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Smoking in movies and smoking initiation in adolescents: systematic review and meta-analysis

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Abbreviations: RR, relative risk; CI, confidence interval

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ABSTRACT

Background and aims: Preventing young people from initiating smoking is a vital public health objective. There is strong evidence that exposure to smoking imagery in movies is associated with an increased risk of smoking uptake. However, the estimate of the magnitude of effect is not clear since previous reviews have synthesised estimates of cross-sectional and longitudinal associations. Therefore, we have performed a systematic review to quantify cross-sectional and longitudinal associations between exposure to smoking in movies and initiating smoking in adolescents.

Methods: Four electronic databases (MEDLINE, EMBASE, PsycINFO, and International Bibliography of the Social Sciences, IBSS) and grey literature were searched from inception to May 2015 for comparative epidemiological studies (cross sectional and cohort studies) that reported the relation between exposure to smoking in movies and smoking initiation in adolescence (10-19 years). Reference lists of studies and previous reviews were also screened. Two authors independently screened papers and extracted data.

Results: 17 studies met our inclusion criteria. Random effects meta-analysis of nine cross sectional studies demonstrated higher exposure (typically highest vs lowest quantile) of smoking in movies was significantly associated with a doubling in risk of ever trying smoking (RR 1.93, 95% CI 1.66 to 2.25). In 8 longitudinal studies (all deemed high quality), higher exposure to smoking in movies was significantly associated with a 46% increased risk of initiating smoking (RR 1.46; 95% CI 1.23 to 1.73). These pooled estimates were significantly different from each other (p=0.02). Moderate levels of heterogeneity were seen in the meta-analyses.

Conclusions: The cross-sectional association between young people reporting having seen smoking imagery in films and smoking status is greater than the prospective association. Both associations are substantial but it is not clear whether they are causal.

INTRODUCTION

Preventing uptake of smoking among young people is a vital public health objective, and to which preventing exposure of young people to tobacco advertising and promotion is crucial to success. With increasing global implementation of the World Health Organisation (WHO) framework convention on tobacco control [1]; paid-for tobacco advertising is being prohibited in a growing number of countries, states and jurisdictions. Such measures do not, however, prevent exposure of young people to tobacco branding or more generic behavioural imagery, whether paid for or otherwise, in movies and other media. There is now strong evidence base demonstrating that exposure to smoking imagery in movies whether branded or generic is associated with an increased likelihood of smoking in young people, and various authorities have concluded that this effect is likely to be causal. [2-5] However, the magnitude of this effect has not been clearly defined.

Much of the available evidence arises from cross-sectional surveys in which the association between exposure to smoking in film and smoking uptake is recorded at a single point in time; therefore it is difficult to determine whether a temporal association exists. In contrast, the design of a longitudinal study allows for directionality to be established where exposure to tobacco imagery is measured and occurs before smoking uptake. Although more limited, the longitudinal study evidence base is now substantial, but includes studies from a range of settings and ages, and with a wide variation in estimates of the magnitude of effect. Furthermore, in 2012, the US Surgeon General report on preventing tobacco use among youth and young adults demonstrated a causal relationship between exposure to smoking in film and smoking onset [4], but the parameter estimates and variances from the meta-analyses may be inaccurate due to including multiple estimates from the same cohort. We have therefore carried out a systematic review and meta-analysis of longitudinal and cross-

sectional associations to provide summary estimates of the effect of exposure to smoking in movies on subsequent smoking uptake in young people.

METHODS

Criteria for considering studies

We included all comparative epidemiological studies (cross sectional and cohort studies) that reported the relation between exposure to smoking in movies and smoking initiation in adolescence (10-19 years). Since some cohorts of adolescents were the participants in more than one publication, typically using different endpoints or measures of exposure, we included the most recent publication reporting cross-sectional or longitudinal associations. Longitudinal associations were only considered in adolescents who were never smokers at baseline. We excluded studies which solely focussed on exposure to smoking in television programmes, series, sitcoms and trailers; and studies in which the average age of the population was older than 19 years.

Search Strategy

We performed a comprehensive search of four electronic databases from inception to May 2015 (MEDLINE, EMBASE, PsycINFO, and International Bibliography of the Social Sciences, IBSS) using MeSH and text words for smoking initiation and movie, and recognised search terms for limiting the searches to specific study designs (Table S1). [6] We also searched reference lists of included studies and previous reviews to identify further studies.

Screening and data extraction

Papers were screened independently by two authors (MN and JLB or JB) using a two stage approach based on i) titles and abstracts and ii) full text. Any disagreements were resolved through discussion and consensus. No restrictions were placed on language, and translations were sought where necessary.

Data extraction was conducted independently by two authors (MN and JLB or JB) using a piloted data extraction form, which collected information relating to study design, data collection period, definitions of exposure (smoking in movies) and outcome (smoking uptake), country, setting, inclusion and exclusion criteria for participants, number of participants recruited and evaluated, demographics of study population (for example, age and socio-economic status), quantitative results, and the limitations of the study.

The Newcastle-Ottawa Quality Assessment Scale [7] was used to assess the quality of the included studies (maximum score for cohort and cross-sectional studies was 9 and 7, respectively), where assessments were made independently by two authors (MN and JLB or JB), with discrepancies resolved through discussion. A score of 6 or more was deemed to be high quality.

Data synthesis

Random effects meta-analyses were conducted to estimate pooled relative risk of the effect of exposure to smoking in movies and smoking initiation in adolescents. Effect estimates adjusted for socioeconomic status and demographics were used in preference to crude estimates. We attempted to include estimates of cross-sectional and longitudinal associations from each cohort identified; therefore, to prevent double counting we performed separate analyses for cross sectional and longitudinal associations. Odds ratios and risk ratios were pooled as relative risks. Where exposure to smoking in movies was reported using categories or quartiles, we used the most exposed group compared to the least exposed group. Continuous measures of exposure to smoking in movies were used as reported in the publication. Continuous and categorical measures of exposure were pooled together in the meta-analyses. Heterogeneity between studies was quantified using I^2. [8] Subgroup analyses

were conducted to explore the reasons for heterogeneity based on methodological quality and country. We performed additional post-hoc subgroup analyses based on whether studies quantified exposure to smoking in movies using quantiles or continuous measures. Publication bias was assessed using a funnel plot and Egger's asymmetry test. P values <0.05 were deemed statistically significant. Review Manager 5.2 and STATA/MP 13.1 were used to perform analyses. We adhered to the MOOSE [9] and PRISMA [10] guidelines throughout the review (Table S2). The protocol was registered with the National Institute for Health Research International prospective register of systematic reviews (PROSPERO) under the registration number CRD42014009177 in March 2014.

RESULTS

From a total of 697 titles generated by our searches we identified 87 potentially eligible abstracts of which 42 were appropriate for full text screening. Of these, 25 were excluded because of the exposure studied was not relevant (4 studies); ineligible outcomes (10 studies), such as established smoking rather than smoking uptake; ineligible study design (2 studies); studying a cohort used in a more recent included study (2 studies); participants who were too old (2 studies), or because the aim of the study was to examine the influence of moderators or mediators of the association and did not provide a valid measure of the main effect (5 studies). A total of 17 studies were therefore selected for inclusion in the review and meta-analyses (Figure 1).

Nine of the included studies were cross sectional in design [11-19] and eight longitudinal [20-27] (Table 1). The majority of studies were conducted in single countries (United States, 7 studies; Mexico, 2 studies UK, 3 studies; Germany 2 studies; India, 1 study), though 2 studies were carried out in a group of 6 European counties. [15, 23] The participant population age range varied from 7 to 19 years old and in most cases comprised young teenagers. The median sample size of the included studies was 4919 for those reporting cross sectional associations, and 2298 for those reporting longitudinal associations.

The majority of studies estimated exposure to smoking in top grossing or popular contemporary movies using a composite measure based on summing the number of smoking occurrences in single viewings of all the movies that participants reported they had seen. Two studies included exposure from multiple viewings of the same movie. [13, 21] In the majority of studies, the exposure measure was classified into quantiles, though five studies analysed exposure as a continuous variable. [13, 20, 21, 26, 27]

In the cross-sectional studies analysed, all reported 'ever tried smoking' as their outcome of interest. In longitudinal studies the outcome of interest was initiation of smoking in adolescents who had never smoked at the baseline assessment. All of the studies reported results adjusted for a measure of socioeconomic status; other common confounders adjusted for included age, sex, school performance, sibling/parental smoking status, parenting style, and sensation seeking (Table 1). When comparing the unadjusted and adjusted measures of effect in the 13 studies that reported both, the majority of studies (n=8, 62%) found notable differences [12, 15-18, 23-25] where the unadjusted estimate was on average twice as large in magnitude compared to the adjusted estimate (range from 40-400%), thereby highlighting the importance of adjustment for confounders. Seven of the nine cross sectional studies, and all eight of the longitudinal studies, were deemed to be of high quality with a Newcastle Ottawa Score ≥6 (Table S3). All of the included studies did not meet the criteria for ascertainment of exposure and none of the studies reporting longitudinal associations met the criterion for ascertainment of outcome, since they relied on self-reported assessments. There was no evidence of publication bias within the cross sectional studies (Egger's test, p=0.33; Figure S1a); however, some evidence of publication bias was seen in the longitudinal studies (Egger's test, p=0.03; Figure S1b).

Meta-analysis of effect estimates from the nine cross-sectional studies found higher exposure to movie smoking significantly increased the risk of having ever trying smoking by 1.93 (95% CI 1.66 to 2.25; I^2=60%, Figure 2). For the longitudinal studies, higher exposure to movie smoking significantly increased the risk of smoking initiation among young people by 1.46 (95% CI 1.23 to 1.73, I^2=90%; 8 studies; Figure 2).

As all of the longitudinal studies were deemed to be high quality, subgroup analysis according to study quality was limited to the cross-sectional studies. Of these, the estimate for higher (Newcastle-Ottawa score ≥6) quality studies (pooled RR 1.86, 95% CI 1.58 to 2.19) was marginally smaller in magnitude than that from lower quality studies (pooled RR 2.47, 95% CI 1.75 to 3.48), albeit the difference was not statistically significant (p-value for subgroup differences = 0.15; Figure 3). A subgroup analysis comparing risk estimates between study country found a significant (p=0.01) difference between the pooled estimates from longitudinal studies, where relative risks were lower in the US than elsewhere (US pooled RR 1.29, 95% CI 1.10 to 1.51, 5 studies; Mexico RR 1.41, 95% CI 0.95 to 2.10, 1 study; Germany RR 1.96, 95% CI 1.56 to 2.47, 1 study). A post-hoc subgroup analysis in studies reporting longitudinal associations found the magnitude of effect was significantly larger in studies which quantified exposure to smoking in movies using quantiles (RR 1.85, 95% CI 1.54 to 2.23, 4 studies) than as a continuous measure (RR 1.18, 95% CI 1.18, 95% CI 1.03 to 1.34, 4 studies) (test for subgroup differences, p<0.001). However, no significant difference was seen in studies reporting cross-sectional associations (quantiles: RR 1.93, 95% CI 1.64 to 2.27, 8 studies; continuous measure: RR 2.08, 95% CI 1.22 to 3.55, 1 study; test for subgroup difference, p=0.79).

DISCUSSION

This paper reports the first meta-analysis of longitudinal studies of the association between exposure to smoking imagery in movies among young people and the risk of becoming a smoker. The most exposed young people are over 40% more likely to become smokers than the least exposed. Our review also updates the previously reported meta-analysis of cross-sectional studies of this association, which included five studies, [19] and finds a slight reduction in the risk estimate, to just under a two-fold increase. Together these findings

confirm that tobacco imagery in movies significantly increases the risk of smoking. Since evidence from the studies we have analysed and from elsewhere demonstrates that the prevalence of exposure to tobacco imagery in movies among young people is high, our review validates the likelihood that tobacco imagery in films is a major driver of smoking uptake.

Although it is well recognised that young people exposed to movie smoking are more likely to be smokers themselves, the evidence for this association has, until recently, been derived predominantly from cross-sectional surveys, or from different longitudinal studies carried out in the same cohort. Since the former are susceptible to bias by a range of potential confounders, and the latter do not represent truly independent studies, it was therefore important that our analysis separated cross-sectional from longitudinal designs, and included only one study from each of the various cohorts of children in which the association has been studied. That the pooled estimate derived from longitudinal studies was lower than from cross-sectional designs is consistent with the lesser degree of confounding in the former group, but the magnitude of the effect remained strong, confirming its importance in public health terms.

We anticipated that there would be a high level of heterogeneity between the estimates of the studies due to the nature of the study designs, and attempted to model this variation using random effects within the meta-analysis. We also attempted to minimise heterogeneity between studies through extracting effect estimates which had been adjusted for socioeconomic factors in addition to other demographic factors; we were able to achieve this for all studies. We explored reasons for heterogeneity between studies based on country and methodological quality.. There was little variation in the methodological quality of the

included studies, with only two cross-sectional studies deemed as lower quality due to not meeting the criteria for representativeness of the sample [11] or response rate. [16] The two cross-sectional studies with lower quality had marginally larger magnitudes of effect than seen in the higher quality studies; however, due to the likely insufficient power the difference was not statistically significant. Also, there was some evidence that the magnitude of effect amongst studies reporting longitudinal associations varied by country. However, the findings from these subgroup analyses need to be confirmed as they are exploratory in nature. We were unable to perform further analyses to assess whether heterogeneity was due to differences in the populations recruited, for example age of respondents and length of follow-up, as this would require individual participant level data, which was beyond the scope of this systematic review. There was some evidence of publication bias amongst the studies which assessed the longitudinal association between exposure to smoking in movies and smoking initiation; however, the findings from this analysis of publication bias need to be interpreted with caution due to a small number of studies involved [28] and the potential for a false positive result when the odds ratios is used. [29] We performed a thorough search of the literature using a range of electronic databases and screened reference lists of full texts and previous reviews, and did not impose any language restrictions, but the possibility remains that we may have missed a small number of recently published or unpublished eligible studies.

An association between exposure to film smoking and smoking uptake is highly plausible. Tobacco advertising is a recognised driver of smoking uptake [4] and although paid-for advertising is now prohibited in most richer countries, promotion through other means is unlikely to be any less effective. Adult constructs of what represents positive or negative tobacco imagery have previously been reported to have little effect on the strength of

association between exposure and smoking, indicating that young people are influenced by tobacco imagery of any kind. [30] There are also no grounds to believe that imagery depicting tobacco use is any more or less likely to drive behaviour change according to whether the tobacco involved is branded. As with the effect of parental and peer influences on smoking, it is likely that it is the behaviour, rather than the brand, that makes a difference.

The following evidence suggests that exposure to smoking in movies causes smoking initiation: (a) the effect is greater among children whose scores on sensation seeking are relatively low and independent from those of rebelliousness or risk taking [31, 32]; (b) the effect appears to be exposure related [31, 32]; (c) smoking in films is viewed more negatively if films are preceded by anti-tobacco advertising [33, 34]; and (d) parental restrictions on viewing adult-rated films are associated with lower smoking rates [35]. The effect of exposure may also be mediated in part through social pattern involving peer networks [35, 36].

Studies tracking the smoking content in movies over time have indicated that levels are falling, albeit slowly, [37, 38]; however, more recent evidence suggests that there may have been a rebound in 2014 where an increase in tobacco incidents was seen in youth-related movies [39]. Additionally, these trends in content do not necessarily reflect exposure, since young people watch a wide range of movies, both new and old. Television is a significant source of exposure to movie smoking, and movies shown on television include old as well as newer releases. Young people are also exposed to significant smoking imagery in the new media, particularly music videos. Preventing this exposure therefore requires measures that extend beyond controlling the content of movies alone.

There are many means of preventing movie exposure among young people, including default 18 adult age classification of movies containing smoking; requiring movies with smoking content shown on television to be broadcast after peak viewing hours for young people; or defining tobacco content, whether branded or not, as advertising and hence subject to prohibition under advertising legislation, in those countries where tobacco advertising is banned. The example set by India, of requiring anti-smoking messages to be shown before and during films containing smoking and subtitled health warnings to be shown during smoking scenes could also be applied more widely to both reduce the impact of the exposure, and discourage moviemakers from including tobacco content. The latter approaches may also help to reduce the impact of movies watched through online services. Whatever the solution however, the evidence now available indicates that measures to protect young people from such imagery are long overdue.

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FIGURES AND TABLE LEGENDS

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Supplementary material

FIGURES

Figure 1 Flow chart of studies

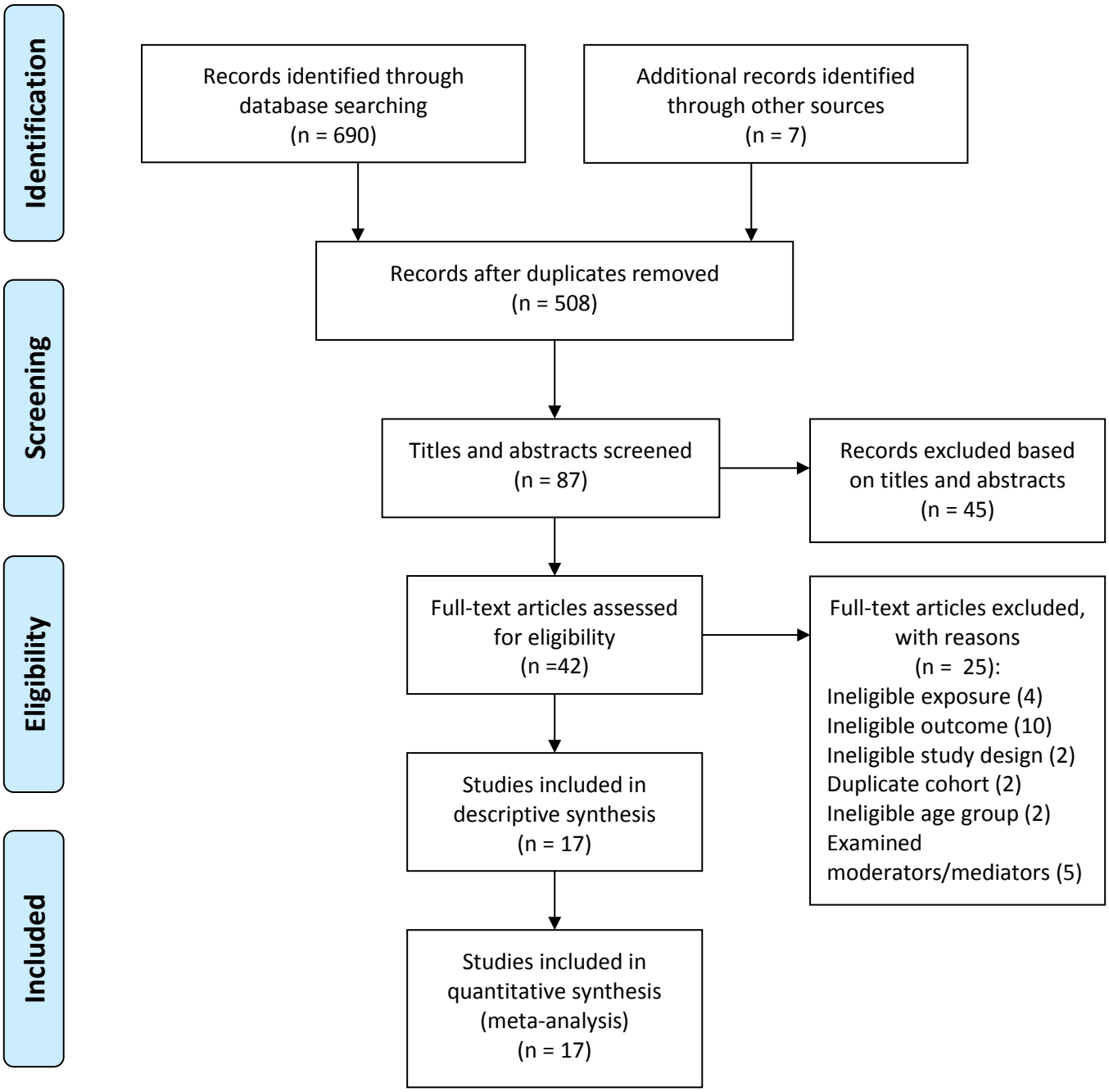


Figure 2 Forest plot of smoking in movies and smoking initiation among adolescents: cross-sectional and longitudinal studies

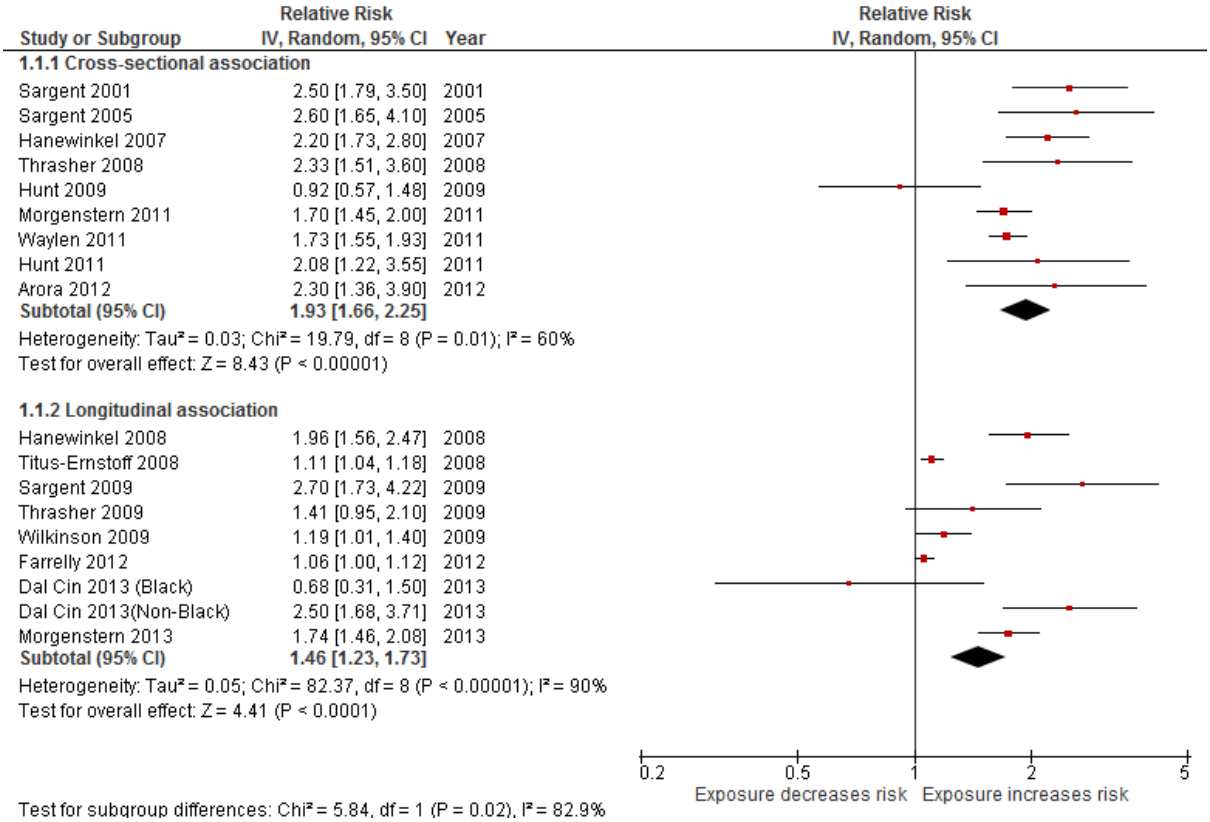
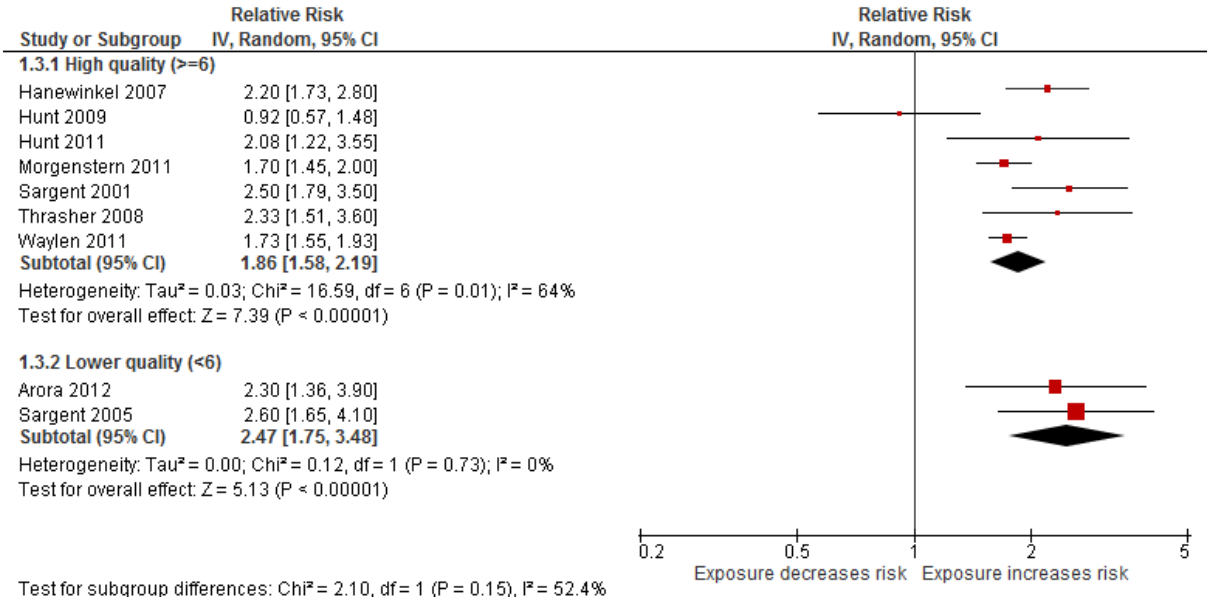


Figure 3 Forest plot of smoking in movies and smoking initiation among adolescents: subgroup analysis based on methodological quality among cross-sectional studies



TABLES

Table 1 Summary of Included Studies

Study (reference)	Country	Sample size, age (years)	Sample of movies, quantiles used in analysis* (dates)	Outcome measures	Outcome data collection period	Length of follow-up (years)	Analysis method	Confounders adjusted for in multivariable analyses
Cross-sectional associations								
Arora 2012	India	3956, 12-16 yrs	59 Bollywood top grossing movies, quantiles: 0-86, 87-144, 145-288, >228 (2006-2008)	Ever tried smoking	2009	N/A	Logistic regression	Age, gender, school, class, receptive to tobacco advertisements, family smoking, friends smoking, social influences, academic performance, sensation seeking, authoritative parenting
Hanewinkel 2007	Germany	5586, 10-17 yrs	50 out of 398 top box office movies, quantiles: ≤167, 168-423, 424-801, ≥802 (1994-2004)	Ever tried smoking	2005	N/A	Logistic regression	Age, sex, parental smoking, sibling smoking, friend smoking, school performance, school, sensation seeking/rebelliousness, television, DVD and video consumption during the week and at the weekend, receptivity to tobacco marketing, parenting style
Hunt 2009	Scotland	948, 19 yrs	50 out of 601 popular contemporary and box office movies, quantiles: 1-139, 140-201, 202-286,	Ever tried smoking	2002-2004	N/A	Logistic regression	Gender, parent social class, parent smoking, risk behaviour, education, peer smoking

			>287 (1998-1999)					
Hunt 2011	Scotland	1999, 15-16 yrs	50 out of 368 top box office movies, quantiles: analysed as continuous measure (2001-2006)	Ever tried smoking	1999	N/A	Logistic regression	Sex, Television/film parenting scale, internet usage supervision, film viewing patterns, housing tenure, parental education, family connectedness, parental monitoring, number of national exams being sat, school leaving plans, peer smoking, views films with friends
Morgenstern 2011	6 European countries	16551, 10-19 yrs	50 out of 250 top box office movies, quantile: definitions not reported (2004-2009)	Ever tried smoking	2009-2010	N/A	Mixed effect logistic regression	Age, sex, family affluence, school performance, television screen time, number of movies seen, sensation seeking, rebelliousness, parental smoking, sibling smoking, friend smoking, country, school, class
Sargent 2001	United States	4919, 9-15 yrs	50 out of 603 box office movies, quantiles: 0-50, 51-100, 101-150, >150 (1988-1999)	Ever tried smoking	1999	N/A	Logistic regression	Age, sex, parents' education, school, friend smoking, sibling smoking, parent smoking, receptivity to tobacco promotions, school performance, propensity to sensation seeking, rebelliousness, authoritative parenting, perception of parent disapproval of smoking
Sargent 2005	United States	6522, 10-14 yrs	50 out of 532 top box office movies, quantiles: <19, 19-45, 46-87, ≥88 (1998-2002)	Ever tried smoking	2003	N/A	Weighted logistic regression	Age, sex, race, parents' education, peer smoking, parent smoking, sibling smoking, school performance, sensation seeking, rebelliousness, self-esteem, parenting style

Thrasher 2008	Mexico	3874, 11-16 yrs	42 out of 165 top grossing movies with at least one minute of smoking content, quantiles: ≤22.83, 22.84-47.92, 47.93-74.13, ≥74.13 minutes of tobacco content (2000-2005)	Ever tried smoking	2006	N/A	Logistic regression	Age, sex, sensation seeking, self-esteem, parental smoking, sibling smoking, best friend smoking, television in bedroom, school, bogus films watched
Waylen 2011	UK	5166, 7-13 yrs	50 out of 306 top box office movies, quantiles: ≤38, 39-68, 69-108, ≥109 (2001-2005)	Ever tried smoking	2006-2007	N/A	Poisson regression	Age, sex, social class, financial difficulties, housing, maternal age, maternal education, marital status, maternal smoking, parity, partner smoking, breast feeding, parental monitoring
Longitudinal associations								
Dal Cin 2013	United States	2341, 13-19 yrs	50 out of 383 Black orientated and mainstream movies, quantiles: analysed as continuous measure (dates not reported)	Initiation of smoking	2007-2009	2 years	Logistic regression	Age, sex, socioeconomic status, conduct disorder symptoms, sensation seeking, peer and sibling smoking, parental responsiveness and monitoring, hours of television per day, presence of television in bedroom
Farrelly 2012	United States	1511, 13-16 yrs	30 top grossing movies selected based on having smoking occurrences, quantiles: analysed as continuous measure (2004-2007)	Initiation of smoking	2005-2008	3 years	Logistic regression	Age, sex, race, residence, school, academic achievement, adults at home after school, employment, income, church attendance, friend smoke tobacco, friend smoke marijuana, exposure to second-hand smoke, presence of smoking ban in household, exposure to tobacco use prevention lessons in school, sensation seeking,

								receptivity to tobacco marketing, parental monitoring of and rules about watching R-rated movies
Hanewinkel 2008	Germany	2711, 10-16 yrs	50 out of 383 box office movies, quantiles: 0-89, 90-279, 280-580, >581 (1994-2004)	Initiation of smoking	2005	1 year	Generalized linear regression	Age, sex, school, parent smoking, sibling smoking, friend smoke, school performance, favourite tobacco advertisement, sensational seeking/rebelliousness, parenting style
Morgenstern 2013	6 European countries	9987, 13-15 yrs	50 box office movies, quantiles: definitions not reported (dates not reported)	Initiation of smoking	2011	1 year	Mixed effect logistic regression	Age, sex, family affluence, school performance, television screen time, sensation seeking, peer smoking, sibling smoking, parental smoking, country, school, class
Sargent 2009	United States	2603, 10-14 yrs	50 out of 601 popular contemporary movies, quantiles: definitions not reported (dates not reported)	Initiation of smoking	1999	1-2 years	Generalized linear regression	Age, sex, school, parents' education, parental smoking, sibling smoking, friend smoking, school performance, sensation seeking, rebelliousness, self-esteem, maternal demandingness, maternal responsiveness, parental disapproval of smoking
Thrasher 2009	Mexico	1741, 11-14 yrs	42 out of 165 top grossing movies with at least one minute of smoking content, quantiles: <17.9, 17.9-39.5, 39.5-64.3, >64.3 minutes of tobacco content (2000-2005)	Initiation of smoking	2006	1 year	Logistic regression	Age, sex, parent smoking, sibling smoking, best friend smoking, parental punishment for smoking, parental authority, own something with tobacco branding, school, self-esteem, sensation seeking, bogus films watched

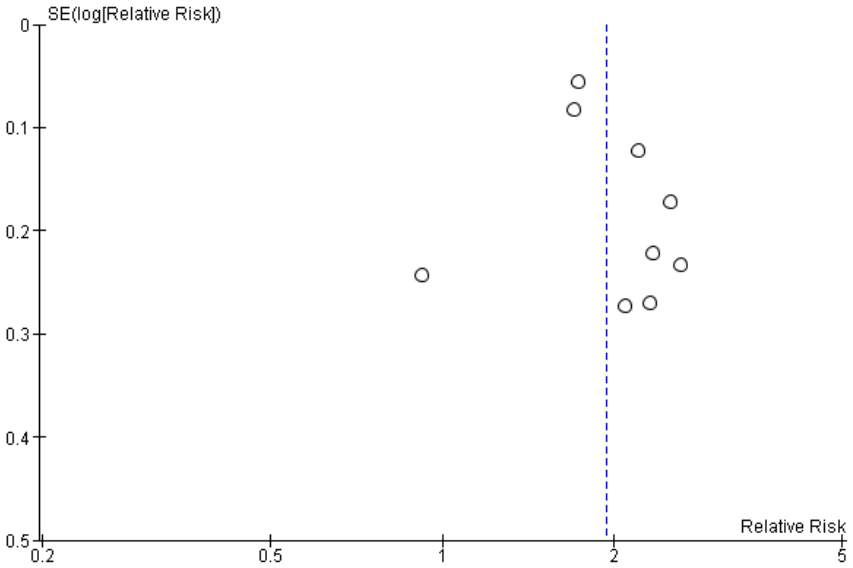
Titus-Ernstoff 2008	United States	2255, 9-12 yrs	50 out of 550 popular contemporary movies, quantiles: analysed as continuous measure (1997-2003)	Initiation of smoking	2002-2003	2 years	Poisson regression	Age, sex, race, school performance, self-esteem, self-regulation, rebelliousness, sensation seeking, parental education, parental smoking, maternal monitoring, maternal responsiveness, friend smoking
Wilkinson 2009	United States	1129, 11-13 yrs	50 out of 250 top box office movies, quantiles: analysed as continuous exposure (1999-2004)	Initiation of smoking	2001	2 years	Logistic regression	Age, sex, friend smoking, risk taking tendencies, detentions at school

* exposure variable was measured as the number of smoking occurrences in movies, unless otherwise specified

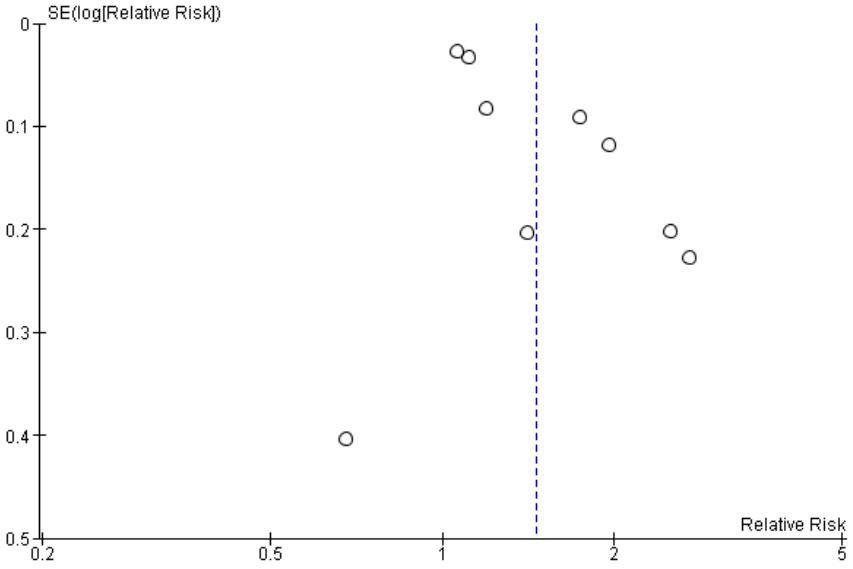
SUPPLEMENTARY MATERIAL

Figure S1: Smoking in movies and smoking initiation among adolescents: funnel plots

a) Cross-sectional studies



b) Longitudinal studies



Supplementary Table S1 Search strategy

1. smok*.mp. or smoking.mp. or exp Smoking/ or tobacco.mp. or exp Tobacco Products/ or exp "Tobacco Use"/ or tobacco.mp. or exp Tobacco/ or nicotine.mp. or nicotine.mp. or exp Nicotine/ or cigarette.mp. or cigar.mp.
2. film*.mp. or film.mp. or exp Motion Pictures as Topic/ or movie*.mp. or "motion picture*".mp. or cinema*.mp.
3. longitudinal.mp. or exp Longitudinal Studies/ or longitudinal.mp. or "cohort stud*".mp. or cohort study.mp. or exp Cohort Studies/ or "cohort analysis".mp. or "follow up stud*".mp. or exp Follow-Up Studies/ or retrospective.mp. or exp Retrospective Studies/ or "cross sectional stud*".mp. or exp Cross-Sectional Studies/
4. 1 and 2 and 3

Supplementary Table S2: PRISMA checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3,4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Table S1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5,6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5,6

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8, Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8,9,Table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9,Tables S3a and S3b
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Fig 2, 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	9,10,Fig 2,3
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9,Figures S1a, S1b
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item	10,Fig 3

		16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11,12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	1

Supplementary Table S3a Methodological quality of the included studies – cross sectional associations

Study (reference)	Selection		Comparability		Ascertainment			
	Case definition	Representativeness of sample	Controlled for SES	Other controlled factors	Ascertainment of exposure	Same method of ascertainment	≥70% response rate	Overall score
Arora 2012	✓	-	✓	✓	-	✓	✓	5
Hanewinkel 2007	✓	✓	✓	✓	-	✓	✓	6
Hunt 2009	✓	✓	✓	✓	-	✓	✓	6
Hunt 2011	✓	✓	✓	✓	-	✓	✓	6
Morgenstern 2011	✓	✓	✓	✓	-	✓	✓	6
Sargent 2001	✓	✓	✓	✓	-	✓	✓	6
Sargent 2005	✓	✓	✓	✓	-	✓	-	5
Thrasher 2008	✓	✓	✓	✓	-	✓	✓	6
Waylen 2011	✓	✓	✓	✓	-	✓	✓	6

Supplementary Table S3b Methodological quality of the included studies – longitudinal associations

Study (reference)	Selection				Comparability		Outcome			Overall score
	Representativeness of exposed cohort	Selection of non-exposed cohort	Ascertainment of exposure	No history of outcome	Controlled for SES	Other controlled factors	Ascertainment of outcome	Length of follow-up	≥70% follow-up	
Dal Cin 2013	✓	✓	-	✓	✓	✓	-	✓	✓	7
Farrelly 2012	✓	✓	-	✓	✓	✓	-	✓	-	6
Hanewinkel 2008	✓	✓	-	✓	✓	✓	-	✓	✓	7
Morgenstern 2013	✓	✓	-	✓	✓	✓	-	✓	✓	7
Sargent 2009	✓	✓	-	✓	✓	✓	-	✓	✓	7
Thrasher 2009	✓	✓	-	✓	✓	✓	-	✓	✓	7
Titus-Ernstoff 2008	✓	✓	-	✓	✓	✓	-	✓	✓	7
Wilkinson 2009	✓	✓	-	✓	✓	✓	-	✓	✓	7