
- The study also shows that advertising allowed under partial bans still reaches adolescents.

Strengths and limitations of this study

- One of few studies that tests the specificity of the association between tobacco advertising and smoking.
- Long follow-up period with smoking outcomes that are strongly predictive of becoming an addicted smoker.
- A high drop-out rate and attrition bias are limiting factors of this study.

INTRODUCTION

Tobacco companies were among the first companies to use integrated marketing strategies, and their products have long been among the most heavily marketed products in the United States and worldwide.[1] The tobacco industry still denies that their marketing is targeted at young people. According to the industry the purpose of tobacco advertising is to maintain and increase market shares of adult consumers.[2] In contrast, empirical research indicates that adolescents are aware of, recognize, and are influenced by tobacco marketing strategies. The U.S. Surgeon General's 2012 comprehensive review of the tobacco marketing literature concluded that advertising and promotional activities by tobacco companies are key risk factors for the uptake to smoking in adolescents.[3]

A 2011 Cochrane review identified 19 longitudinal studies that followed up a total of over 29,000 subjects, who were adolescents aged 18 or younger, and were not regular smokers at baseline. In 18 of the 19 studies the nonsmoking adolescents who were more aware of tobacco advertising or receptive to it, were more likely to experiment with cigarettes or become smokers at follow up.[4]

Based on these research results, article 13 of the World Health Organization's (WHO) Framework Convention on Tobacco Control stipulates a comprehensive ban on tobacco advertising, promotion, and sponsorship.[5] A number of countries all over the world follow these recommendations, and have banned tobacco advertisings. However, other countries, such as the United States and Germany, have implemented considerably weaker tobacco marketing policies.[6] Germany has banned tobacco advertisements in television, radio, newspapers, and magazines, but there are still opportunities for the industry to promote their products: Tobacco marketing is allowed at point of sale, on billboards, and in cinemas before movies that show after 6:00 pm. Brand extension, i.e. the use of tobacco brand names for other products, is also allowed.

From a scientific point of view, the best way to study the effects of tobacco marketing would be a randomized controlled trial. But this kind of study design would be both unethical and

impractical. Since experimental studies cannot be conducted, we have to rely on observational studies. Sir Austin Bradford Hill identified several criteria for evaluating causality in epidemiological studies.[7] According to these criteria the risk factor (e.g. tobacco marketing) must clearly precede the hypothesized effect (e.g. smoking uptake in young people). In addition, the association should be strong, consistent, expected from theory, and specific.

The Cochrane review on the effects of tobacco advertising on young people[4] listed our previous study[8;9] as the only one that tested the specificity of tobacco advertising compared to advertisements of other consumer goods. Limitations of this study included (a) the short nine months follow-up period, and (b) the outcome measure which defined smoking initiation during the observational period as any smoking including a few puffs. Clearly, not all adolescents who try smoking will go on to become addicted smokers. With the current study we present findings from the same cohort, only for a much longer follow-up period (30 months). The longer follow-up period enables us to study established and daily smoking as outcomes in young people, outcomes that are more strongly predictive of becoming an addicted smoker.[10]

METHODS

Study sample

In May 2008 we invited 120 randomly selected schools from three states of Germany (Brandenburg, Hamburg, and Schleswig-Holstein) to participate in a school-based survey. The German school system has different types of schools (*Grundschule, Hauptschule, Realschule, Oberschule, Gemeinschaftsschule, Gymnasium)* that mainly differ with regard to the academic skills of their students and graduation level. The selection was stratified by state and type of school, assuring a balanced representation of all school types of the respective states. Twenty-nine schools with 176 classes and 4195 sixth to eighth grade students agreed to participate after a four week recruitment interval. In September and October 2008 we surveyed a total of 174 classes with 3415 students (81.4% of the sampled students). Reasons for exclusion were either absence (2 classes, 134 students) or missing parental consent (646 students). From the 3415 students surveyed at baseline, 2346 were classified as never smokers. Of these, 1320 (56.3%) could be reached again at the follow-up assessment in May/June 2011. Reasons for study drop-out were loss of primary schools that end after sixth grade (7 schools, 14 classes, 194 students), refusal to participate at the follow-up assessment (1 school, 8 classes, 59 students) or class absence (24 classes, 291 students). Other reasons were unexplained absence on the day of data assessment or unmatchable student codes (482 students). The number of analyzed never smokers per school ranged from 3 to 232, class-sizes ranged from 1 to 26.

Survey implementation

Data were collected through self-completed anonymous questionnaires during one school hour (45 min. period), administered by trained research staff. Only students with written parental consent were qualified for participation, parent consent forms were disseminated by class teachers three weeks prior to the baseline assessment. Students did not receive incentives for participation and irrespective of parental consent all students were free to

refuse participation (none refused). Class teachers assigned tasks for students that did not participate. After completion of the survey, questionnaires were placed in an envelope and sealed in front of the class. Students were assured that their individual information would not be seen by parents or teachers. To permit a linking of the baseline and follow-up questionnaires, students generated an anonymous seven-digit individual code, a procedure that had been tested in previous studies, slightly modified for this study.[11] Implementation was approved by all Ministries of Cultural Affairs of the three involved states, and ethical approval was obtained from the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Measures

Advertising exposure

Advertising exposure has been operationalized in numerous ways across studies.[4] It has been measured both in terms of the physical presence of advertisements in individuals' environments and in terms of the psychological processes underlying individuals' memories for these advertisements.[12] In the present study we approximated the individual advertising contact frequency by providing masked colored images of billboard ads for cigarettes and fixed-images of TV commercials for non-tobacco ads with all brand-identifying content digitally removed, asking the students to rate how often they have ever seen each ad extract (on a 4-point scale with scale points 0="Never,",1="1 to 4 times," 2="5 to 10 times" and 3="More than 10 times"). The answers were post-coded as 0=0, 1=2.5, 2=7.5, and 3=11 and summed up to create the tobacco and non-tobacco ad scales, respectively.

The images included six cigarette brands, and eight "control" ads for products that included sweets, clothes, mobile phones, and cars. The following cigarette brands were included in the survey (with ad theme or cue in parentheses): (1) Marlboro (cowboy; horses); (2) F6 (sunrise); (3) Gauloises (couple); (4) Pall Mall (Empire State Building); (5) L&M (couple); (6) Lucky Strike (cigarette packs). These six cigarette brands are among the eight most popular

cigarette brands in Germany.[13] For other commercial products, the following ads were included in the survey (with product type and ad theme or cue in parentheses): (1) Jack Wolfskin (trekking-clothing; climber); (2) Volkswagen (car; the performer Seal); (3) Tic Tac (candy; elevator); (4) Dr. Best (tooth brush; tomato); (5) Kinder Pingui (chocolate bar; penguins); (6) T-Mobile (mobile phone; dog); (7) Spee (detergent; fox); (8) Toyota (car). Advertising selection was based on a pilot study on 28 tobacco and non-tobacco ads (110 students aged 11 to 16 years, mean age 13.6 years), selecting the half of ads that revealed neither ceiling nor floor effects and had corrected item-test correlations above r_{it}=0.40.

We assessed ad exposure to non-tobacco products to control for the propensity to be receptive or attentive to advertising in general, which could confound the relation between tobacco-specific advertising exposure and smoking behavior.

Smoking behavior

We assessed lifetime smoking experience by asking "How many cigarettes have you smoked in your life?" (never smoked, just a few puffs, 1-19 cigarettes, 20-100 cigarettes, >100 cigarettes).[14] Students that indicated any smoking at baseline, even just a few puffs, were excluded from the analysis. Having smoked more than 100 cigarettes at the follow-up assessment was defined as being an established smoker. Current smoking frequency was measured by asking, “How often do you smoke at present?” to which respondents could answer, “I don’t smoke,” “less than once a month,” “at least once a month, but not weekly,” “at least once a week, but not daily,” or “daily.” For the present analysis, this variable was dichotomized into daily and non-daily smoking. To account for different smoking susceptibility in never-smokers at baseline we also assessed future use intentions (“Do you think you will ever smoke in the future?”) and refusal intentions (“If one of your friends offered you a cigarette, would you take it?”), with response categories “Definitely not”, “Probably not”, “Probably yes”, and “Definitely yes”.[15]

Covariates

Covariate measures were derived from studies that focus on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to ad exposure and the smoking measures.[16-18]

Sociodemographics: age, gender, study region, and socioeconomic status (SES); SES of the students was approximated with a combination of student and class teacher ratings: Students answered three items of the PISA cultural and social capital assessment,[19] asking for the number of books in the household (5-point scale from 0 = "None" to 4 = "More than 100") and parenting characteristics ("My parents always know where I am" and "My parents know other parents from my school"), class teachers filled out an 11-item school evaluation sheet related to SES of their students (examples: "Most students of the school live in families with financial problems", "Most students of the school come from underprivileged families", "Our school has a good reputation", scale range from 0 = "Not true at all" to 3 = "Totally true", Cronbach's alpha = 0.85); student and teacher ratings positively correlated r = 0.57, alpha = 0.72.

Personal characteristics: self-reported school performance ("How would you describe your grades last year?", scale points "excellent", "good", "average", "below average"); average TV screen time ("How many hours do you usually watch TV in your leisure time?", scale points: "none", "about half an hour", "about an hour", "about two hours", "about three hours", "about four hours", "more than four hours a day"); rebelliousness and sensation-seeking, assessed with four items combined into a single index, with higher scores indicating greater propensity for rebelliousness and sensation seeking[20] ("I get in trouble in school"; "I do things my parents wouldn't want me to do"; "I like scary things"; "I like to do dangerous things", scale points 0 = "not at all like me", 1 = "a little like me", 2 = "pretty much like me", and 3 = "exactly like me", Cronbach's alpha = 0.76).

Social environment: parent smoking (0 = “No”, 1 = “Yes, 2) and peer smoking (0 = “None”, 1 = “Some, 2 = “Most”, 3 = “All”). As mentioned above, we also controlled for the adolescent’s ability to recall advertising in general with the non-tobacco ad scale.

Statistical analysis

All data analyses were conducted with Stata version 12.0 (Stata Corp, College Station, TX). Chi-squared tests and T-tests were performed to check whether subjects included in the analysis differed systematically from those not reached at the follow-up assessment. Bivariate associations between the study variables were analyzed using Spearman rank correlations. The multivariate associations between amount of advertising exposure and smoking initiation were analyzed with Poisson regressions. Poisson regression allows for the presentation of adjusted Incidence Rate Ratios (IRRs) and 95% confidence intervals (CIs) for the relationship between exposure to advertising and smoking at follow-up, having the advantage of not being influenced by the prevalence of the exposure. IRRs were calculated for every 10 advertising contacts, indicating the relative increase in smoking incidence (established smoking and daily smoking) for each additional 10 contacts. The dichotomized outcome variables were regressed on advertising exposure after inclusion of all covariates and with clustered robust standard errors to account for intra-class correlations within schools. In a subsequent analysis we repeated the Poisson regressions with advertising contact frequency being parsed into tertiles to account for the skewed distribution of tobacco advertising contact and to replicate the approach used in our previous analysis.[9] Missing data were handled by listwise deletion.

RESULTS

Descriptive statistics at baseline and attrition analysis

Table 1 gives descriptive statistics for all interviewed never smokers at baseline, for those lost to follow-up, and the final analyzed sample, allowing comparisons of differences due to

attrition. Never smokers lost to follow-up were significantly younger of age, more often male, had lower scores on the SES scale, rated their school performance more poorly, had higher scores in sensation seeking/rebelliousness and more often reported at least one parent who smoked. No differences were found with regard to tobacco or non-tobacco advertising contact.

Table 1. Descriptive sample statistics at baseline and attrition analysis.

	Baseline never smokers (n=2346) %	Lost to follow-up (n=1026) %	Analyzed Sample (n=1320) %	p
Sociodemographics				
Age at baseline, mean (SD)	12.24 (1.01)	12.16 (1.09)	12.30 (0.93)	.001
Gender: Female	54.9	51.9	57.3	.008
SES: Below Median	51.1	60.6	43.8	<.001
State				
Schleswig-Holstein	41.6	39.8	43.0	.279
Hamburg	28.4	29.1	27.8	
Brandenburg	30.0	31.1	29.2	
Personal characteristics				
School performance				
Below average	2.5	3.7	1.5	<.001
Average	33.7	37.8	30.6	
Good	49.9	44.9	53.9	
Excellent	13.9	13.6	14.0	
TV screen time				
≤ 30 min	16.8	15.5	17.8	.051
1-2 h	59.5	58.8	60.1	
3-4 h	19.0	19.8	18.3	
> 4 h	4.7	5.9	3.8	
Sensation seeking and	0.53 (0.50)	0.56 (0.51)	0.50 (0.49)	.010
Social environment				
Peer smoking: None	71.7	71.5	71.9	.858
Parent smoking: No	53.3	49.3	56.4	.001
Advertising exposure				
Tobacco advertising, range 0-55				
Low (< 1)	35.3	35.3	35.4	.600
Medium (1 - 10)	38.7	39.7	38.0	
High (> 10)	26.0	25.0	26.6	
Non-tobacco advertising, range 0-88				
Low (< 35)	39.8	40.8	39.0	.469
Medium (35 – 54)	32.1	32.4	32.0	
High (> 54)	28.1	26.8	29.0	

Smoking initiation during the observational period

Thirty months after the baseline assessment 436 never smokers reported trying cigarette smoking including a few puffs (33% incidence rate), 138 reported smoking in the past 30 days (10.5% incidence rate), Sixty-six had smoked more than 100 cigarettes and were classified as established smokers (incidence rate 5%), and 58 reported daily smoking (incidence rate 4.4%). Daily smoking incidence was not significantly related to age (p=0.526) or sex (p=0.153), with 33% of the daily smokers at follow-up being 14 years of age or younger and 24% being 16 or older.

Exposure to advertisements at baseline

Table 2. Contact frequency for tobacco and non-tobacco advertisings (n = 1320 never smokers at baseline)

	Seen at least once	Seen more than 10 times
	%	%
Tobacco ads (product type)		
Lucky Strike (cigarettes)	49	13
Marlboro (cigarettes)	28	6
Pall Mall (cigarettes)	24	6
Gauloises (cigarettes)	19	2
L&M (cigarettes)	18	4
F6 (cigarettes)	12	1
Non-tobacco ads (product type)		
Kinder Pingui (sweet)	96	71
Tic Tac (candy)	87	44
Dr. Best (tooth brush)	83	36
T-Mobile (mobile phone)	85	35
Spee (detergent)	76	24
Volkswagen (car)	50	14
Toyota (car)	54	10
Jack Wolfskin (trekking-clothing)	45	9

Table 2 gives contact frequencies (how often the students had seen the ad) for all advertised products at baseline. The cigarette ad with the highest contact frequency was Lucky Strike, for which about half of the sample reported at least one contact. The lowest tobacco ad

contact frequency rate was found for F6, a regional German cigarette brand sold mainly in eastern Germany. Ad contact frequency for non-tobacco products was generally much higher than for tobacco products. For example, almost all students (96%) reported having seen the ad for Kinder Pingui, a chocolate bar. The range of the sum of contacts over all depicted advertisements was 0 to 55 (mean=7.9) for the tobacco ads, and 0 to 88 (mean=42.2) for the non-tobacco ads, also reflecting the lower number of tobacco ads (6 vs. 8).

Zero order associations

Table 3 shows pairwise Spearman rank correlations between the study variables, demonstrating significant crude associations between the assessed covariates and smoking behavior as well as between covariates and advertising contact, justifying their inclusion in the multivariate analyses. The highest correlations with all smoking outcomes was found for peer smoking, followed by tobacco advertising contact. There were some differences in the correlational pattern between tobacco and non-tobacco advertising contact. Compared to the amount of contact with tobacco ads, non-tobacco advertising exposure was stronger related to age and showed no association with gender, and also had a stronger correlation with SES, TV screen time, and parental smoking. The zero-order correlation between tobacco and non-tobacco advertising contact indicated a proportion of about 20% shared variance.

Association between advertising contact and smoking initiation

Figures 1a and 1b show the adjusted predictions of established smoking and daily smoking based on the amount of tobacco and non-tobacco advertising contact. The curves illustrate an increasing risk for the two smoking outcomes dependent on the amount of tobacco ad contact, but not for non-tobacco advertising contact.

Insert Figures 1a and 1b about here

Table 3. Zero-order correlation matrix for all study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1.00													
2. Gender (0=female, 1=male)	0.02	1.00												
3. SES	**-0.07***	0.02	1.00											
4. Region (0=west, 1=east)	**0.25*****	-0.01	**-0.10***	1.00										
5. School performance	**0.11*****	0.03	**-0.16*****	-0.05	1.00									
6. TV screen time	**0.17*****	**0.07****	**-0.30*****	**0.25*****	**0.15*****	1.00								
7. Sensation seeking	**0.09*****	**0.24*****	-0.03	0.01	**0.16*****	**0.18*****	1.00							
8. Peer smoking	**0.28*****	0.02	**-0.22*****	**0.28*****	**0.15*****	**0.24*****	**0.24*****	1.00						
9. Parent smoking	0.04	-0.02	**-0.26*****	**0.09*****	**0.11****	**0.22*****	**0.08****	**0.17*****	1.00					
10. Tobacco ad exposure	**0.14*****	**0.13*****	0.02	**-0.06***	0.05	**0.11****	**0.24*****	**0.13*****	**0.08****	1.00				
11. Non-tobacco ad exposure	**0.20*****	0.05	**-0.08****	**0.11****	**0.06***	**0.36*****	**0.21*****	**0.18*****	**0.18*****	**0.44*****	1.00			
12. Ever smoking	**0.15*****	0.01	**-0.17*****	**0.14*****	**0.09****	**0.14*****	**0.18*****	**0.24*****	**0.13*****	**0.19*****	**0.15*****	1.00		
13. Past 30 days smoking	**0.09****	-0.02	**-0.12****	**0.08****	**0.06***	**0.12****	**0.15*****	**0.21*****	**0.14*****	**0.17*****	**0.12*****	**0.61*****	1.00	
14. Established smoking (>100 cig.)	**0.07***	**0.09****	**-0.07***	**0.08****	0.05	**0.10***	**0.12****	**0.16*****	**0.09*****	**0.13*****	**0.09****	**0.33*****	**0.51*****	1.00
15. Daily smoking	0.02	0.04	**-0.14*****	**0.08****	**0.07***	**0.10***	**0.09****	**0.14*****	**0.13*****	**0.08****	0.03	**0.30*****	**0.49*****	**0.75*****

Bold figures == significant associations
*p<0.05; **p<0.01; ***p<0.001

The Figures also report the adjusted incidence rate ratios associated with an increase in advertising exposure. There was an adjusted IRR for established smoking of 1.38 (95% CI 1.16, 1.63; p<0.001) for each additional 10 tobacco ad contacts and 1.00 (95% CI 0.84, 1.19; p=0.996) for each additional 10 non-tobacco ad contacts. For daily smoking, the corresponding IRRs were 1.30 (95% CI 1.03, 1.64; p=0.029) for 10 tobacco ad contacts and 0.92 (95% CI 0.79, 1.08; p=0.296) for 10 non-tobacco ad contacts, respectively.

Due to the skewed distribution of tobacco ad contact frequency (more than half of the never-smoking students had fewer than 10 contacts), we repeated the analysis using contact frequency parsed into tertiles, representing relative low (0-2.5), medium (5-10), and high (11-55) advertising contact. For established smoking the adjusted IRRs were 1.52 for tobacco ads (95% CI 1.14, 2.03; p=0.004) and 1.05 for non-tobacco ads (95% CI 0.68, 1.62; p=0.819). Using daily smoking as outcome variable the IRRs were 1.43 (95% CI 1.08, 1.90; p=0.012) and 0.84 (95% CI 0.58, 1.22; p=0.363) for each additional tertile of tobacco and non-tobacco advertising contact. These IRRs relate to 3.1%, 4.8%, and 7.3% established smoking attributable incidence rate or 3.1%, 4.6%, and 6.4% daily smoking incidence for low, medium, and high tobacco advertising contact, respectively, assuming the adjusted analysis adequately controlled for third variable influence.

To address the question if some never smokers had higher tobacco advertising contact because they were already more susceptible towards smoking at baseline, we conducted a sensitivity analysis with only never smokers with low susceptibility. These students reported at baseline that they will definitely never smoke in the future and would definitely not try cigarettes if a friend offered one (n = 803). In this restricted sub-sample the adjusted IRR for each additional 10 tobacco ad contacts was 1.37 for established smoking (95% CI 1.07, 1.76; p=0.012) and 1.33 for daily smoking (95% CI 1.02, 1.75; p=0.038). Again, no significant associations were found for non-tobacco advertisings.

DISCUSSION

This longitudinal study is a further test of the relationship between tobacco advertising exposure and youth smoking behavior, confirming the specificity of the advertising-smoking link by comparing the effects of tobacco versus non-tobacco advertising. The study extends previous work by using two less prevalent outcome measures (established and daily smoking) and a longer follow-up period of 2.5 years, measures likely to indicate an addiction component to the smoking.[21] Compared to the results reported on smoking initiation in terms of ever smoking (even a few puffs),[9] the increase in the adjusted relative risk for daily smoking dependent on tobacco advertising exposure was even more pronounced. Specificity was shown by the finding that tobacco advertising at baseline predicted these outcomes independent of the amount of general advertising contact and after controlling for a number of well-known risk factors for smoking initiation. This result confirms the content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not simply a marker for adolescents that are generally more receptive or attentive towards marketing. In addition, a sub-sample sensitivity analysis revealed that the association between tobacco advertising exposure and smoking uptake was also found in the group of unsusceptible never smokers. This is important as one could argue that never smokers with higher exposure were already more susceptible towards smoking at baseline and therefore more attentive towards the tobacco ads.

This longitudinal study also clearly points out the implications of partial tobacco advertising bans in countries like the United States and Germany. The one-third of adolescents in the highest tertile of advertising had rates of daily and established smoking that were double (3 percentage points higher) than adolescents in the first tertile. In reverse, assuming that the models were fully adjusted for other confounding influences, one might expect a significant further decrease in youth smoking uptake in these countries after a total elimination of tobacco advertising.

Some limitations of the study have to be considered. There was a severe loss of students during the 30 months interval (44%). To a large degree the drop-out was due to organizational issues (e.g., school and class changes) that are unlikely systematically related to advertising exposure or smoking behavior on the individual level. However, the lost students differed on a couple of dimensions from the retained students, i.e., age, gender, socio-economic status, school performance, sensation seeking, and parental smoking. With the exception of the lower age, the drop-out markers indicate that lower risk adolescents were more likely to be retained. This might have biased the results as the effect of one risk factor might not be independent of other risk factors. Generally, one would assume that the associations get more conservative if higher risk adolescents are excluded, because this group has a higher likelihood of starting to smoke. However, in the context of media effects on smoking initiation there is also evidence that lower risk adolescents have a higher responsiveness towards media effects[22;23], indicating that the present results might not be generalised to the whole population of adolescents. Second, as with any observational study, the results may be biased by unmeasured confounding – that is, an unmeasured risk factor could alter the estimates reported for the association between tobacco advertising and smoking onset. Third, the memory-based measure of ad exposure could be biased by memory effects other than the ones we controlled for. The potential to remember ads (in terms of contact frequency) should, however, not be completely independent of actual exposure. Finally, because the implemented method did not use a representative sample of all broadcasted ads, it does not allow for an accurate estimation of the total amount of tobacco and non-tobacco advertising exposure or the advertising pressure of specific brands. This is amplified by the modification of the stimulus material which did not contain any brand information.

The finding that exposure to tobacco advertising predicts smoking in youth could have important public health implications. A total ban of tobacco advertising and promotion around the world is one key policy measure of the WHO Framework Convention on Tobacco Control (FCTC) [24]. Under Article 13.1 of the FCTC, ‘Parties recognize that a comprehensive ban on

advertising, promotion and sponsorship would reduce the consumption of tobacco products'. Data from this study support this measure, because only exposure to tobacco advertisements predicted smoking initiation, which cannot be attributed to a general receptiveness to marketing and because it shows that advertising allowed under partial bans is still reaching adolescents.

STATEMENTS

Licence

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None.

Contributors:

Conception and design of the study: All authors

Analysis and interpretation of data: MM, RH

Collection and assembly of data: MM, BI

Drafting of the article: MM, JS, RH

Critical revision of the article for important intellectual content: All authors

Final approval of the article: All authors

All authors have full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Study implementation was approved by the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

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Figure legend

Figures 1a and 1b

----- Tobacco advertising —— Non-tobacco advertising

IRR = Incidence Rate Ratio for 10 additional advertising contacts
Figures in brackets = 95% Confidence Interval
n.s. = not significant; *=p<.05; ***=p<.001

From never to daily smoking in 30 months:

The predictive value of tobacco and non-tobacco advertising exposure

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ABSTRACT

Objective: To test the specificity of the association between tobacco advertising and youth smoking initiation.

Design: Longitudinal survey with a 30-months interval.

Setting: Twenty-one public schools in 3 German states.

Participants: A total of 1320 sixth- to eighth-grade students who were never-smokers at baseline (age range at baseline, 10-15 years; mean, 12.3 years).

Exposures: Exposure to tobacco and non-tobacco advertisements was measured at baseline with images of 6 tobacco and 8 non-tobacco advertisements; students indicated the number of times they had seen each ad and the sum score over all advertisements was used to represent inter-individual differences in the amount of advertising exposure.

Primary and secondary outcome measures: Established smoking, defined as smoked >100 cigarettes during the observational period, and daily smoking at follow-up. Secondary outcome measures were any smoking and smoking in the last 30 days.

Results: During the observation period 5% of the never smokers at baseline smoked more than 100 cigarettes and 4.4% were classified as daily smokers. After controlling for age, gender, socio-economic status, school performance, television screen time, personality characteristics, and smoking status of peers and parents, each additional 10 tobacco advertising contacts increased the adjusted relative risk for established smoking by 38% (95% confidence interval: 16% - 63%; $p<0.001$) and for daily smoking by 30% (95% confidence interval: 3% - 64%; $p<0.05$). No significant association was found for non-tobacco advertising contact.

Conclusions: The study confirms a content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not

simply a marker for adolescents that are generally more receptive or attentive towards marketing.

ARTICLE SUMMARY

Article focus

- High exposure to tobacco advertising might just be an indicator of high advertising exposure in general.
- In this study we compare the potential of tobacco advertising vs. non-tobacco advertising exposure in predicting established and daily smoking of formerly never-smoking German adolescents.

Key messages

- Exposure to tobacco advertisements predicted established smoking and daily smoking, exposure to non-tobacco advertising did not.
- The study also shows that advertising allowed under partial bans still reaches adolescents.

Strengths and limitations of this study

- One of few studies that tests the specificity of the association between tobacco advertising and smoking.
- Long follow-up period with smoking outcomes that are strongly predictive of becoming an addicted smoker.
- A high drop-out rate and attrition bias are limiting factors of this study.

INTRODUCTION

Tobacco companies were among the first companies to use integrated marketing strategies, and their products have long been among the most heavily marketed products in the United States and worldwide.[1] The tobacco industry still denies that their marketing is targeted at young people. According to the industry the purpose of tobacco advertising is to maintain and increase market shares of adult consumers.[2] In contrast, empirical research indicates that adolescents are aware of, recognize, and are influenced by tobacco marketing strategies. The U.S. Surgeon General's 2012 comprehensive review of the tobacco marketing literature concluded that advertising and promotional activities by tobacco companies are key risk factors for the uptake to smoking in adolescents.[3]

A 2011 Cochrane review identified 19 longitudinal studies that followed up a total of over 29,000 subjects, who were adolescents aged 18 or younger, and were not regular smokers at baseline. In 18 of the 19 studies the nonsmoking adolescents who were more aware of tobacco advertising or receptive to it, were more likely to experiment with cigarettes or become smokers at follow up.[4]

Based on these research results, article 13 of the World Health Organization's (WHO) Framework Convention on Tobacco Control stipulates a comprehensive ban on tobacco advertising, promotion, and sponsorship.[5] A number of countries all over the world follow these recommendations, and have banned tobacco advertisings. However, other countries, such as the United States and Germany, have implemented considerably weaker tobacco marketing policies.[6] Germany has banned tobacco advertisements in television, radio, newspapers, and magazines, but there are still opportunities for the industry to promote their products: Tobacco marketing is allowed at point of sale, on billboards, and in cinemas before movies that show after 6:00 pm. Brand extension, i.e. the use of tobacco brand names for other products, is also allowed.

From a scientific point of view, the best way to study the effects of tobacco marketing would be a randomized controlled trial. But this kind of study design would be both unethical and

impractical. Since experimental studies cannot be conducted, we have to rely on observational studies. Sir Austin Bradford Hill identified several criteria for evaluating causality in epidemiological studies.[7] According to these criteria the risk factor (e.g. tobacco marketing) must clearly precede the hypothesized effect (e.g. smoking uptake in young people). In addition, the association should be strong, consistent, expected from theory, and specific.

The Cochrane review on the effects of tobacco advertising on young people[4] listed our previous study[8;9] as the only one that tested the specificity of tobacco advertising compared to advertisements of other consumer goods. Limitations of this study included (a) the short nine months follow-up period, and (b) the outcome measure which defined smoking initiation during the observational period as any smoking including a few puffs. Clearly, not all adolescents who try smoking will go on to become addicted smokers. With the current study we present findings from the same cohort, only for a much longer follow-up period (30 months). The longer follow-up period enables us to study established and daily smoking as outcomes in young people, outcomes that are more strongly predictive of becoming an addicted smoker.[10]

METHODS

Study sample

In May 2008 we invited 120 randomly selected schools from three states of Germany (Brandenburg, Hamburg, and Schleswig-Holstein) to participate in a school-based survey. The German school system has different types of schools (*Grundschule, Hauptschule, Realschule, Oberschule, Gemeinschaftsschule, Gymnasium)* that mainly differ with regard to the academic skills of their students and graduation level. The selection was stratified by state and type of school, assuring a balanced representation of all school types of the respective states. Twenty-nine schools with 176 classes and 4195 sixth to eighth grade students agreed to participate after a four week recruitment interval. In September and October 2008 we surveyed a total of 174 classes with 3415 students (81.4% of the sampled students). Reasons for exclusion were either absence (2 classes, 134 students) or missing parental consent (646 students). From the 3415 students surveyed at baseline, 2346 were classified as never smokers. Of these, 1320 (56.3%) could be reached again at the follow-up assessment in May/June 2011. Reasons for study drop-out were loss of primary schools that end after sixth grade (7 schools, 14 classes, 194 students), refusal to participate at the follow-up assessment (1 school, 8 classes, 59 students) or class absence (24 classes, 291 students). Other reasons were unexplained absence on the day of data assessment or unmatchable student codes (482 students). The number of analyzed never smokers per school ranged from 3 to 232, class-sizes ranged from 1 to 26.

Survey implementation

Data were collected through self-completed anonymous questionnaires during one school hour (45 min. period), administered by trained research staff. Only students with written parental consent were qualified for participation, parent consent forms were disseminated by class teachers three weeks prior to the baseline assessment. Students did not receive incentives for participation and irrespective of parental consent all students were free to

refuse participation (none refused). Class teachers assigned tasks for students that did not participate. After completion of the survey, questionnaires were placed in an envelope and sealed in front of the class. Students were assured that their individual information would not be seen by parents or teachers. To permit a linking of the baseline and follow-up questionnaires, students generated an anonymous seven-digit individual code, a procedure that had been tested in previous studies, slightly modified for this study.[11] Implementation was approved by all Ministries of Cultural Affairs of the three involved states, and ethical approval was obtained from the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

Measures

Advertising exposure

Advertising exposure has been operationalized in numerous ways across studies.[4] It has been measured both in terms of the physical presence of advertisements in individuals' environments and in terms of the psychological processes underlying individuals' memories for these advertisements.[12] In the present study we approximated the individual advertising contact frequency by providing masked colored images of billboard ads for cigarettes and fixed-images of TV commercials for non-tobacco ads with all brand-identifying content digitally removed, asking the students to rate how often they have ever seen each ad extract (on a 4-point scale with scale points 0="Never,",1="1 to 4 times," 2="5 to 10 times" and 3="More than 10 times"). The answers were post-coded as 0=0, 1=2.5, 2=7.5, and 3=11 and summed up to create the tobacco and non-tobacco ad scales, respectively.

The images included six cigarette brands, and eight "control" ads for products that included sweets, clothes, mobile phones, and cars. The following cigarette brands were included in the survey (with ad theme or cue in parentheses): (1) Marlboro (cowboy; horses); (2) F6 (sunrise); (3) Gauloises (couple); (4) Pall Mall (Empire State Building); (5) L&M (couple); (6) Lucky Strike (cigarette packs). These six cigarette brands are among the eight most popular

cigarette brands in Germany.[13] For other commercial products, the following ads were included in the survey (with product type and ad theme or cue in parentheses): (1) Jack Wolfskin (trekking-clothing; climber); (2) Volkswagen (car; the performer Seal); (3) Tic Tac (candy; elevator); (4) Dr. Best (tooth brush; tomato); (5) Kinder Pingui (chocolate bar; penguins); (6) T-Mobile (mobile phone; dog); (7) Spee (detergent; fox); (8) Toyota (car). Advertising selection was based on a pilot study on 28 tobacco and non-tobacco ads (110 students aged 11 to 16 years, mean age 13.6 years), selecting the half of ads that revealed neither ceiling nor floor effects and had corrected item-test correlations above r_{it}=0.40.

We assessed ad exposure to non-tobacco products to control for the propensity to be receptive or attentive to advertising in general, which could confound the relation between tobacco-specific advertising exposure and smoking behavior.

Smoking behavior

We assessed lifetime smoking experience by asking "How many cigarettes have you smoked in your life?" (never smoked, just a few puffs, 1-19 cigarettes, 20-100 cigarettes, >100 cigarettes).[14] Students that indicated any smoking at baseline, even just a few puffs, were excluded from the analysis. Having smoked more than 100 cigarettes at the follow-up assessment was defined as being an established smoker. Current smoking frequency was measured by asking, “How often do you smoke at present?” to which respondents could answer, “I don’t smoke,” “less than once a month,” “at least once a month, but not weekly,” “at least once a week, but not daily,” or “daily.” For the present analysis, this variable was dichotomized into daily and non-daily smoking. To account for different smoking susceptibility in never-smokers at baseline we also assessed future use intentions (“Do you think you will ever smoke in the future?”) and refusal intentions (“If one of your friends offered you a cigarette, would you take it?”), with response categories “Definitely not”, “Probably not”, “Probably yes”, and “Definitely yes”.[15]

Covariates

Covariate measures were derived from studies that focus on risk factors of adolescent tobacco use, to control for confounding variables that would be theoretically related to ad exposure and the smoking measures.[16-18]

Sociodemographics: age, gender, study region, and socioeconomic status (SES); SES of the students was approximated with a combination of student and class teacher ratings: Students answered three items of the PISA cultural and social capital assessment,[19] asking for the number of books in the household (5-point scale from 0 = "None" to 4 = "More than 100") and parenting characteristics ("My parents always know where I am" and "My parents know other parents from my school"), class teachers filled out an 11-item school evaluation sheet related to SES of their students (examples: "Most students of the school live in families with financial problems", "Most students of the school come from underprivileged families", "Our school has a good reputation", scale range from 0 = "Not true at all" to 3 = "Totally true", Cronbach's alpha = 0.85); student and teacher ratings positively correlated r = 0.57, alpha = 0.72.

Personal characteristics: self-reported school performance ("How would you describe your grades last year?", scale points "excellent", "good", "average", "below average"); average TV screen time ("How many hours do you usually watch TV in your leisure time?", scale points: "none", "about half an hour", "about an hour", "about two hours", "about three hours", "about four hours", "more than four hours a day"); rebelliousness and sensation-seeking, assessed with four items combined into a single index, with higher scores indicating greater propensity for rebelliousness and sensation seeking[20] ("I get in trouble in school"; "I do things my parents wouldn't want me to do"; "I like scary things"; "I like to do dangerous things", scale points 0 = "not at all like me", 1 = "a little like me", 2 = "pretty much like me", and 3 = "exactly like me", Cronbach's alpha = 0.76).

Social environment: parent smoking (0 = “No”, 1 = “Yes, 2) and peer smoking (0 = “None”, 1 = “Some, 2 = “Most”, 3 = “All”). As mentioned above, we also controlled for the adolescent’s ability to recall advertising in general with the non-tobacco ad scale.

Statistical analysis

All data analyses were conducted with Stata version 12.0 (Stata Corp, College Station, TX). Chi-squared tests and T-tests were performed to check whether subjects included in the analysis differed systematically from those not reached at the follow-up assessment. Bivariate associations between the study variables were analyzed using Spearman rank correlations. The multivariate associations between amount of advertising exposure and smoking initiation were analyzed with Poisson regressions. Poisson regression allows for the presentation of adjusted Incidence Rate Ratios (IRRs) and 95% confidence intervals (CIs) for the relationship between exposure to advertising and smoking at follow-up, having the advantage of not being influenced by the prevalence of the exposure. IRRs were calculated for every 10 advertising contacts, indicating the relative increase in smoking incidence (established smoking and daily smoking) for each additional 10 contacts. The dichotomized outcome variables were regressed on advertising exposure after inclusion of all covariates and with clustered robust standard errors to account for intra-class correlations within schools. In a subsequent analysis we repeated the Poisson regressions with advertising contact frequency being parsed into tertiles to account for the skewed distribution of tobacco advertising contact and to replicate the approach used in our previous analysis.[9] Missing data were handled by listwise deletion.

RESULTS

Descriptive statistics at baseline and attrition analysis

Table 1 gives descriptive statistics for all interviewed never smokers at baseline, for those lost to follow-up, and the final analyzed sample, allowing comparisons of differences due to

attrition. Never smokers lost to follow-up were significantly younger of age, more often male, had lower scores on the SES scale, rated their school performance more poorly, had higher scores in sensation seeking/rebelliousness and more often reported at least one parent who smoked. No differences were found with regard to tobacco or non-tobacco advertising contact.

Table 1. Descriptive sample statistics at baseline and attrition analysis.

	Baseline never smokers (n=2346) %	Lost to follow-up (n=1026) %	Analyzed Sample (n=1320) %	p
Sociodemographics				
Age at baseline, mean (SD)	12.24 (1.01)	12.16 (1.09)	12.30 (0.93)	.001
Gender: Female	54.9	51.9	57.3	.008
SES: Below Median	51.1	60.6	43.8	<.001
State				
Schleswig-Holstein	41.6	39.8	43.0	.279
Hamburg	28.4	29.1	27.8	
Brandenburg	30.0	31.1	29.2	
Personal characteristics				
School performance				
Below average	2.5	3.7	1.5	<.001
Average	33.7	37.8	30.6	
Good	49.9	44.9	53.9	
Excellent	13.9	13.6	14.0	
TV screen time				
≤ 30 min	16.8	15.5	17.8	.051
1-2 h	59.5	58.8	60.1	
3-4 h	19.0	19.8	18.3	
> 4 h	4.7	5.9	3.8	
Sensation seeking and	0.53 (0.50)	0.56 (0.51)	0.50 (0.49)	.010
Social environment				
Peer smoking: None	71.7	71.5	71.9	.858
Parent smoking: No	53.3	49.3	56.4	.001
Advertising exposure				
Tobacco advertising, range 0-55				
Low (< 1)	35.3	35.3	35.4	.600
Medium (1 - 10)	38.7	39.7	38.0	
High (> 10)	26.0	25.0	26.6	
Non-tobacco advertising, range 0-88				
Low (< 35)	39.8	40.8	39.0	.469
Medium (35 – 54)	32.1	32.4	32.0	
High (> 54)	28.1	26.8	29.0	

Smoking initiation during the observational period

Thirty months after the baseline assessment 436 never smokers reported trying cigarette smoking including a few puffs (33% incidence rate), 138 reported smoking in the past 30 days (10.5% incidence rate), Sixty-six had smoked more than 100 cigarettes and were classified as established smokers (incidence rate 5%), and 58 reported daily smoking (incidence rate 4.4%). Daily smoking incidence was not significantly related to age (p=0.526) or sex (p=0.153), with 33% of the daily smokers at follow-up being 14 years of age or younger and 24% being 16 or older.

Exposure to advertisements at baseline

Table 2. Contact frequency for tobacco and non-tobacco advertisings (n = 1320 never smokers at baseline)

	Seen at least once	Seen more than 10 times
	%	%
Tobacco ads (product type)		
Lucky Strike (cigarettes)	49	13
Marlboro (cigarettes)	28	6
Pall Mall (cigarettes)	24	6
Gauloises (cigarettes)	19	2
L&M (cigarettes)	18	4
F6 (cigarettes)	12	1
Non-tobacco ads (product type)		
Kinder Pingui (sweet)	96	71
Tic Tac (candy)	87	44
Dr. Best (tooth brush)	83	36
T-Mobile (mobile phone)	85	35
Spee (detergent)	76	24
Volkswagen (car)	50	14
Toyota (car)	54	10
Jack Wolfskin (trekking-clothing)	45	9

Table 2 gives contact frequencies (how often the students had seen the ad) for all advertised products at baseline. The cigarette ad with the highest contact frequency was Lucky Strike, for which about half of the sample reported at least one contact. The lowest tobacco ad

contact frequency rate was found for F6, a regional German cigarette brand sold mainly in eastern Germany. Ad contact frequency for non-tobacco products was generally much higher than for tobacco products. For example, almost all students (96%) reported having seen the ad for Kinder Pingui, a chocolate bar. The range of the sum of contacts over all depicted advertisements was 0 to 55 (mean=7.9) for the tobacco ads, and 0 to 88 (mean=42.2) for the non-tobacco ads, also reflecting the lower number of tobacco ads (6 vs. 8).

Zero order associations

Table 3 shows pairwise Spearman rank correlations between the study variables, demonstrating significant crude associations between the assessed covariates and smoking behavior as well as between covariates and advertising contact, justifying their inclusion in the multivariate analyses. The highest correlations with all smoking outcomes was found for peer smoking, followed by tobacco advertising contact. There were some differences in the correlational pattern between tobacco and non-tobacco advertising contact. Compared to the amount of contact with tobacco ads, non-tobacco advertising exposure was stronger related to age and showed no association with gender, and also had a stronger correlation with SES, TV screen time, and parental smoking. The zero-order correlation between tobacco and non-tobacco advertising contact indicated a proportion of about 20% shared variance.

Association between advertising contact and smoking initiation

Figures 1a and 1b show the adjusted predictions of established smoking and daily smoking based on the amount of tobacco and non-tobacco advertising contact. The curves illustrate an increasing risk for the two smoking outcomes dependent on the amount of tobacco ad contact, but not for non-tobacco advertising contact.

Insert Figures 1a and 1b about here

Table 3. Zero-order correlation matrix for all study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1.00													
2. Gender (0=female, 1=male)	0.02	1.00												
3. SES	**-0.07***	0.02	1.00											
4. Region (0=west, 1=east)	**0.25*****	-0.01	**-0.10***	1.00										
5. School performance	**0.11*****	0.03	**-0.16*****	-0.05	1.00									
6. TV screen time	**0.17*****	**0.07****	**-0.30*****	**0.25*****	**0.15*****	1.00								
7. Sensation seeking	**0.09*****	**0.24*****	-0.03	0.01	**0.16*****	**0.18*****	1.00							
8. Peer smoking	**0.28*****	0.02	**-0.22*****	**0.28*****	**0.15*****	**0.24*****	**0.24*****	1.00						
9. Parent smoking	0.04	-0.02	**-0.26*****	**0.09*****	**0.11****	**0.22*****	**0.08****	**0.17*****	1.00					
10. Tobacco ad exposure	**0.14*****	**0.13*****	0.02	**-0.06***	0.05	**0.11****	**0.24*****	**0.13*****	**0.08****	1.00				
11. Non-tobacco ad exposure	**0.20*****	0.05	**-0.08****	**0.11****	**0.06***	**0.36*****	**0.21*****	**0.18*****	**0.18*****	**0.44*****	1.00			
12. Ever smoking	**0.15*****	0.01	**-0.17*****	**0.14*****	**0.09****	**0.14*****	**0.18*****	**0.24*****	**0.13*****	**0.19*****	**0.15*****	1.00		
13. Past 30 days smoking	**0.09****	-0.02	**-0.12****	**0.08****	**0.06***	**0.12****	**0.15*****	**0.21*****	**0.14*****	**0.17*****	**0.12*****	**0.61*****	1.00	
14. Established smoking (>100 cig.)	**0.07***	**0.09****	**-0.07***	**0.08****	0.05	**0.10***	**0.12****	**0.16*****	**0.09*****	**0.13*****	**0.09****	**0.33*****	**0.51*****	1.00
15. Daily smoking	0.02	0.04	**-0.14*****	**0.08****	**0.07***	**0.10***	**0.09****	**0.14*****	**0.13*****	**0.08****	0.03	**0.30*****	**0.49*****	**0.75*****

Bold figures == significant associations
*p<0.05; **p<0.01; ***p<0.001

The Figures also report the adjusted incidence rate ratios associated with an increase in advertising exposure. There was an adjusted IRR for established smoking of 1.38 (95% CI 1.16, 1.63; p<0.001) for each additional 10 tobacco ad contacts and 1.00 (95% CI 0.84, 1.19; p=0.996) for each additional 10 non-tobacco ad contacts. For daily smoking, the corresponding IRRs were 1.30 (95% CI 1.03, 1.64; p=0.029) for 10 tobacco ad contacts and 0.92 (95% CI 0.79, 1.08; p=0.296) for 10 non-tobacco ad contacts, respectively.

Due to the skewed distribution of tobacco ad contact frequency (more than half of the never-smoking students had fewer than 10 contacts), we repeated the analysis using contact frequency parsed into tertiles, representing relative low (0-2.5), medium (5-10), and high (11-55) advertising contact. For established smoking the adjusted IRRs were 1.52 for tobacco ads (95% CI 1.14, 2.03; p=0.004) and 1.05 for non-tobacco ads (95% CI 0.68, 1.62; p=0.819). Using daily smoking as outcome variable the IRRs were 1.43 (95% CI 1.08, 1.90; p=0.012) and 0.84 (95% CI 0.58, 1.22; p=0.363) for each additional tertile of tobacco and non-tobacco advertising contact. These IRRs relate to 3.1%, 4.8%, and 7.3% established smoking attributable incidence rate or 3.1%, 4.6%, and 6.4% daily smoking incidence for low, medium, and high tobacco advertising contact, respectively, assuming the adjusted analysis adequately controlled for third variable influence.

To address the question if some never smokers had higher tobacco advertising contact because they were already more susceptible towards smoking at baseline, we conducted a sensitivity analysis with only never smokers with low susceptibility. These students reported at baseline that they will definitely never smoke in the future and would definitely not try cigarettes if a friend offered one (n = 803). In this restricted sub-sample the adjusted IRR for each additional 10 tobacco ad contacts was 1.37 for established smoking (95% CI 1.07, 1.76; p=0.012) and 1.33 for daily smoking (95% CI 1.02, 1.75; p=0.038). Again, no significant associations were found for non-tobacco advertisings.

DISCUSSION

This longitudinal study is a further test of the relationship between tobacco advertising exposure and youth smoking behavior, confirming the specificity of the advertising-smoking link by comparing the effects of tobacco versus non-tobacco advertising. The study extends previous work by using two less prevalent outcome measures (established and daily smoking) and a longer follow-up period of 2.5 years, measures likely to indicate an addiction component to the smoking.[21] Compared to the results reported on smoking initiation in terms of ever smoking (even a few puffs),[9] the increase in the adjusted relative risk for daily smoking dependent on tobacco advertising exposure was even more pronounced. Specificity was shown by the finding that tobacco advertising at baseline predicted these outcomes independent of the amount of general advertising contact and after controlling for a number of well-known risk factors for smoking initiation. This result confirms the content-specific association between tobacco advertising and smoking behaviour and underlines that tobacco advertising exposure is not simply a marker for adolescents that are generally more receptive or attentive towards marketing. In addition, a sub-sample sensitivity analysis revealed that the association between tobacco advertising exposure and smoking uptake was also found in the group of unsusceptible never smokers. This is important as one could argue that never smokers with higher exposure were already more susceptible towards smoking at baseline and therefore more attentive towards the tobacco ads.

This longitudinal study also clearly points out the implications of partial tobacco advertising bans in countries like the United States and Germany. The one-third of adolescents in the highest tertile of advertising had rates of daily and established smoking that were double (3 percentage points higher) than adolescents in the first tertile. In reverse, assuming that the models were fully adjusted for other confounding influences, one might expect a significant further decrease in youth smoking uptake in these countries after a total elimination of tobacco advertising.

Some limitations of the study have to be considered. There was a severe loss of students during the 30 months interval (44%). To a large degree the drop-out was due to organizational issues (e.g., school and class changes) that are unlikely systematically related to advertising exposure or smoking behavior on the individual level. However, the lost students differed on a couple of dimensions from the retained students, i.e., age, gender, socio-economic status, school performance, sensation seeking, and parental smoking. With the exception of the lower age, the drop-out markers indicate that lower risk adolescents were more likely to be retained. This might have biased the results as the effect of one risk factor might not be independent of other risk factors. Generally, one would assume that the associations get more conservative if higher risk adolescents are excluded, because this group has a higher likelihood of starting to smoke. However, in the context of media effects on smoking initiation there is also evidence that lower risk adolescents have a higher responsiveness towards media effects[22;23], indicating that the present results might not be generalised to the whole population of adolescents. Second, as with any observational study, the results may be biased by unmeasured confounding – that is, an unmeasured risk factor could alter the estimates reported for the association between tobacco advertising and smoking onset. Third, the memory-based measure of ad exposure could be biased by memory effects other than the ones we controlled for. The potential to remember ads (in terms of contact frequency) should, however, not be completely independent of actual exposure. Finally, because the implemented method did not use a representative sample of all broadcasted ads, it does not allow for an accurate estimation of the total amount of tobacco and non-tobacco advertising exposure or the advertising pressure of specific brands. This is amplified by the modification of the stimulus material which did not contain any brand information.

The finding that exposure to tobacco advertising predicts smoking in youth could have important public health implications. A total ban of tobacco advertising and promotion around the world is one key policy measure of the WHO Framework Convention on Tobacco Control (FCTC) [24]. Under Article 13.1 of the FCTC, ‘Parties recognize that a comprehensive ban on

advertising, promotion and sponsorship would reduce the consumption of tobacco products'. Data from this study support this measure, because only exposure to tobacco advertisements predicted smoking initiation, which cannot be attributed to a general receptiveness to marketing and because it shows that advertising allowed under partial bans is still reaching adolescents.

STATEMENTS

Licence

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None.

Contributors:

Conception and design of the study: All authors

Analysis and interpretation of data: MM, RH

Collection and assembly of data: MM, BI

Drafting of the article: MM, JS, RH

Critical revision of the article for important intellectual content: All authors

Final approval of the article: All authors

All authors have full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Study implementation was approved by the Ethical Committee of the Medical Faculty of the University of Kiel (Ref.: D 417/08).

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(23) Hanewinkel R, Sargent JD. Exposure to smoking in internationally distributed American movies and youth smoking in Germany: a cross-cultural cohort study. *Pediatrics* 2008; 121(1):e108-e117.

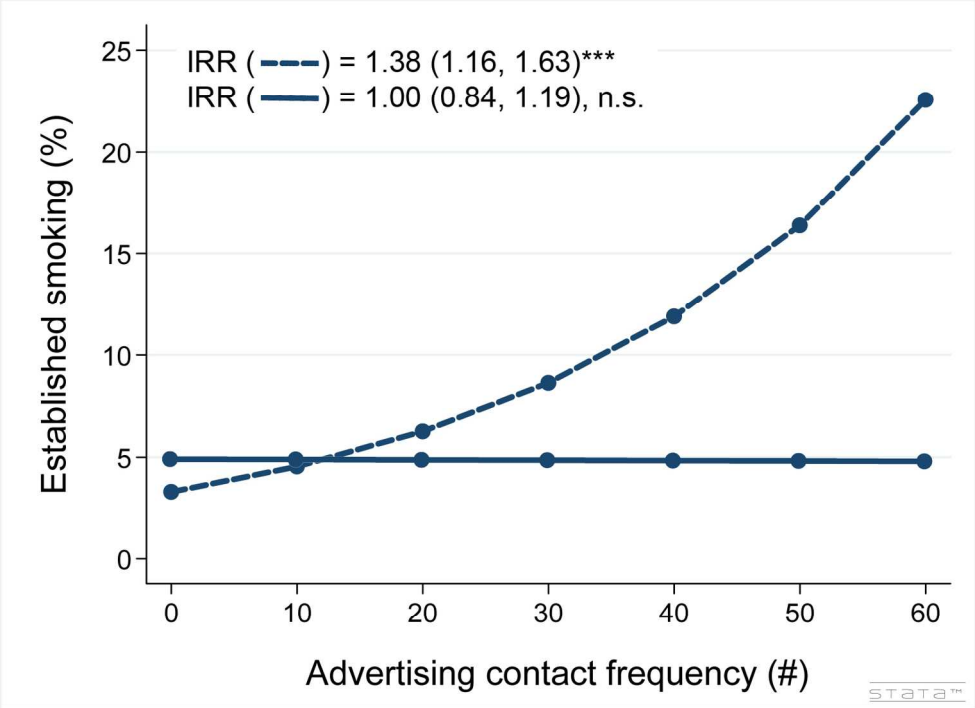
(24) Shibuya K, Ciecierski C, Guindon E, Bettcher DW, Evans DB, Murray CJ. WHO Framework Convention on Tobacco Control: development of an evidence based global public health treaty. *BMJ* 2003; 327(7407):154-157.

Figure legend

Figures 1a and 1b

----- Tobacco advertising —— Non-tobacco advertising

IRR = Incidence Rate Ratio for 10 additional advertising contacts
Figures in brackets = 95% Confidence Interval
n.s. = not significant; *=p<.05; ***=p<.001



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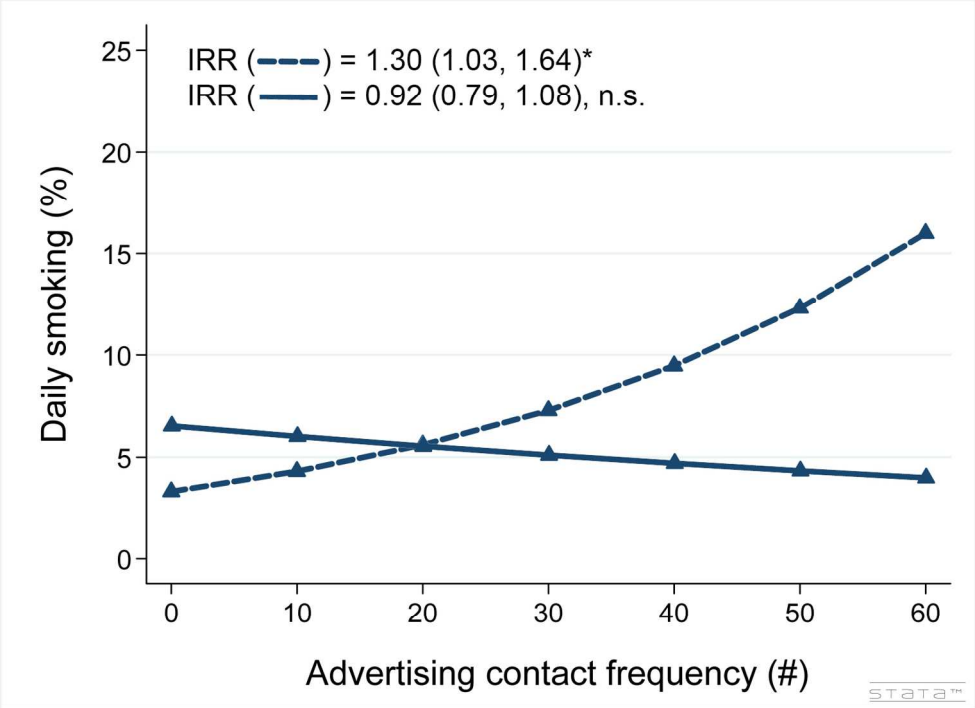

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STROBE statement
Manuscript entitled "From never to daily smoking in 30 months:
The predictive value of tobacco and non-tobacco advertising exposure"

	Item No	Recommendation	Manuscript page
Title and abstract			
	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8,9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8,9
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9, 10
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	10
		(d) If applicable, explain how loss to follow-up was addressed	10
		(*e*) Describe any sensitivity analyses	10

Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study? eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(*b*) Give reasons for non-participation at each stage	6
		(*c*) Consider use of a flow diagram	--
Descriptive data	14*	(*a*) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(*b*) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8, 13, 15 Figure 1
		(*b*) Report category boundaries when continuous variables were categorized	15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	--
Other analyses	17	Report other analyses done? eg analyses of subgroups and interactions, and sensitivity analyses	--
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16,17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18