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Effectiveness of school-based smoking prevention curricula: systematic review and meta-analysis

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Key words: tobacco, adolescents, prevention, randomised controlled trials, systematic review and meta-analysis

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Abstract

Objective: Assess effectiveness of school-based smoking prevention curricula keeping children never-smokers.

Design: Systematic review, meta-analysis. Data: Medline (1966+), Embase (1974+), Cinahl, PsycINFO (1967+), ERIC (1982+), Cochrane CENTRAL, Health Star, Dissertation Abstracts, conference proceedings. Data synthesis: Pooled analyses, fixed-effects models, adjusted odds ratios. Risk of bias assessed with Cochrane Risk of Bias tool.

Setting: All randomised controlled trials (RCTs) of school-based smoking curricula; never-smokers age 5-18; follow-up ≥ 6 months, all countries, no date/language limitations.

Participants: 57 RCTs included of which 50 (n=143,495) provided analysable data on baseline/follow-up never-smokers.

Interventions: Information, social influences, social competence, combined social influences/competence, and multi-modal.

Outcome measure: Remaining a never-smoker at follow-ups.

Results: Pooling all curricula, trials with follow-up ≤ one year showed no statistically significant differences compared to controls [OR 0.91 (0.82, 1.01)], though trials of combined social competence/ social influences curricula had a significant effect on smoking prevention [7 trials, OR 0.59 (95% CI 0.41, 0.85)].

Pooling all trials with longest follow-up showed an overall significant effect in favour of the curricula [OR 0.88 (0.82, 0.95)], as did the social competence [OR 0.65 (0.43, 0.96)]

and combined social competence/social influences curricula [OR 0.60 (0.43 to 0.83)]. No effect for information, social influences or multi-modal curricula.

Principal findings were not sensitive to inclusion of booster sessions in curricula or whether peer- or adult-led. Differentiation into tobacco-only or multifocal curricula had a similar effect on the primary findings. Few trials assessed outcomes by gender: there were significant effects for females at both follow-up periods, but not for males.

Conclusions: RCTs of baseline never-smokers at longest follow-up found an overall significant effect with average 12% reduction in starting smoking compared to controls, but no effect for all trials pooled at ≤ one year. However, combined social competence/social influences curricula showed a significant effect at both follow-up periods.

Systematic review registration: Cochrane Tobacco Review Group CD001293

Strengths

- comprehensive searches were conducted in multiple electronic databases, grey literature and reference lists with no limitations of date or language, and experts were consulted. It is unlikely that key trials were missed
- use of baseline never-smoker intention-to-treat cohorts. We either derived cohorts of baseline never-smokers from trial articles or asked authors to provide such cohorts with new data runs. Using smoking outcomes from cohorts of baseline never-smokers provides the clearest indication of whether smoking prevention curricula are effective

- we included 50 trials with 143,495 baseline never-smokers. Statistical heterogeneity between these trials was low, and sensitivity analyses which assessed the effects of removing studies at unclear or higher risk of bias did not change the conclusions.

Limitations

- several trials did not provide data on baseline never-smokers, some trials did not provide analysable data, and the complexity of some curricula mad them difficult to classify.
- We were not able to obtain baseline never-smoker data for 15 trials which reported data as changes in smoking behaviour over time, and 65 trials which provided only point prevalence of smoking data.
- From the original 256 eligible trials we were unable to include 57 trials because authors did not provide analysable data on basic facts such as smoking outcomes or key elements of trial design (e.g., n's in intervention and control groups) either in the article or by e-mail correspondence.
- A further seven trials were excluded because there was no comparison to a control group or there were concerns over the data that were not resolved by e-mail correspondence.
- Six trials used unique curricula that could neither be included in the pre-specified five basic curricula types, nor grouped together into a sixth group.

- The pre-specified selection criteria were trials that compared a curriculum to a control group and we did not compare head-to-head the limited number of trials that compared curricula.
- It is possible in some trials that "never smokers" could include some quitters, although most authors checked for inconsistencies in statements on baseline and follow-up questionnaires.
- Further bias could have been introduced by certain assumptions made by the review authors in data extraction, and subsequent statistical analysis. However, the consistency of results and low heterogeneity in the comparison suggest a consistent effect.

Introduction

Tobacco use is the main preventable cause of death and disease worldwide and a global average of 50% of young males and 10% of young females start smoking.[1] It is estimated that smoking will kill about one billion people in the 21st Century.[1] Mortality among smokers is 2-3 times higher than never-smokers and causes a loss of 10 years of life.[1]

In the US it has been estimated that of those children who were 17 or younger in 1995 five million would die prematurely of tobacco-related causes, and that 20% of deaths could be avoided if smokers had either never started or had quit.[2] In 2007 in the US 20 per cent of high school students reported smoking in the last 30 days[3] and in the UK the prevalence figures report a smoking rate of 6 percent within the 11-15 age group.[4] Starting smoking usually leads to the behaviour lasting decades, with great difficulty in

quitting. Villanti [5] identified five types of smoking behaviour as adolescents become young adults: non-smokers, early stable smokers, late starters, quitters, and 'light or intermittent smokers.'

Over the past three decades the school environment has been a particular focus of efforts to influence youth smoking behaviour. The main perceived advantages are that almost all children can be reached through schools and a focus on tobacco education fits naturally within their daily activities. Researchers have used five types of curriculum in schools, each based on a different theoretical orientation: information only curricula, social competence curricula, social influence curricula, combined social competence/social influences curricula, and multimodal curricula.[6] (Table 1).

Social competence curricula help adolescents refuse offers to smoke by improving their general social competence and personal and social skills. Adolescents are taught a combination of skills to improve problem solving, decision-making, self-control, self-esteem, assertiveness and strategies to cope with stress, and to resist general personal or media influences.[6]

Social influence curricula focus specifically on teaching adolescents skills for awareness of social influences that encourage substance use, and to resist tobacco offers, peer pressure and high risk situations which might persuade an adolescent directly or indirectly to smoke. Some studies have tested teaching skills to resist multiple problem behaviours such as drinking and drug use as well as tobacco.[6]

Multimodal curricula can be broad-ranging, including tobacco prevention curricula in schools, the community, with parents and community members, school or state policies to change tobacco sales, increase taxes, and prevent sales to minors.[6]

The first edition of this Cochrane review was published in 2002, included 96 studies, and was narrative without any meta-analyses. The second edition incorporated meta-analyses for RCTs with relevant information for smoking prevention, but the largest comparison only contained 13 studies.

Authors often include data for never-smokers, triers, quitters, occasional, regular and heavy smokers in their baseline and follow-up data. Some use the term current “non-smokers” and include never-smokers, triers, experimenters and quitters. It is thus not possible to determine the effect of curricula on each of these groups, and if some groups increased and others decreased their smoking the effect of the curricula could be completely obscured. Thus we identified cohorts of never-smokers from articles or asked authors to provide new data sets for never-smokers. (A separate Cochrane review has assessed interventions to reduce smoking in current smokers).

We were thus able to pre-specify the ideal outcome to give the best estimate of the prevention effect and were able to extract more evidence from existing and new studies without changing the curricula classification in the review Protocol. However, six new studies did not fit any of the theoretical approaches in the Protocol and we added them as a separate heterogeneous group.

In 2013 the second edition was updated and radically refined: we re-assessed the theoretical orientation of each study and all included trials were re-categorised and data completely re-extracted and re-analysed to ensure they were correct. The new analysis used baseline never-smoking cohorts, which provide the clearest indication of whether curricula are more effective than no curricula in preventing smoking. We either recomputed these never-smoking cohorts ourselves from the articles or asked authors

to provide new data runs. The primary objective of this review is to assess the effectiveness of school-based curricula versus no curriculum in preventing never-smoking children and adolescents from starting smoking. A second objective is to assess which curricula types are the most effective.

Methods

Search strategy and trial selection:

We searched the Cochrane Central Register of Controlled Trials (CENTRAL), the Cochrane Tobacco Addiction Group's Specialized Register, MEDLINE, EMBASE, PsyclNFO, ERIC, CINAHL, Health Star, and Dissertation Abstracts for terms relating to school-based smoking cessation programmes from inception to January 2014, with no date or language restrictions (see online supplementary material). We checked article bibliographies and ran individual MEDLINE searches for 133 authors who had undertaken research in this area. We searched for all trials evaluating school-based curricula to prevent smoking. There was no restriction on the theoretical orientation of the curricula providing they aimed to prevent tobacco use. Students aged 5 – 18 years during the intervention phase of the trial were included both as individuals in randomised control trials (RCTs) and as classes, schools, or school districts in cluster randomised control trials (C-RCTs). Trials were excluded if there was no control group. Control groups included no curriculum, usual practice or an active non-relevant control, for example homework study group. We required a minimum follow-up of 6 months after completion of the curricula. We did not require biochemical validation of self-reported tobacco use, but recorded its use. We excluded trials that did not assess baseline

smoking status or reported only smoking attitudes and knowledge.

Two reviewers (RET, JM) independently assessed all titles, abstracts and full text articles for trials that met the inclusion criteria. Any disagreements were resolved by consensus or referral to third person (RP).

Data extraction and study classification:

Data were independently extracted into RevMan[7] by two reviewers (RET, JM) for each included study using a form piloted first in a small subset of trials. Any disagreements were resolved by consensus or referral to the third author (RP). We extracted data for all included trials on design and focus, country and site of school(s), participants (age, gender, and ethnicity), curriculum duration and follow-up, curriculum deliverer, a brief overview of the curriculum, and details of the control group. Two authors (RET, JM) classified curricula according to their dominant theoretical orientation: information only, social competence, social skills, combined social competence/social skills or multi-modal. An independent reviewer commented on this classification and as a result a small number of trials using strategies which did not fit into these broad types were grouped separately (Table 1). Accuracy of category classification between the authors and the independent reviewer was tested using a KAPPA statistic.

We extracted data for never smokers at baseline and follow-up for curricula and control groups. If authors included in the category of 'non-smoker' both never smokers and those not currently smoking we classified non-smokers with previous smoking experience as smokers for this review.

We used the Cochrane risk of bias tool[8] to assess whether trials were at low, high or unclear risk of selection bias (random sequence generation and allocation

concealment), detection bias, attrition bias and reporting bias.

If data were missing, or in a format not analysable, we contacted the authors to request the data, new data runs or clarification. We did not impute missing data.

Data analysis:

We extracted data as absolute numbers or odds ratios, where possible, based on loss of never smokers from baseline to follow-up. In some instances if data were available, but only the total number of schools or classes was known and not the numbers allocated to each arm, then the number of schools or classes was estimated based on the proportion of individuals within the group. Where the authors used a denominator which did not include all the participants originally randomised (e.g., a sample which the author described as the 'analysis sample,' which excluded drop-outs and thus had smaller numbers at follow-up) we recomputed the data based on the same percentage loss to never smokers using the numbers originally randomised. We calculated adjusted odds ratios based on the number of never-smokers at specific time points. Adjustment was made for clustering by school/group based on estimated intraclass correlation coefficients (0.097) and cluster sizes to determine design effects for each of the curricula groups. We then used this design effect to determine the effective sample size for each curricula group.

Our analysis used a fixed effects meta-analysis using the generalised inverse variance method. Only trials for which never-smoking outcome data could be extracted were included in the analysis. Trial data were excluded if the publication or author could not provide data or it was incomplete for either the curricula or control groups for baseline or follow-up, where the number of cluster sizes could not be extracted or estimated, where

the data were in an unusable format or where the data were judged to be unreliable or contradictory. The included data were pooled to obtain estimates for an overall effect, with subgroups based on curriculum used. Trials in the 'other curricula' group were sufficiently different from each other that, although they were presented within the meta-analysis for the entire group, it would be inappropriate to combine them as a distinct group by curriculum within the Results and Discussion sections. If a trial compared more than one curriculum arm then the control group was split equally between the arms for both outcome events and sample size. We used the I^2 statistic to assess inconsistency across trials and provide a measure of heterogeneity.[9]

A priori we identified attrition and selection as the two most relevant sources of bias. We conducted sensitivity analyses to compare the overall result of trials with low risk of attrition and selection bias to all trials to see whether the quality of the trials had any impact on the overall results. Risk of publication bias was assessed by a visual inspection of a funnel plot.

We further conducted sub-analyses based on gender, peer-led (or substantially peer-led) versus adult-led trials, trials with a tobacco only focus (tobacco-only) versus multifocal curricula, and curricula that had subsequent booster sessions versus those with none. Though not pre-specified, we subsequently explored whether it was relevant to complete a sub-analysis by age (age 11 and under vs. over 11).

Results

We identified 256 potential RCTs or C-RCTs. Of these 135 C-RCTs and one RCT provided a total of 202 different curricula arms with 431,315 participants providing data

(figure 1). Trials were categorised by curricula type; the robustness of this classification was confirmed as very good when the agreement between authors and an independent reviewer was tested (KAPPA 0.98).

Fifty-seven of the 136 trials followed never smoking cohorts and of these 50 C-RCTs (74 different intervention arms, n = 143,495) provided analysable data for this review (Figure 1).

Characteristics of included studies:

Table 2 provides a summary of the baseline characteristics of included studies. The control groups in the 50 trials were varied. In 22 (44%) the group receiving the curriculum was compared head-to-head with a control group which received "usual practice," in 12 trials the control group received no alternative curricula, 9 did not state whether the control group received an alternative curricula, one provided no alternative curriculum in the control group in 6 schools and "usual practice" in the control group in 4 schools, two provided only information, one a curriculum to help students complete schoolwork, one offered a talk by a physician on either tobacco or alcohol, one posted 4 booklets to the control group, one asked students to produce a newspaper and one helped students with reading skills. Of the 50 trials 47 were in individual countries and three in multiple countries (total 60 country arms): 26 trials were the USA, four each from the UK, Netherlands and Germany, three from Spain and Italy, two each from Australia, Canada and China and the remainder singularly from South Africa, Thailand and across Europe (Denmark, Finland, Portugal, Austria, Belgium, Greece, Sweden and the Czech Republic).

Principal findings:

(See online supplementary material for raw data)

All curricula types versus control, with follow-up one year or less (26 trials, 41 curriculum arms, Figure 2)

There was no overall effect for all curricula with follow-up of one year or less (odds ratio (OR) 0.91, 95% confidence interval (CI) 0.82 to 1.01; I^2 = 19%). The I^2 statistic for subgroup differences across all curricula was 45.9%, but within each curriculum type heterogeneity was minimal, except for multimodal (I^2 = 51%). The combined social competence/social influences curricula (seven C-RCTs/eight arms) showed a statistically significant effect in preventing the onset of smoking at one year or less(OR 0.59, CI 0.41 to 0.85; I^2 = 0%). However, for the social influences curricula (16 RCTs/25 arms, the multi-modal curricula (three RCTs/five arms) and one small trial,[36] which tested an information only curriculum, the results were non-significant. There was no RCT testing a social competence curriculum versus control with a follow-up duration of one year or less.

All curricula types versus control, with longest follow up (50 trials, 74 curriculum arms, Figure 3)

Fifteen trials (twenty five arms) provided data for analysis at follow-up of one year or less and for longest follow-up (34% of trials). Of the remaining trials 86% had a follow-up between 1-5 years, 10% between 5-10 years and 4% over 10 years.

There was a significant effect favouring all curricula compared to control for the longest follow-up periods (OR 0.88, 95%, CI 0.82 to 0.95; I^2 = 12%), with a mean risk reduction of 12%. Heterogeneity was low (0-12%), except for the multimodal curricula trials (I^2 = 64%). There were 10 trials (15 arms) that provided separate data both for analysis at

one year or less and for the analysis at longest follow-up. Restricting the analysis to these trials alone showed the same overall effects as the primary findings; no overall effect at one year or less follow-up and a statistically significant effect at longest follow-up.

By individual curricula social competence curricula (five C-RCTs/seven arms) compared to control showed a statistically significant result in favour of the curricula (OR 0.65, CI 0.43 to 0.96; I^2 = 0%) and also the combined social competence/social influences (nine C-RCTs/eleven arms) compared to control (OR 0.60, CI 0.43 to 0.83; I^2 = 0%). There were no statistically significant differences for the one information only curriculum, or the social influences or multi-modal curricula. Four trials (six arms) were classified as 'other curricula' and contributed to the overall results, but not to the individual curricula types.[17, 32, 38, 39]

Sensitivity analysis:

(See online supplementary material for sensitivity analyses).

Sensitivity analyses restricted to trials at low risk of attrition bias with follow-up one year or less (n=9) found no differences compared to all trials in terms of point estimates, though trials testing combined social competence/social influences curricula no longer demonstrated a significant effect when studies at unclear or high risk of bias were removed (OR 0.55, CI 0.28 to 1.09). At longest follow-up, analyses restricted to low risk of attrition bias (n=20) were similar to pooled results from all trials, except the confidence interval was wider and hence included the line of no effect for trials at low risk of bias (OR 0.90, CI 0.80 to 1.03) compared to all trials (OR 0.88, CI 0.82 to 0.95).

- Furthermore, at one year or less follow-up duration, sensitivity analysis restricted to trials at low risk of selection bias (n=12) showed no difference from the principal findings; though similarly trials of combined social competence and social influences curricula no longer showed a significant result (OR 0.55, CI 0.28 to 1.10). However, at longest follow-up analyses showed sensitivity to selection bias. For all trials classified as low risk of selection bias the overall effect was no longer significant (OR 0.92, CI 0.83 to 1.01). By curricula type both social competence and combined social competence and social influences were no longer significant and the group of multi-modal trials now favoured the control groups (OR 1.26, CI 0.78, 2.04). Full details of the risk of bias assessments can be found in the Cochrane review.[61] We were not able to obtain baseline never-smoker data for 15 trials which reported data as changes in smoking behaviour over time, and 65 trials which provided only point prevalence of smoking data (reported in the Cochrane review.[61])

Publication bias: A funnel plot of all included studies did not suggest publication bias.

Sub group analyses:

(See online supplementary material for sub group analyses).

Gender: At one year for the limited number of trials which presented data by gender, there was a statistically significant effect for females (five trials, seven arms, OR 0.68, CI 0.50 to 0.93; $I^2 = 0\%$) and no significant effect for males (four trials, six arms, OR 0.76, CI 0.53 to 1.10; $I^2 = 51\%$). The largest effect was found in one trial[25] which tested a multi-modal curriculum in males (OR 0.32, CI 0.16 to 0.65). At longest follow-up the results were similar; statistically significant differences were found for females (seven

trials, nine arms, OR 0.80, CI 0.66 to 0.97) whereas results were not statistically significant for males (six trials, eight arms, OR 0.93, CI 0.76 to 1.15).

Adult- vs. peer-led: For adult-led curricula with follow-up ≤ one year (21 trials, 30 arms) there were no significant effects except for combined social competence/social influences curricula which were more effective than controls (OR 0.58, CI 0.40 to 0.85; $I^2 = 0\%$). For the peer-led curricula (six trials, eight arms) compared to controls there was no overall effect, though it should be noted that social influences curricula were only tested with a single trial[14] which offered a combined social competence/ social influences curriculum.

In contrast, at longest follow-up there were significant overall effects for adult-led curricula (42 trials, 57 arms) compared to the control groups (OR 0.87, CI 0.81 to 0.94; $I^2 = 23\%$), and significant effects for two of the four curricula tested: social competence (five trials, seven arms, OR 0.62, CI 0.40 to 0.96; $I^2 = 0\%$) and combined social competence/social influences (seven trials, eight arms, OR 0.58, CI 0.42 to 0.82; $I^2 = 0\%$), but not for social influences or multi-modal curricula. For peer-led programmes (8 trials, 11 arms) compared to controls there were no statistically significant differences overall, nor for the three curricula tested (social influences, combined social competence/social influences and multi-modal). Four trials which compared peer-led and adult-led curricula to controls were not included, either because it was not clear who delivered the programme[22, 49] or because it was delivered online.[18, 45]

Tobacco only vs. multi-focal curricula: Multi-focal curricula showed no overall effect compared to control either at one year or at longest follow-up. Multi-focal social competence curriculum (five trials, seven arms, OR 0.65, CI 0.43 to 0.96; $I^2 = 0\%$) and

multi-focal combined social competence/influences (five trials, six arms, OR 0.53, CI 0.34 to 0.83; I^2 = 0%) both showed a significant effect at longest follow-up. Curricula focused on only tobacco compared to control (16 trials, 27 arms) showed no effect for follow-up ≤ one year (OR 0.93, CI 0.83 to 1.04; I^2 = 31%), but there was an effect at longest follow-up (28 trials, 43 arms, OR 0.89, CI 0.81 to 0.97; I^2 = 24%). None of the other three curricula (social influences, combined social competence/social influences, and multi-modal) found significant differences at follow-up of either ≤ one year or longest follow-up.

Adding booster sessions after the main curriculum: Curricula without booster sessions showed no significant effect at follow up ≤ one year (24 trials, 37 arms) compared to controls (OR 0.92, CI 0.83 to 1.02; I^2 = 21%), but did at longest follow-up (45 trials, 67 arms, OR 0.90, CI 0.83 to 0.96; I^2 = 10%). Similarly, for all curricula with booster sessions there were no significant differences from controls at one year or less (three trials, four arms, OR 0.70, CI 0.40 to 1.07; I^2 = 0%), but at longest follow-up (six trials, seven arms) there was a significant difference (OR 0.73, CI 0.55 to 0.97; I^2 = 21%). The combined social competence/social influences curricula, with booster sessions, had a positive effect at one year or less (OR 0.50, CI 0.26 to 0.96; I^2 = 0%) and also at longest follow-up (OR 0.56, CI 0.33 to 0.96; I^2 = 0%), but for only for two[15, 16] and three trials[15, 16, 51] respectively.

Age: An exploratory scatter plot of all trials of age versus odd ratios showed no trend and no sub-analysis was completed by age.

Discussion

Cluster-randomised controlled trials with follow-up of a year or less demonstrated no overall significant effect, and the only individual curricula types within this group which showed positive results were the combined social competence/social influences curricula. The pooled results of the trials of all curricula at longest follow-up showed a positive effect in preventing starting smoking (OR 0.88, 95% CI 0.82 to 0.95). This represents an average reduction of 12% and suggests that the effect is more evident when assessed over a longer time period. There have been no studies to identify why curricula with longer periods of follow-up are more effective.

The only individual curricula types at longest follow-up that showed a statistically significant result were social competence and combined social competence/social influence curricula.

A significant finding of this review is that over 60% of trials use social influences curricula, but these were not effective. Social influences curricula are widely used worldwide. 43% of included trials in this review were based in the USA; here the DARE (Drug Abuse Resistance Education) program, which is a social influences curriculum, is used in 75% of school districts.[60] Few studies reported results by gender. For curricula presented by adults there were significant overall effects at longest follow-up and also for social competence and combined social competence/social influences curricula.

The focus of the curricula, tobacco prevention only or multifocal, did not appear to make a difference. Pooled estimates at either one year or less or at longest follow-up showed estimates of a similar size. For curricula with booster sessions there was a significant

effect only for combined social competence/social influences curricula with follow-up of one year or less and at longest follow-up.

Results in the context of other reviews

This is the most systematic and comprehensive review of these curricula to date. Other reviews have considered large numbers of trials, but none have exclusively used randomised control trials or examined pure prevention cohorts of never-smokers. There are only three reviews published in the past five years which could be expected to be up-to-date with the most recent studies and potentially comparable. However, none of them focused on assessing the effectiveness of curricula in schools to prevent smoking. Ramo in 2012[62] assessed the co-use of tobacco and marijuana, Lisha in 2010[63] assessed athletic participation and tobacco and drug use and Griffin in 2010[64] described two frequently used school curricula (Life Skills Training and Project Toward No Drug Abuse) and reviewed family and community-based programmes. Griffin provided no outcome data but concluded: “The most effective programs are highly interactive in nature, skills-focused, and implemented over multiple years.” Earlier reviews are now out of date.[65-73]

A separate Cochrane review assessed interventions to help adolescent smokers quit.[74]

Summary

This review found that for baseline child and adolescent never-smokers there was no effect of school based smoking prevention curricula with a follow-up of one year or less, but a 12% reduction in the onset of smoking when assessed over a longer period of follow-up. When individual curricula are considered, only social competence and combined social competence/social influences studies are effective. One interpretation

why social competence curricula are effective may be that students see these as helpful to their personal development and social skills as they provide general personal and social competence, problem solving, decision-making, assertiveness and cognitive skills to resist interpersonal or media influences, coping strategies for stress, and how to increase self-control and self-esteem. There is no explanation why information-only, social influences (60% of all curricula used) and multi-modal curricula are not effective because no focus groups, surveys or design workshops have asked for student evaluations of their experiences with these curricula. It is possible that students perceive information curricula as lectures by adults about substance abuse.

Our review indicates that curricula delivered by adults are more effective. Adding boosters to trials with follow-up of one or less showed no significant effect, but did at longest follow-up. Trial designers and policymakers should consider tailoring future studies to explore the various aspects of the social competence curricula with adult presenters and no booster sessions.

This review has highlighted that there are still gaps in our knowledge with regard to smoking prevention curricula. Further research is required to test curricula that would be effective for both genders. We noted that over 50% of trials were from North America and that there were limited trials exploring curricula for different ethnic groups. This would suggest that our results may reflect and be more applicable to developed countries rather than developing countries. A limited number of trials used the internet to deliver curricula; future trials should incorporate the cultural world of adolescents (internet. media, music and teen idols). Future research needs to tailor study design to address these areas. Methodologically, the next steps in research are to standardise

the trial design, definitions of smoking status and the content of curricula so that more studies examine pure baseline never-smokers. Standardisation of key study design features could enable more reliable research into curricula intensity and duration (optimum number, length and frequency of sessions). Researchers should seek to utilise checklists that improve the quality of reporting[75] and increase the potential impact of study findings. There is minimal information on the costs of developing and implementing these programmes and this is important as many programmes have not proven to be effective. Policy makers need to implement only curricula with proven effectiveness, and fund research projects which meet the above standardisation criteria.

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The Lead and Corresponding Author affirms that the manuscript is an honest, accurate and transparent account of the review being reported.

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Figure 1: Flow diagram chart to show screening process

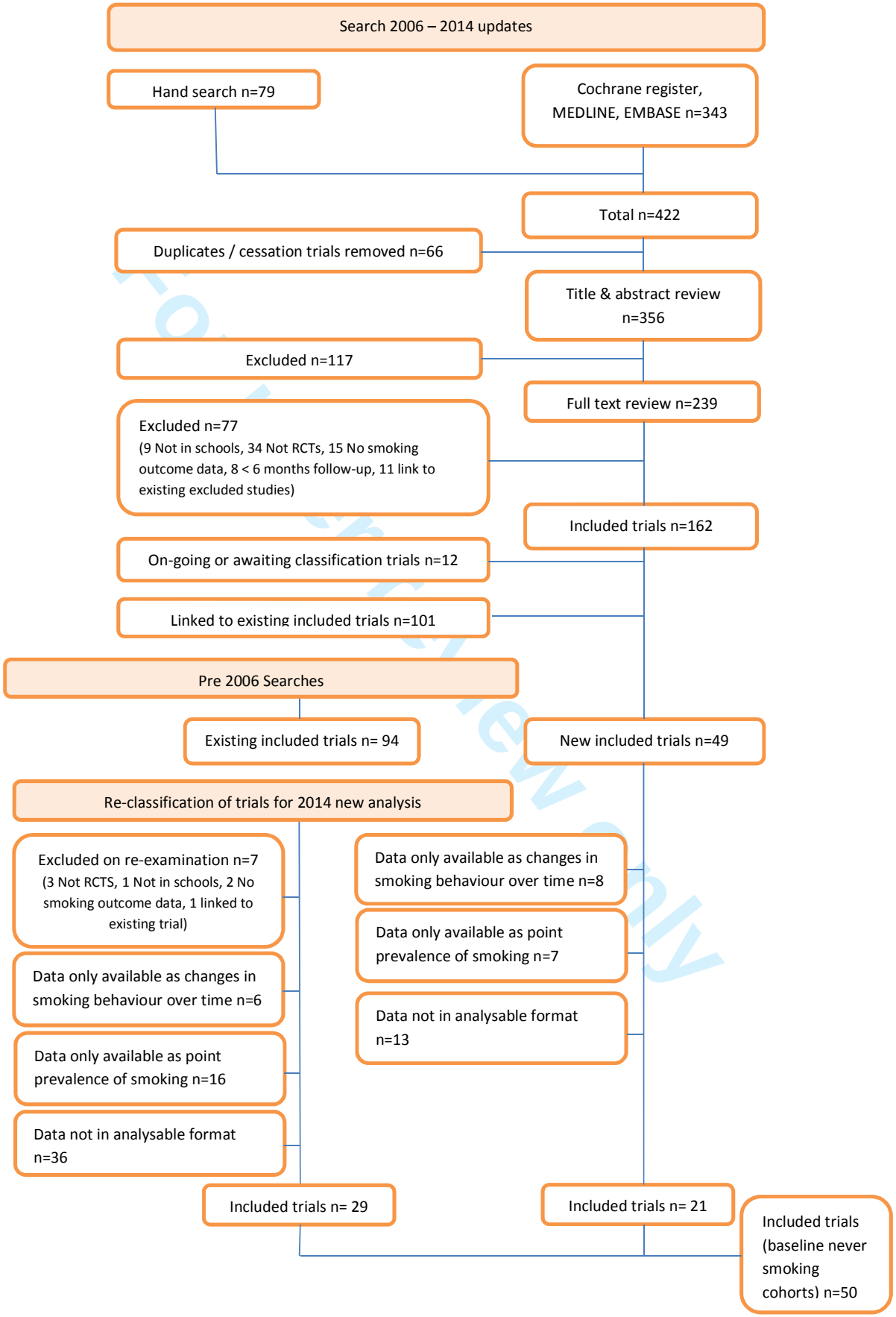
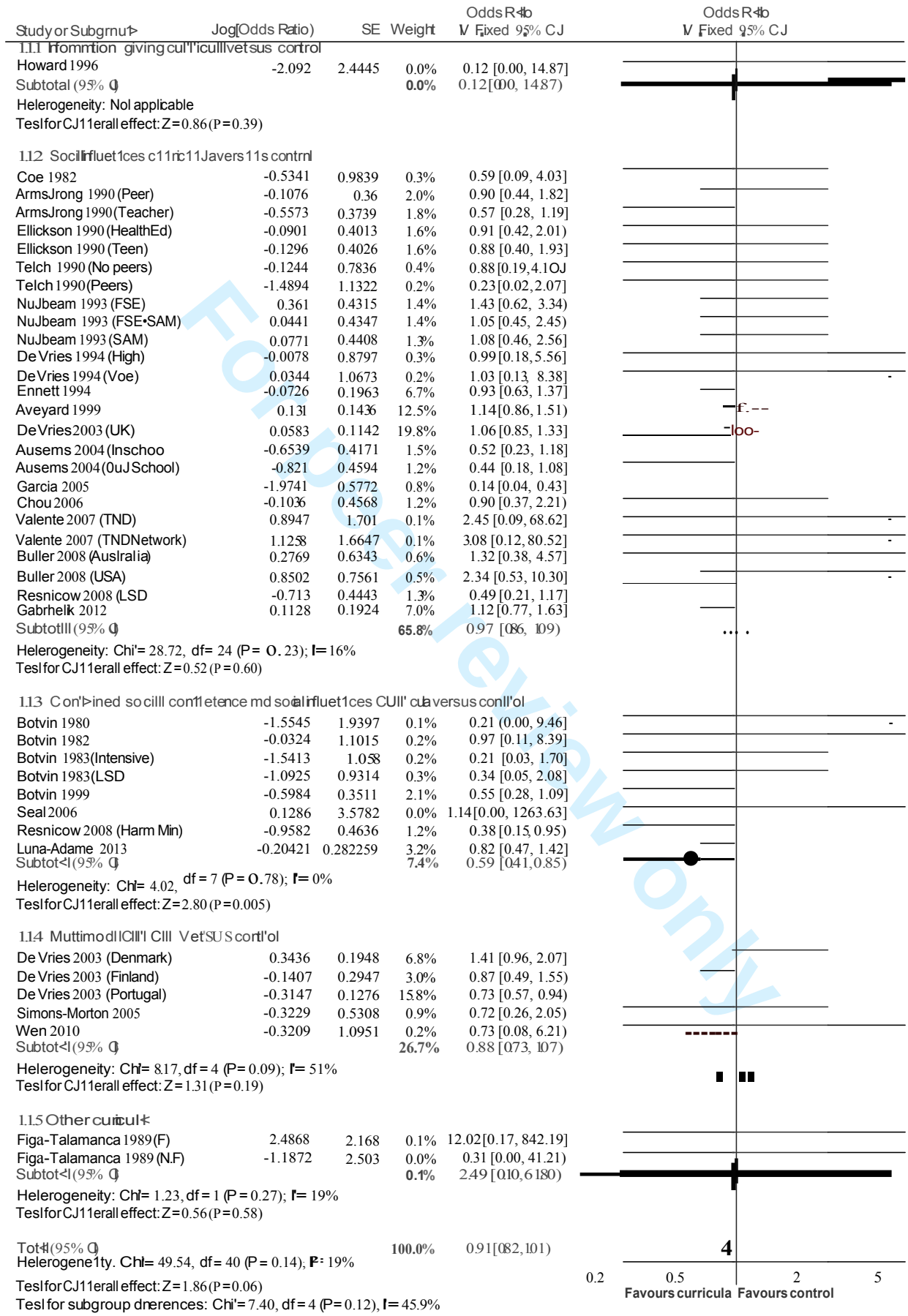


Figure 2: Forest plot showing results for all curricula versus control (one year or less follow-up)



Footnote5

(1)Where the figure entered is 0, there is no absolute numbers only an odds ratio for the effect

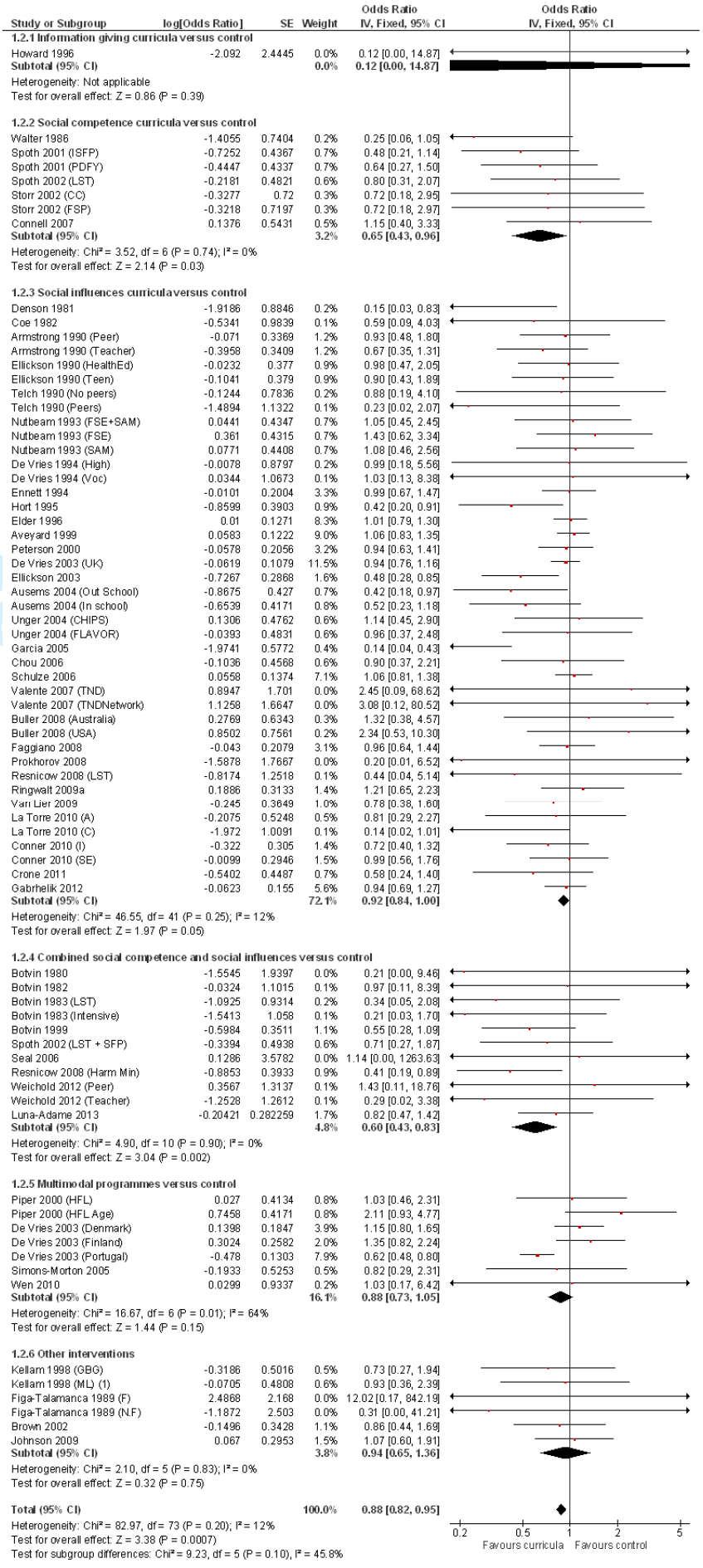


Figure 3: Forest plot showing results for all curricula versus control (longest follow-up)

Table 1: Types of curricula in schools to prevent smoking[6]

Information only curricula
Interventions that provide information to correct inaccurate perceptions regarding the prevalence of tobacco use and oppose inaccurate beliefs that smoking is social acceptable
Social competence curricula
Interventions that help adolescents refuse offers to smoke by improving their general social competence and personal and social skills. Interventions teach problem solving, decision-making, cognitive skills to resist personal or media influences, increase self-control and self-esteem, coping strategies for stress, and assertiveness skills.
Social influence curricula
Interventions that endeavour to overcome social influences to use tobacco by teaching adolescents to be aware of social influences that encourage substance use, teach skills to resist offers of tobacco, and deal with peer pressure and high risk situations which might persuade an adolescent directly or indirectly to smoke.
Combined social competence and social influences curricula
Multi-modal curricula
Programmes in schools, and the community, involving parents and community members, initiatives to change school or state policies about tobacco sales, and taxes, and prevent sales to minors.
Other
School anti-smoking policies, motivations to smoke, classroom good behaviour

Table 2: Baseline characteristics of included studies

Study name	Alternative name (if applicable)	Study design	Average age (yrs)	Gender % female	Curriculum intensity (sessions)	Curriculum duration (months, unless otherwise stated)	Curriculum deliverer	Control group type	Ethnicity (dominant)	Country
Armstrong 1990 (Peer)[10]		C-RCT	12	49	5	6	Peers	No curriculum	NS	Australia
Armstrong 1990 (Teacher)[10]		C-RCT	12	49	5	6	Teachers	No curriculum	NS	Australia
Ausems 2004 (In school)[11]		C-RCT	13	52	3x 50 mins	NS	Teachers	NS	NS	Netherlands
Ausems 2004 (Out School)[11]		C-RCT	13	52	NS	NS	Teachers	NS	NS	Netherlands
Aveyard 1999[12]		C-RCT	13.5	50	6 x 1 hour	12	Teachers	Usual practice	86% White	UK
Botvin 1980[13]		C-RCT	13.5	NS	10	3	Outside specialists	No curriculum	White	USA
Botvin 1982[14]		C-RCT	12.5	NS	12 x 1 hour	3	Peers	No curriculum	90%+ White	USA
Botvin 1983 (LST intensive)[15]		C-RCT	12.5	NS	15	1	Teachers	Usual practice	91% White	USA
Botvin 1983 (LST)[15]		C-RCT	12.5	NS	15	3.5	Teachers	Usual practice	91% White	USA
Botvin 1999[16]		C-RCT	11.5	100	15 + 10 boosters	NS	Teachers	10 sessions of information only, plus 3 boosters	60% African American	USA
Brown 2002[17]		C-RCT	13.5	50	NS	NS	Students and teachers	Usual practice	NS	Canada
Buller 2008 (Australia)[18]	Consider This	C-RCT	11 to 14	52	6 x 1 hour	6	Web-based	Usual practice	73% Australian/European	Australia
Buller 2008 (USA)[18]	Consider This	C-RCT	11 to 13	52	6 x 1 hour	6	Web-based	Usual practice	56% White	USA
Chou 2006[19]		C-RCT	12.5	48	13 x 45 mins	3	Health educators (USA)	Usual practice	NS	China

Coe 1982[20]		C-RCT	12.5	NS	8	NS	Medical students	No curriculum	88%+ White	USA
Connell 2007[21]	Adolescent Tranistions Program	C-RCT	11	47	6	2	Parent consultants	NS	42% White	USA
Conner 2010 (I)[22]		C-RCT	11.5	50	NS	24	NS	Information and homework intentions	NS	UK
Crone 2011[23]		C-RCT	10 to 12	53	6 x 1 hour	24	Teachers	Usual practice	NS	Netherlands
De Vries 1994 (High)[24]		C-RCT	12.5	NS	5 x 45 mins	NS	Peers and teachers	NS	NS	Netherlands
De Vries 2003 (Denmark)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	6 x 1 hour	NS	Teachers	Usual practice	European	Denmark
De Vries 2003 (Finland)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	5 x 45 mins	NS	Teachers	Usual practice	European	Finland
De Vries 2003 (Portugal)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	6	NS	Teachers	Usual practice	European	Portugal
De Vries 2003 (UK)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	50 x 30 mins	NS	Teachers	Usual practice	European	UK
Denson 1981[26]		C-RCT	12 to 14	NS	3	24	Researcher	No curriculum	NS	Canada
Elder 1996[27]	CATCH	C-RCT	10.5	51	4 x 50 mins	NS	Teachers	No curriculum	71% White	USA
Ellickson 1990 (HealthEd)[28]	ALERT	C-RCT	13.5	48	8 + 3 booster	2	Community adults	No curriculum or Usual practice	67% White	USA
Ellickson 1990 (Teen)[28]	ALERT	C-RCT	13.5	48	8 + 3 booster	2	Students	No curriculum or Usual practice	67% White	USA
Ellickson 2003[29]	ALERT	C-RCT	12.5	50	7 + 3	NS	Teachers	Usual practice	NS	USA
Ennett 1994[30]	DARE	C-RCT	10.5	49	17 x 1 hour	4	Uniformed police officer	NS	54% White	USA
Faggiano 2008[31]	Unplugged	C-RCT	12 to 14	48	12 x 1 hour	3	Teachers	Usual practice	NS	Austria, Belgium, Germany, Greece, Italy, Spain, Sweden
Figa-Talamanca 1989[32]		C-RCT	15 to 17	47	3	3 (days)	Health educators	No curriculum	NS	Italy

Gabrhelik 2012[33]	Unplugged	C-RCT	11	50	12 x 45 mins	12	Teachers	Usual practice	Czech	Czech republic
Garcia 2005[34]	ALERT	C-RCT	13	47	8 x 1 hour	NS	Teachers	Usual practice	NS	Spain
Hort 1995[35]		C-RCT	13	38	4 x 1-2 hour + 15 x 1 hour	24	Physicians and teachers	Physician talk on smoking if requested	NS	Germany
Howard 1996[36]		C-RCT	10	46	5 x 40 mins	NS	Teachers	NS	NS	USA
Johnson 2009[37]	Acadiana Coalition of Teens against Tobacco	C-RCT	15	51	NS	30	Teachers	NS	61% White	USA
Kellam 1998 (GBG)[38]	Good Behaviour Game	C-RCT	5.5	50	3 x per week x 10 mins	24	Teachers	Usual practice	70% African American	USA
La Torre 2010 (Adolescents)[39]		C-RCT	14	52	NS	NS	Teachers	NS	NS	Italy
Luna-Adame 2013[40]		C-RCT	11	51	21 x 1 hour in year 1, 12 x 1 hour in second year	24	Psychology students	Usual practice	NS	Spain
Nutbeam 1993 (FSE)[41]		C-RCT	11.5	43	3	NS	Teachers	No curriculum	NS	UK
Peterson 2000[42]	Hutchinson Smoking Prevention Project	C-RCT	7 to 9	49	65	NS	Teachers	Usual practice	90% Caucasian	USA
Piper 2000 (HFL Age)[43]	Healthy for Life Project	C-RCT	14.5	52	58 (in 3 x 4 week periods)	36	Community adults	Usual practice	92%+ White	USA
Piper 2000 (HFL)[43]	Healthy for Life Project	C-RCT	14.5	52	54	12	Community adults	Usual practice	92%+ White	USA
Prokhorov 2008[44]	A Smoking Prevention Interactive Experience	C-RCT	16	59	5 x 30 mins + 2 boosters	NS	Computer	Usual practice	51% Hispanic	USA
Resnicow 2008 (Harm Min)[45]	Keep Left	C-RCT	14	50	8	24	Teachers	Usual practice	60% Black	South Africa
Resnicow 2008 (LST)[45]	Life Skills Training	C-RCT	14	50	8	24	Teachers	Usual practice	60% Black	South Africa
Ringwalt 2009a[46]	ALERT	C-RCT	11	52	11 x 45 mins + 3 boosters	24	Teachers	No curriculum	53% White	USA
Schulze 2006[47]	Be smart – don't start	C-RCT	12	50	NS	NS	Teachers	No curriculum	NS	Germany
Seal 2006[48]		C-RCT	15.5	11	10 x 1 hour	NS	NS	Usual practice	Thai	Thailand
Simons-Morton 2005[49]	Going Places	C-RCT	11	57	18	36	Teachers	NS	72% White	USA

Spoth 2001 (ISFP)[50]	Iowa Strengthening Families Program	C-RCT	11	55	7	1 (day)	Project staff	4 mailed booklets on changes in adolescents	NS	USA
Spoth 2001 PDFY)[50]	Preparing for the Drug Free Years Program	C-RCT	11	55	5	NS	Project staff	4 mailed booklets on changes in adolescents	NS	USA
Spoth 2002 (LST + SFP)[51]	SFP 10	C-RCT	12.5	45	7 x 1 hour + 4 boosters	1 (day) + boosters 1 yr later	Project staff & teachers	NS	95%+ Caucasian	USA
Spoth 2002 (LST)[51]	SFP 10	C-RCT	12.5	45	15 x 45 mins	NS	Project staff & teachers	NS	95%+ Caucasian	USA
Storr 2002 [52]		C-RCT	5.7	47	NS	NS	Teachers	Usual practice	86% African American	USA
Telch 1990 (No peers)[53]		C-RCT	12	47	5	0.75	Teachers	No curriculum	24% White	USA
Telch 1990 (Peers)[53]		C-RCT	12	47	5	0.75	Peers	No curriculum	24% White	USA
Unger 2004 (CHIPS)[54]	Choosing Healthy Influences for a Positive Self	C-RCT	11	54	NS	NS	Health educators	Usual practice	61% Hispanic	USA
Unger 2004 (FLAVOR)[54]	Fun Learning About Vitality, Origins and Respect	C-RCT	11	54	NS	NS	Health educators	Usual practice	58% Hispanic	USA
Valente 2007 [55]	Project Towards No Drug Abuse	C-RCT	16	38	12	3-4 weeks	Peers	Usual practice	72% Hispanic/Latino	USA
Van Lier 2009[56]	Good Behaviour Game	C-RCT	7	48	3 x per week x 10 mins	NS	Teachers	No curriculum	69% Dutch descent	Netherlands
Walter 1986[57]	Know your Body	C-RCT	9	47	2 per week	12	Teachers	Information	84% White	USA
Weichold 2011 (Peer)[58]	Life Skills Training	C-RCT	11	44	10 x 90mins, five x 45 mins + boosters	NS	Peers	Produced student newspaper	German	Germany
Weichold 2012 (Teacher)[58]	Life Skills Training	C-RCT	11	44	10 x 90mins, five x 45 mins + boosters	NS	Teachers	Produced student newspaper	German	Germany

Wen 2010[59]		C-RCT	13	46	NS	18	School nurses and health educators	Usual practice	NS	China

NS not stated; C-RCT cluster randomised control trial

Table 3: Data for included studies

Study name	Curriculum type	Smoking prevention group			Control group			OR	Follow-up post curriculum period (yrs)	ln(OR)	SE(lnOR)
		Number lost to baseline never-smokers	Number of never-smokers at baseline	Number of clusters (schools unless stated)	Number lost to baseline never-smokers	Number of never-smokers at baseline	Number of clusters (schools unless stated)				
Armstrong 1990 (Peer)[10]	SI	96	331	15	106	339	15		1	-0.107638	0.3600305
Armstrong 1990 (Peer) [10]	SI	132	331	15	70.5	169.5	7.5		2	-0.0709958	0.3369252
Armstrong 1990 (Teacher)[10]	SI	74	358	15	106	339	15		1	-0.5573098	0.3738808
Armstrong 1990 (Teacher)[10]	SI	116	358	15	70.5	169.5	7.5		2	-0.3958404	0.3408929
Ausems 2004 (In school) [11]	SI			9			9 baseline/7@1 yr	0.52 (adj)	1	-0.6539265	0.4171404
Ausems 2004 (Out School) [11]	SI			8 baseline/6@1 yr			9 baseline/8@1 yr	0.44 (adj)	1	-0.8209806	0.4594327
Ausems 2004 (Out school) [11]	SI			7 baseline/5@18 mths			8 baseline/7 @18 mths	0.42 (adj)	1.5	-0.8675006	0.4270348
Aveyard 1999[12]	SI			27			26	1.14 (unadj)	1	0.1310283	0.1436052
Aveyard 1999[12]	SI			27			26	1.06 (unadj)	2	0.0582689	0.1221937
Botvin 1980[13]	C	3	79	1	17	108	1		0.5	-1.5544749	1.9397012
Botvin 1982[14]	C	26	120	1	32	144	1		1	-0.0324353	1.1015238
Botvin 1983 (LST intensive)[15]	C	13	170	2	70	251	3		1	-1.5412947	1.0579649
Botvin 1983 (LST) [12]	C	31	270	2	70	251	3		1	-1.0924746	0.9313686
Botvin 1999[16]	C	144	1263	29 total	173	912	29 total		1	-0.5983711	0.3510914

Brown 2002[17]	Other	176	1313	15	183	1201	15		2	-0.1495555	0.3428201
Buller 2008 (Australia)[18]	SI	34	608	13	26	605	12		0.5	0.2769371	1.9529914
Buller 2008 (USA)[18]	SI	41	616	10	11	372	11		0.5	0.8501847	3.144401
Chou 2006[19]	SI	142	862	7	175	975	7		1	-0.1035984	0.4568406
Coe 1982[20]	SI	8	66	2	16	84	2		1	-0.5340825	0.9838762
Connell 2007[21]	SC	95	196	3	100	222	3		11	0.1376072	1.7139036
Conner 2010 (I)[22]	SI	65	297	15	104	373	19		2	-0.3220296	0.8436332
Conner 2010 (SE)[22]	SI	82	257	13	115	358	18		2	-0.0099374	1.1149246
Crone 2011[23]	SI	25	1311	62	33	1022	59		1.6	-0.5402293	1.693079
De Vries 1994 (High)[24]	SI	26	317	5	19	230	3		1	-0.0078076	0.8797456
De Vries 1994 (Voc) 18	SI	9	109	3	6	75	3		1	0.0344014	1.0672853
De Vries 2003 (Denmark)[25]	MM			30		30	1.41	1	0.3435897	0.1947775	
De Vries 2003 (Denmark)[25]	MM			30			30	1.15 (adj)	2.5	0.1397619	0.1846732
De Vries 2003 (Finland)[25]	MM	185	756	13	248	913	14		1	-0.1406751	0.2947061
De Vries 2003 (Finland)[25]	MM	404	756	13	419	913	14		2.5	0.3024483	0.2582134
De Vries 2003 (Portugal)[25]	MM			14			11	0.73 (adj)	1	-0.3147107	0.1276131
De Vries 2003 (Portugal)[25]	MM			14			11	0.62 (adj)	2.5	-0.4780358	0.1303127
De Vries 2003 (UK)[25]	SI			22			21	1.06 (adj)	1	0.0582689	0.1142086
De Vries 2003 (UK)[25]	SI			22			21	0.94 (adj)	2.5	-0.0618754	0.1078716
Denson 1981[26]	SI	8	256	6	49	272	6		2	-1.9186357	0.8845767
Elder 1996[27]	SI			56			40	1.01 (adj)	3	0.0099503	0.1270629
Ellickson 1990 (HealthEd)[8]	SI	506	2099	10	561	2175	10		1	-0.0900877	0.4013297
Ellickson 1990 (HealthEd)[25]	SI	642	2099	10	338	1087.5	5		1.25	-0.0231861	0.3770386
Ellickson 1990 (Teen)[25]	SI	527	2253	10	561	2175	10		1	-	0.4025698

										0.1296114	
Ellickson 1990 (Teen) [25]	SI	651	2253	10	338	1087.5	5		1.25	-0.1041381	0.3789543
Ellickson 2003[29]	SI	152	1765	34	191	1171	21		1.5	-0.7266914	0.2867711
Ennett 1994[30]	SI			18			18	0.93 (adj)	1	-0.0725707	0.1963062
Ennett 1994[25]	SI			18			18	0.99 (adj)	2	-0.0101	0.2004
Faggiano 2008[31]	SI	245	2939	78	242	2791	65		1.5	-0.0430055	0.2079089
Figa-Talamanca 1989 (F) [32]	Other	10	99	8	1	108	8		1	2.4867776	2.1680235
Figa-Talamanca 1989 (N.F)[32]	Other	0	88	8	1	108	8		1	-1.1871657	2.5029619
Gabrhelik 2012[33]	SI	160	917	40	125	787	34		1	0.1127624	0.1923887
Gabrhelik 2012[33]	SI	262	917	40	235	787	34		2	-0.0623282	0.1549634
Garcia 2005[34]	SI	7	147	6	18	68	4		1	-1.974081	0.5771636
Hort 1995[35]	SI	50	268	9	84	239	10		2	-0.8598637	0.3903232
Howard 1996[36]	I	0	51	3 classes	3	47	3 classes		1	-2.0920028	2.4444723
Johnson 2009[37]	Other	381	891	10	459	1116	10		4	0.0670225	0.9489217
Kellam 1998 (GBG)[38]	Other	92	348	6	299	904	6		8	-0.318604	1.6092447
Kellam 1998 (ML)[38]	Other	111	352	7	299	904	6		8	-0.0704818	2.1260203
La Torre 2010 (A)[39]	SI	22	135	8	23	119	7		2	-0.2074914	0.5248481
La Torre 2010 (C)[39]	SI	3	197	11	24	240	13		2	-1.9720213	1.0091488
Luna-Adame 2013[40]											
Nutbeam 1993 (FSE) [41]	SI	362	848	10	325	951	10		1	0.3610075	0.4314552
Nutbeam 1993 (FSE+SAM)[41]	SI	325	924	10	325	951	10		1	0.0441355	0.4347184
Nutbeam 1993 (SAM) [41]	SI	263	732	9	325	951	10		1	0.0771232	0.4408302
Peterson 2000[42]	SI	1466	3684	20	1547	3756	20		12	-0.0578459	0.2056236
Piper 2000 (HFL Age) [43]	MM	385	614	7	159.5	359.5	4		4	0.7457948	1.8398178
Piper 2000 (HFL) [43]	MM	254	564	7	159.5	359.5	4		4	0.0270354	1.3200046

Prokhorov 2008[44]	SI	2	380	9	8	317	8		1.5	-1.5878473	1.7666892
Resnicow 2008 (Harm Min)[45]	C	126	1392	12	226	1097	12		1	-0.9582287	1.4920681
Resnicow 2008 (Harm Min)[45]	C	206	1392	12	162.5	548.5	6		2	-0.885306	1.2651318
Resnicow 2008 (LST)[45]	SI	182	1161	12	226	1097	12		1	-0.333418	1.8545257
Resnicow 2008 (LST)[45]	SI	182	1161	12	162.5	548.5	6		2	-0.8173656	1.7267247
Ringwalt 2009a[46]	SI	368	2335	17	332	2475	17		3	0.1886451	0.313302
Schulze 2006[47]	SI	838	1205	89	596	872	83		1.5	0.0558165	0.1373784
Seal 2006[48]	C	0	52	1	1	59	1		0.5	0.1286174	3.5782467
Simons-Morton 2005[49]	MM	333	1249	3	361	1080	4		1	-0.3228905	1.7611763
Simons-Morton 2005[49]	MM	357	1249	3	353	1080	4		3	-0.1932719	1.7427068
Spoth 2001 (ISFP)[50]	SC	46	141	11	71	142	11		4	-0.7252355	0.4366601
Spoth 2001 PDFY)[50]	SC	50	128	11	71	142	11		4	-0.4446858	0.4337062
Spoth 2002 (LST + SFP)[51]	C	48	385	12	34	204	6		1.5	-0.339444	2.0131701
Spoth 2002 (LST)[51]	SC	64	462	12	68	408	12		1.5	-0.218131	1.4412661
Storr 2002 (CC)[52]	SC	60	230	3	72	219	3		6	-0.3276874	3.8178342
Storr 2002 (FSP)[52]	SC	60	229	3	72	219	3		6	-0.3217877	4.3865296
Telch 1990 (No peers)[53]	SI	14	115	4	27	199	7		0.5	-0.1244056	3.1351432
Telch 1990 (Peers)[53]	SI	4	117	4	27	199	7		0.5	-1.4894358	3.3083324
Unger 2004 (CHIPS)[54]	SI	201	847	8	115.5	538.5	4		1.5	0.1306071	2.1308778
Unger 2004 (FLAVOR)[54]	SI	194	933	8	115.5	538.5	4		1.5	-0.0393381	1.5680161
Valente 2007 (TND)[55]	SI	3	106	22	1	85	28		1	0.8947001	4.3797964
Valente 2007 (TNDNetwork)[55]	SI	4	113	25	1	85	28		1	1.1257633	4.7853811
Van Lier 2009[56]	SI	52	349	16	51	279	15		4	-0.2449684	1.6766025
Walter 1986[57]	SC	16	447	8	61	464	7		6	-1.4054567	0.7404415

Weichold 2011 (Peer)[58]	SI & SC	5	9	1	3.5	7.5	0.5		2	0.3566749	4.1210228
Weichold 2012 (Teacher)[58]	SI & SC	9	45	3	3.5	7.5	0.5		2	-1.252763	3.3219209
Wen 2010[59]	MM	92	1162	2	89	840	2		1	-0.3208561	6.1266491
Wen 2010	MM	77	571	2	59	449	2		2	0.0298792	3.0828153

I Information; SI social influences; SC social competence; MM multi-modal; OR odds ratio; Ln(OR) natural log odds ratio; SE(lnOR) standard error of the natural log odds ratio; yrs years;

What is already known on this topic

- Tobacco is main preventable cause of death and disease worldwide.
- There has been over three decades of research on prevention of child and adolescent smoking in school environment.
- Smoking prevention curricula have been explored in various observational studies and randomised control trials with a variety of outcome measures.
- There has been no consensus on effectiveness of smoking prevention curricula in cohorts of baseline never smokers, furthermore, there has been no consensus on the most effective type of curricula.

What this study adds

- This review and meta-analysis provides evidence from 50 randomised control trials with 143,495 participants who provided data for baseline never smokers.
- There were significant effects for trials that used combined social competence and social influences curricula at all-time points, and social competence curricula at longest follow-up.
- There were no overall significant effects for social influence curricula (although they comprised more than 60% of the trials).
- This review highlights the need for future studies to explore curricula targeted at different genders and ethnic groups, plus studies incorporating internet and media technologies. Further research should aim to standardise study design and outcome measures. Minimal information is available on the cost effectiveness of curricula.

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Effectiveness of school-based smoking prevention curricula: systematic review and meta-analysis

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Effectiveness of school-based smoking prevention curricula: systematic review and meta-analysis

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ABSTRACT

Objective: Assess effectiveness of school-based smoking prevention curricula keeping children never-smokers.

Design: Systematic review, meta-analysis. Data: Medline (1966+), Embase (1974+), Cinahl, PsycINFO (1967+), ERIC (1982+), Cochrane CENTRAL, Health Star, Dissertation Abstracts, conference proceedings. Data synthesis: Pooled analyses, fixed-effects models, adjusted odds ratios. Risk of bias assessed with Cochrane Risk of Bias tool.

Setting: 57 randomised controlled trials (RCTs) of school-based smoking curricula.

Participants: Never-smokers age 5-18 (n=143,495); follow-up ≥ 6 months; all countries; no date/language limitations.

Interventions: Information, social influences, social competence, combined social influences/competence, and multi-modal curricula.

Outcome measure: Remaining a never-smoker at follow-ups.

Results: Pooling all curricula, trials with follow-up ≤ one year showed no statistically significant differences compared to controls [OR 0.91 (0.82, 1.01)], though trials of combined social competence/ social influences curricula had a significant effect on smoking prevention [7 trials, OR 0.59 (95% CI 0.41, 0.85)].

Pooling all trials with longest follow-up showed an overall significant effect in favour of the interventions [OR 0.88 (0.82, 0.95)], as did the social competence [OR 0.65 (0.43, 0.96)] and combined social competence/social influences curricula [OR 0.60 (0.43 to 0.83)]. No effect for information, social influences or multi-modal curricula.

Principal findings were not sensitive to inclusion of booster sessions in curricula or

whether peer- or adult-led. Differentiation into tobacco-only or multifocal curricula had a similar effect on the primary findings. Few trials assessed outcomes by gender: there were significant effects for females at both follow-up periods, but not for males.

Conclusions: RCTS of baseline never-smokers at longest follow-up found an overall significant effect with average 12% reduction in starting smoking compared to controls, but no effect for all trials pooled at ≤ one year. However, combined social competence/social influences curricula showed a significant effect at both follow-up periods.

Systematic review registration: Cochrane Tobacco Review Group CD001293

Strengths and limitations of this study

- This review and meta-analysis provides evidence from 50 randomised control trials with 143,495 participants. Comprehensive searches with no limits on data and language mean that it is unlikely trials were missed.
- Using smoking outcomes from cohorts of baseline never smokers provides the clearest indication of whether smoking prevention curricula are effective.
- Statistical heterogeneity between the trials was low and results were consistent after various sensitivity analyses.
- Not all trials reported outcomes based on cohorts of baseline never smokers and though authors were contacted it is possible that the data may be incomplete.
- The complexity and reporting of some curricula can make them difficult to classify and therefore the classification of curricula may not be completely accurate.

INTRODUCTION

Tobacco use is the main preventable cause of death and disease worldwide and a global average of 50% of young males and 10% of young females start smoking.[1] It is estimated that smoking will kill about one billion people in the 21st Century.[1] Mortality among smokers is 2-3 times higher than never-smokers and causes a loss of 10 years of life.[1]

In the US it has been estimated that of those children who were 17 or younger in 1995 five million would die prematurely of tobacco-related causes, and that 20% of deaths could be avoided if smokers had either never started or had quit.[2] In 2007 in the US 20 per cent of high school students reported smoking in the last 30 days[3] and in the UK the prevalence figures report a smoking rate of 6 percent within the 11-15 age group.[4] Starting smoking usually leads to the behaviour lasting decades, with great difficulty in quitting. Villanti [5] identified five types of smoking behaviour as adolescents become young adults: non-smokers, early stable smokers, late starters, quitters, and 'light or intermittent smokers.'

Over the past three decades the school environment has been a particular focus of efforts to influence youth smoking behaviour. The main perceived advantages are that almost all children can be reached through schools and a focus on tobacco education fits naturally within their daily activities. Researchers have used five types of curriculum in schools, each based on a different theoretical orientation: information only curricula, social competence curricula, social influence curricula, combined social competence/social influences curricula, and multimodal curricula.[6] (Table 1).

Table 1: Types of curricula in schools to prevent smoking

Information only curricula Interventions that provide information to correct inaccurate perceptions regarding the prevalence of tobacco use and oppose inaccurate beliefs that smoking is social acceptable
Social competence curricula Interventions that help adolescents refuse offers to smoke by improving their general social competence and personal and social skills. Interventions teach problem solving, decision-making, cognitive skills to resist personal or media influences, increase self-control and self-esteem, coping strategies for stress, and assertiveness skills.
Social influence curricula Interventions that endeavour to overcome social influences to use tobacco by teaching adolescents to be aware of social influences that encourage substance use, teach skills to resist offers of tobacco, and deal with peer pressure and high risk situations which might persuade an adolescent directly or indirectly to smoke.
Combined social competence and social influences curricula
Multi-modal curricula

Programmes in schools, and the community, involving parents and community members, initiatives to change school or state policies about tobacco sales, and taxes, and prevent sales to minors.
Other
School anti-smoking policies, motivations to smoke, classroom good behaviour

Social competence interventions help adolescents refuse offers to smoke by improving their general social competence and personal and social skills. Adolescents are taught a combination of skills to improve problem solving, decision-making, self-control, self-esteem, assertiveness and strategies to cope with stress, and to resist general personal or media influences.

Social influence interventions focus specifically on teaching adolescents skills for awareness of social influences that encourage substance use, and to resist tobacco offers, peer pressure and high risk situations which might persuade an adolescent directly or indirectly to smoke. Some studies have tested teaching skills to resist multiple problem behaviours such as drinking and drug use as well as tobacco. Multimodal interventions can be broad-ranging, including tobacco prevention interventions in schools, the community, with parents and community members, school or state policies to change tobacco sales, increase taxes, and prevent sales to minors.

The first edition of this Cochrane review was published in 2002, included 96 studies, and was narrative without any meta-analyses. The second edition incorporated meta-analyses for RCTs with relevant information for smoking prevention, but the largest

comparison only contained 13 studies. Authors often include data for never-smokers, triers, quitters, occasional, regular and heavy smokers in their baseline and follow-up data. Some use the term current “non-smokers” and include never-smokers, triers, experimenters and quitters. It is thus not possible to determine the effect of smoking prevention curricula interventions on each of these groups, and if some groups increased and others decreased their smoking the effect of the curricula could be completely obscured. We were thus able to pre-specify the ideal outcome to give the best estimate of the prevention effect would be baseline never-smoking cohorts and were then able to extract more evidence from existing and new studies without changing the curricula classification in the review protocol.

Hence, in 2013 the second edition was updated and radically refined: we checked the theoretical orientation of each trial and all included trials were re-categorised, data completely re-extracted and re-analysed based on baseline never-smoking cohorts. .

The primary objective of this review is to assess the effectiveness of school-based curricula versus no curricula in preventing never-smoking children and adolescents from starting smoking. Effectiveness is the appropriate term as researchers tested interventions in real schools, but did not always control for adherence or attendance. A second objective is to assess which curricula types are the most effective.

METHODS

Search strategy and trial selection

We searched the Cochrane Central Register of Controlled Trials (CENTRAL), the Cochrane Tobacco Addiction Group’s Specialized Register, MEDLINE, EMBASE, PsyclNFO, ERIC, CINAHL, Health Star, and Dissertation Abstracts for terms relating to

school-based smoking cessation programmes from inception to January 2014, with no date or language restrictions (see online supplementary material A). We checked article bibliographies and ran individual MEDLINE searches for 133 authors who had undertaken research in this area. We searched for all trials evaluating school-based curricula to prevent smoking. There was no restriction on the theoretical orientation of the curricula providing they aimed to prevent tobacco use. Students aged 5 – 18 years during the intervention phase of the trial were included both as individuals in randomised control trials (RCTs) and as classes, schools, or school districts in cluster randomised control trials (C-RCTs). Trials were excluded if there was no control group. Control groups included no curricula, usual practice or an active non-relevant control, for example homework study group. We required a minimum follow-up of 6 months after completion of the curricula. We did not require biochemical validation of self-reported tobacco use, but recorded its use. We excluded trials that did not assess baseline smoking status or reported only smoking attitudes and knowledge.

Two reviewers (RET, JM) independently assessed all titles, abstracts and full text articles for trials that met the inclusion criteria. Any disagreements were resolved by consensus or referral to third person (RP).

Data extraction and study classification

Data were independently extracted into RevMan[7] by two reviewers (RET, JM) for each included study using a form piloted first in a small subset of trials. Any disagreements were resolved by consensus or referral to the third author (RP). We extracted data for all included trials on design and focus, country and site of school(s), participants (age, gender, and ethnicity), curriculum duration and follow-up, curriculum deliverer, a brief

overview of the curriculum, and details of the control group. Two authors (RET, JM) classified curricula according to their dominant theoretical orientation: information only, social competence, social skills, combined social competence/social skills or multi-modal. An independent reviewer commented on this classification and as a result a small number of trials using strategies which did not fit into these broad types were grouped separately (Table 1). Accuracy of category classification between the authors and the independent reviewer was tested using a KAPPA statistic.

We extracted data for never smokers at baseline and follow-up for curricula and control groups. If authors included in the category of 'non-smoker' both never smokers and those not currently smoking we classified non-smokers with previous smoking experience as smokers for this review.

We used the Cochrane risk of bias tool[8] to assess whether trials were at low, high or unclear risk of selection bias (random sequence generation and allocation concealment), detection bias, attrition bias and reporting bias.

If data were missing, or in a format not analysable, we contacted the authors to request the data, new data runs or clarification. We did not impute missing data.

Data analysis

We extracted data as absolute numbers or odds ratios, where possible, based on loss of never smokers from baseline to follow-up i.e. those children that started smoking. In some instances if data were available, but only the total number of schools or classes was known and not the numbers allocated to each arm, then the number of schools or classes was estimated based on the proportion of individuals within the group. Where the authors used a denominator which did not include all the participants originally

randomised (e.g., a sample which the author described as the 'analysis sample,' which excluded drop-outs and thus had smaller numbers at follow-up) we recomputed the data based on the same percentage loss to never smokers using the numbers originally randomised. We calculated adjusted odds ratios based on the number of never-smokers at specific time points. Adjustment was made for clustering by school/group based on estimated intraclass correlation coefficients (0.097) and cluster sizes to determine design effects for each of the curricula groups. We then used this design effect to determine the effective sample size for each curricula group.

Our analysis used a fixed effects meta-analysis using the generalised inverse variance method. Only trials for which never-smoking outcome data could be extracted were included in the analysis. Trial data were excluded if the publication or author could not provide data or it was incomplete for either the curricula or control groups for baseline or follow-up, where the number of cluster sizes could not be extracted or estimated, where the data were in an unusable format or where the data were judged to be unreliable or contradictory. The included data were pooled to obtain estimates for an overall effect, with subgroups based on curriculum used. Trials in the 'other curricula' group were sufficiently different from each other that, although they were presented within the meta-analysis for the entire group, it would be inappropriate to combine them as a distinct group by curriculum within the Results and Discussion sections. If a trial compared more than one curriculum arm then the control group was split equally between the arms for both outcome events and sample size. We used the I^2 statistic to assess inconsistency across trials and provide a measure of heterogeneity.[9]

Our analysis examined the curricula versus the control groups at two defined times of

follow-up: one year or less and longest follow-up. In the latter, we used one set of data at the longest follow–up point for each study, meaning that some data sets appeared in both analyses. In order to determine the impact that trials only reported short term follow-up (one year or less) had on our the long term effect estimates we carried out a sensitivity analysis excluding these studies from this estimate.

A priori we identified attrition and selection as the two most relevant sources of bias. We conducted sensitivity analyses to compare the overall result of trials with low risk of attrition and selection bias to all trials to see whether the quality of the trials had any impact on the overall results. Risk of publication bias was assessed by a visual inspection of a funnel plot.

We further conducted sub-analyses based on gender, peer-led (or substantially peer-led) versus adult-led trials, trials with a tobacco only focus (tobacco-only) versus multifocal curricula (curricula that focused on tobacco together with other substances such as alcohol and drugs), and curricula that had subsequent booster sessions versus those with none. Booster sessions were additional 'refresher' sessions separate from the initial curricula. Though not pre-specified, we subsequently explored whether it was relevant to complete a sub-analysis by age (age 11 and under vs. over 11).

RESULTS

We identified 256 potential RCTs or C-RCTs. Of these 135 C-RCTs and one RCT provided a total of 202 different curricula arms with 431,315 participants providing data (figure 1). Trials were categorised by curricula type; the robustness of this classification was confirmed as very good when the agreement between authors and an independent reviewer was tested (KAPPA 0.98).

Fifty-seven of the 136 trials followed never smoking cohorts and of these 50 C-RCTs (74 different intervention arms, n = 143,495) provided analysable data for this review (Figure 1).

Characteristics of included studies

Table 2 provides a summary of the baseline characteristics of included studies. The control groups in the 50 trials were varied. In 22 (44%) the group receiving the curriculum was compared head-to-head with a control group which received "usual practice," in 12 trials the control group received no alternative curricula, 9 did not state whether the control group received an alternative curricula, one provided no alternative curriculum in the control group in 6 schools and "usual practice" in the control group in 4 schools, two provided only information, one a curriculum to help students complete schoolwork, one offered a talk by a physician on either tobacco or alcohol, one posted 4 booklets to the control group, one asked students to produce a newspaper and one helped students with reading skills. Of the 50 trials 47 were in individual countries and three in multiple countries (total 60 country arms): 26 trials were the USA, four each from the UK, Netherlands and Germany, three from Spain and Italy, two each from Australia, Canada and China and the remainder singularly from South Africa, Thailand and across Europe (Denmark, Finland, Portugal, Austria, Belgium, Greece, Sweden and the Czech Republic).

Table 2: Baseline characteristics of included studies

Study name	Alternative name (if applicable)	Study design	Average age (yrs.)	Gender % female	Curriculum intensity (sessions)	Curriculum Duration months, unless otherwise stated)	Curriculum deliverer	Control group type	Ethnicity (dominant)	Country
Armstrong 1990 (Peer)[10]		C-RCT	12	49	5	6	Peers	No curriculum	NS	Australia
Armstrong 1990 (Teacher)[10]		C-RCT	12	49	5	6	Teachers	No curriculum	NS	Australia
Ausems 2004 (In school)[11]		C-RCT	13	52	3x 50 mins	NS	Teachers	NS	NS	Netherlands
Ausems 2004 (Out School)[11]		C-RCT	13	52	NS	NS	Teachers	NS	NS	Netherlands
Aveyard 1999[12]		C-RCT	13.5	50	6 x 1 hour	12	Teachers	Usual practice	86% White	UK
Botvin 1980[13]		C-RCT	13.5	NS	10	3	Outside specialists	No curriculum	White	USA
Botvin 1982[14]		C-RCT	12.5	NS	12 x 1 hour	3	Peers	No curriculum	90%+ White	USA
Botvin 1983 (LST intensive)[15]		C-RCT	12.5	NS	15	1	Teachers	Usual practice	91% White	USA
Botvin 1983 (LST)[15]		C-RCT	12.5	NS	15	3.5	Teachers	Usual practice	91% White	USA
Botvin 1999[16]		C-RCT	11.5	100	15 + 10 boosters	NS	Teachers	10 sessions of information only, plus 3 boosters	60% African American	USA
Brown 2002[17]		C-RCT	13.5	50	NS	NS	Students and teachers	Usual practice	NS	Canada
Buller 2008 (Australia)[18]	Consider This	C-RCT	11 to 14	52	6 x 1 hour	6	Web-based	Usual practice	73% Australian/European	Australia
Buller 2008 (USA)[18]	Consider This	C-RCT	11 to 13	52	6 x 1 hour	6	Web-based	Usual practice	56% White	USA
Chou 2006[19]		C-RCT	12.5	48	13 x 45 mins	3	Health educators (USA)	Usual practice	NS	China
Coe 1982[20]		C-RCT	12.5	NS	8	NS	Medical students	No curriculum	88%+ White	USA

Connell 2007[21]	Adolescent Transitions Program	C-RCT	11	47	6	2	Parent consultants	NS	42% White	USA
Conner 2010 (I)[22]		C-RCT	11.5	50	NS	24	NS	Information and homework intentions	NS	UK
Crone 2011[23]		C-RCT	10 to 12	53	6 x 1 hour	24	Teachers	Usual practice	NS	Netherlands
De Vries 1994 (High)[24]		C-RCT	12.5	NS	5 x 45 mins	NS	Peers and teachers	NS	NS	Netherlands
De Vries 2003 (Denmark)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	6 x 1 hour	NS	Teachers	Usual practice	European	Denmark
De Vries 2003 (Finland)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	5 x 45 mins	NS	Teachers	Usual practice	European	Finland
De Vries 2003 (Portugal)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	6	NS	Teachers	Usual practice	European	Portugal
De Vries 2003 (UK)[25]	European Smoking Prevention Framework Approach	C-RCT	13	50	50 x 30 mins	NS	Teachers	Usual practice	European	UK
Denson 1981[26]		C-RCT	12 to 14	NS	3	24	Researcher	No curriculum	NS	Canada
Elder 1996[27]	CATCH	C-RCT	10.5	51	4 x 50 mins	NS	Teachers	No curriculum	71% White	USA
Ellickson 1990 (HealthEd)[28]	ALERT	C-RCT	13.5	48	8 + 3 booster	2	Community adults	No curriculum or Usual practice	67% White	USA
Ellickson 1990 (Teen)[28]	ALERT	C-RCT	13.5	48	8 + 3 booster	2	Students	No curriculum or Usual practice	67% White	USA
Ellickson 2003[29]	ALERT	C-RCT	12.5	50	7 + 3	NS	Teachers	Usual practice	NS	USA
Ennett 1994[30]	DARE	C-RCT	10.5	49	17 x 1 hour	4	Uniformed police officer	NS	54% White	USA
Faggiano 2008[31]	Unplugged	C-RCT	12 to 14	48	12 x 1 hour	3	Teachers	Usual practice	NS	Austria, Belgium, Germany, Greece, Italy, Spain, Sweden

Figa-Talamanca 1989[32]		C-RCT	15 to 17	47	3	3 (days)	Health educators	No curriculum	NS	Italy
Gabrhelik 2012[33]	Unplugged	C-RCT	11	50	12 x 45 mins	12	Teachers	Usual practice	Czech	Czech Republic
Garcia 2005[34]	ALERT	C-RCT	13	47	8 x 1 hour	NS	Teachers	Usual practice	NS	Spain
Hort 1995[35]		C-RCT	13	38	4 x 1-2 hour + 15 x 1 hour	24	Physicians and teachers	Physician talk on smoking if requested	NS	Germany
Howard 1996[36]		C-RCT	10	46	5 x 40 mins	NS	Teachers	NS	NS	USA
Johnson 2009[37]	Acadiana Coalition of Teens against Tobacco	C-RCT	15	51	NS	30	Teachers	NS	61% White	USA
Kellam 1998 (GBG)[38]	Good Behaviour Game	C-RCT	5.5	50	week x 10 mins	24	Teachers	Usual practice	70% African American	USA
La Torre 2010 (Adolescents)[39]		C-RCT	14	52	NS	NS	Teachers	NS	NS	Italy
Luna-Adame 2013[40]		C-RCT	11	51	21 x 1 hour in year 1, 12 x 1 hour in second year	24	Psychology students	Usual practice	NS	Spain
Nutbeam 1993 (FSE)[41]		C-RCT	11.5	43	3	NS	Teachers	No curriculum	NS	UK
Peterson 2000[42]	Hutchinson Smoking Prevention Project	C-RCT	7 to 9	49	65	NS	Teachers	Usual practice	90% Caucasian	USA
Piper 2000 (HFL Age)[43]	Healthy for Life Project	C-RCT	14.5	52	58 (in 3 x 4 week periods)	36	Community adults	Usual practice	92%+ White	USA
Piper 2000 (HFL)[43]	Healthy for Life Project	C-RCT	14.5	52	54	12	Community adults	Usual practice	92%+ White	USA
Prokhorov 2008[44]	A Smoking Prevention Interactive Experience	C-RCT	16	59	5 x 30 mins + 2 boosters	NS	Computer	Usual practice	51% Hispanic	USA
Resnicow 2008 (Harm Min)[45]	Keep Left	C-RCT	14	50	8	24	Teachers	Usual practice	60% Black	South Africa
Resnicow 2008 (LST)[45]	Life Skills Training	C-RCT	14	50	8	24	Teachers	Usual practice	60% Black	South Africa

Ringwalt 2009a[46]	ALERT	C-RCT	11	52	11 x 45 mins + 3 boosters	24	Teachers	No curriculum	53% White	USA
Schulze 2006[47]	Be smart – don't start	C-RCT	12	50	NS	NS	Teachers	No curriculum	NS	Germany
Seal 2006[48]		C-RCT	15.5	11	10 x 1 hour	NS	NS	Usual practice	Thai	Thailand
Simons-Morton 2005[49]	Going Places	C-RCT	11	57	18	36	Teachers	NS	72% White	USA
Spoth 2001 (ISFP)[50]	Iowa Strengthening Families Program	C-RCT	11	55	7	1 (day)	Project staff	4 mailed booklets on changes in adolescents	NS	USA
Spoth 2001 PDFY)[50]	Preparing for the Drug Free Years Program	C-RCT	11	55	5	NS	Project staff	4 mailed booklets on changes in adolescents	NS	USA
Spoth 2002 (LST + SFP)[51]	SFP 10	C-RCT	12.5	45	7 x 1 hour + 4 boosters	1 (day) + boosters 1 yr later	Project staff & teachers	NS	95%+ Caucasian	USA
Spoth 2002 (LST)[51]	SFP 10	C-RCT	12.5	45	15 x 45 mins	NS	Project staff & teachers	NS	95%+ Caucasian	USA
Storr 2002 [52]		C-RCT	5.7	47	NS	NS	Teachers	Usual practice	86% African American	USA
Telch 1990 (No peers)[53]		C-RCT	12	47	5	0.75	Teachers	No curriculum	24% White	USA
Telch 1990 (Peers)[53]		C-RCT	12	47	5	0.75	Peers	No curriculum	24% White	USA
Unger 2004 (CHIPS)[54]	Choosing Healthy Influences for a Positive Self	C-RCT	11	54	NS	NS	Health educators	Usual practice	61% Hispanic	USA
Unger 2004 (FLAVOR)[54]	Fun Learning About Vitality, Origins and Respect	C-RCT	11	54	NS	NS	Health educators	Usual practice	58% Hispanic	USA
Valente 2007 [55]	Project Towards No Drug Abuse	C-RCT	16	38	12	3-4 weeks	Peers	Usual practice	72% Hispanic/Latino	USA

Van Lier 2009[56]	Good Behaviour Game	C-RCT	7	48	3 x per week x 10 mins	NS	Teachers	No curriculum	69% Dutch descent	Netherlands
Walter 1986[57]	Know your Body	C-RCT	9	47	2 per week	12	Teachers	Information	84% White	USA
Weichold 2011 (Peer)[58]	Life Skills Training	C-RCT	11	44	10 x 90mins, five x 45 mins + boosters	NS	Peers	Produced student newspaper	German	Germany
Weichold 2012 (Teacher)[58]	Life Skills Training	C-RCT	11	44	10 x 90mins, five x 45 mins + boosters	NS	Teachers	Produced student newspaper	German	Germany
Wen 2010[59]		C-RCT	13	46	NS	18	School nurses and health educators	Usual practice	NS	China

NS not stated; C-RCT cluster randomised control trial

Principal findings

(See online supplementary material B for raw data)

All curricula types versus control, with follow-up one year or less (26 trials, 41 curriculum arms, Figure 2, Table 3)

There was no overall effect for all curricula with follow-up of one year or less (odds ratio (OR) 0.91, 95% confidence interval (CI) 0.82 to 1.01; I^2 = 19%). The I^2 statistic for subgroup differences across all curricula was 45.9%, but within each curriculum type heterogeneity was minimal, except for multimodal (I^2 = 51%). The combined social competence/social influences curricula (seven C-RCTs/eight arms) showed a statistically significant effect in preventing the onset of smoking at one year or less(OR 0.59, CI 0.41 to 0.85; I^2 = 0%). However, for the social influences curricula (16 RCTs/25 arms, the multi-modal curricula (three RCTs/five arms) and one small trial,[36] which tested an information only curriculum, the results were non-significant. There was no RCT testing a social competence curriculum versus control with a follow-up duration of one year or less.

Table 3: All curricula versus control groups, broken down by curricula type and overall

Theoretical orientation of curricula	Curricula versus control (one year or less) Odds ratios (95% CI)	Curricula versus control (longest follow-up) Odds ratios (95% CI)
Information only	0.12 (0.00, 14.87	0.12 (0.00, 14.87)
Social competence	Not estimable	0.65 (0.43, 0.96)
Social influences	0.97 (0.86, 1.09	0.92 (0.84, 1.00)
Combined Social competence and Social influences	0.59 (0.41, 0.85)	0.60 (0.43, 0.83)
Multi Modal	0.88 (0.73, 1.07)	0.88 (0.73, 1.05)
Overall	0.91 (0.82, 1.01)	0.88 (0.82, 0.95)

All curricula types versus control, with longest follow up (50 trials, 74 curriculum arms, Figure 3, Table 3)

Fifteen trials (twenty five arms) provided data for analysis at follow-up of one year or less and for longest follow-up (34% of trials). Of the remaining trials 86% had a follow-up between 1-5 years, 10% between 5-10 years and 4% over 10 years.

There was a significant effect favouring all curricula compared to control for the longest follow-up periods (OR 0.88, 95%, CI 0.82 to 0.95; I^2 = 12%), with a mean risk reduction of 12%. Heterogeneity was low (0-12%), except for the multimodal curricula trials (I^2 = 64%).

Our estimate of long term effect was robust to the exclusion of trials that reported only short term (1 year or less) follow-up (see online supplementary material C). There were 10 trials (15 arms) that provided separate data both for analysis at one year or less and for the analysis at longest follow-up. Restricting the analysis to these trials alone showed the same overall effects as the primary findings; no overall effect at one year or less follow-up and a statistically significant effect at longest follow-up.

By individual curricula social competence curricula (five C-RCTs/seven arms) compared to control showed a statistically significant result in favour of the curricula (OR 0.65, CI 0.43 to 0.96; I^2 = 0%) and also the combined social competence/social influences (nine C-RCTs/eleven arms) compared to control (OR 0.60, CI 0.43 to 0.83; I^2 = 0%). There were no statistically significant differences for the one information only curriculum, or the social influences or multi-modal curricula. Four trials (six arms) were classified as 'other curricula' and contributed to the overall results, but not to the individual curricula types.[17, 32, 38, 39]

Sensitivity analysis

(See online supplementary material D for sensitivity analyses).

Sensitivity analyses restricted to trials at low risk of attrition bias with follow-up one year or less (n=9) found no differences compared to all trials in terms of point estimates, though trials testing combined social competence/social influences curricula no longer

demonstrated a significant effect when studies at unclear or high risk of bias were removed (OR 0.55, CI 0.28 to 1.09). At longest follow-up, analyses restricted to low risk of attrition bias (n=20) were similar to pooled results from all trials, except the confidence interval was wider and hence included the line of no effect for trials at low risk of bias (OR 0.90, CI 0.80 to 1.03 compared to all trials (OR 0.88, CI 08.2 to 0.95). Furthermore, at one year or less follow-up duration, sensitivity analysis restricted to trials at low risk of selection bias (n=12) showed no difference from the principal findings; though similarly trials of combined social competence and social influences curricula no longer showed a significant result (OR 0.55, CI 0.28 to 1.10). However, at longest follow-up analyses showed sensitivity to selection bias. For all trials classified as low risk of selection bias the overall effect was no longer significant (OR 0.92, CI 0.83 to 1.01). By curricula type both social competence and combined social competence and social influences were no longer significant and the group of multi-modal trials now favoured the control groups (OR 1.26, CI 0.78, 2.04). Full details of the risk of bias assessments can be found in the Cochrane review.[60]

Publication bias

A funnel plot of all included studies did not suggest publication bias.

Sub group analyses

(See online supplementary material D for sub group analyses).

Gender: At one year for the limited number of trials which presented data by gender, there was a statistically significant effect for females (five trials, seven arms, OR 0.68, CI 0.50 to 0.93; $I^2 = 0\%$) and no significant effect for males (four trials, six arms, OR 0.76, CI 0.53 to 1.10; $I^2 = 51\%$). The largest effect was found in one trial[25] which tested

a multi-modal curriculum in males (OR 0.32, CI 0.16 to 0.65). At longest follow-up the results were similar; statistically significant differences were found for females (seven trials, nine arms, OR 0.80, CI 0.66 to 0.97) whereas results were not statistically significant for males (six trials, eight arms, OR 0.93, CI 0.76 to 1.15).

Adult- vs. peer-led: For adult-led curricula with follow-up ≤ one year (21 trials, 30 arms) there were no significant effects except for combined social competence/social influences curricula which were more effective than controls (OR 0.58, CI 0.40 to 0.85; $I^2 = 0\%$). For the peer-led curricula (six trials, eight arms) compared to controls there was no overall effect, though it should be noted that social influences interventions were only tested with a single trial[14] which offered a combined social competence/ social influences curriculum.

In contrast, at longest follow-up there were significant overall effects for adult-led interventions (42 trials, 57 arms) compared to the control groups (OR 0.87, CI 0.81 to 0.94; $I^2 = 23\%$), and significant effects for two of the four curricula tested: social competence (five trials, seven arms, OR 0.62, CI 0.40 to 0.96; $I^2 = 0\%$) and combined social competence/social influences (seven trials, eight arms, OR 0.58, CI 0.42 to 0.82; $I^2 = 0\%$), but not for social influences or multi-modal curricula. For peer-led programmes (8 trials, 11 arms) compared to controls there were no statistically significant differences overall, nor for the three curricula tested (social influences, combined social competence/social influences and multi-modal). Four trials which compared peer-led and adult-led interventions to controls were not included, either because it was not clear who delivered the programme[22, 49] or because it was delivered online.[18, 45]

Tobacco only vs. multi-focal curricula: Multi-focal curricula showed no overall effect compared to control either at one year or at longest follow-up. Multi-focal social competence curriculum (five trials, seven arms, OR 0.65, CI 0.43 to 0.96; I^2 = 0%) and multi-focal combined social competence/influences (five trials, six arms, OR 0.53, CI 0.34 to 0.83; I^2 = 0%) both showed a significant effect at longest follow-up. Curricula focused on only tobacco compared to control (16 trials, 27 arms) showed no effect for follow-up ≤ one year (OR 0.93, CI 0.83 to 1.04; I^2 = 31%), but there was an effect at longest follow-up (28 trials, 43 arms, OR 0.89, CI 0.81 to 0.97; I^2 = 24%). None of the other three curricula (social influences, combined social competence/social influences, and multi-modal) found significant differences at follow-up of either ≤ one year or longest follow-up.

Adding booster sessions after the main curriculum: Six trials had 3[28,29,46], 4[51], 8[15] and 10[16] booster sessions ranging from one to two years after the initial curricula. Curricula without booster sessions showed no significant effect at follow up ≤ one year (24 trials, 37 arms) compared to controls (OR 0.92, CI 0.83 to 1.02; I^2 = 21%), but did at longest follow-up (45 trials, 67 arms, OR 0.90, CI 0.83 to 0.96; I^2 = 10%). Similarly, for all curricula with booster sessions there were no significant differences from controls at one year or less (three trials, four arms, OR 0.70, CI 0.40 to 1.07; I^2 = 0%), but at longest follow-up (six trials, seven arms) there was a significant difference (OR 0.73, CI 0.55 to 0.97; I^2 = 21%). The combined social competence/social influences curricula, with booster sessions, had a positive effect at one year or less (OR 0.50, CI 0.26 to 0.96; I^2 = 0%) and also at longest follow-up (OR 0.56, CI 0.33 to 0.96; I^2 = 0%), but for only for two[15, 16] and three trials[15, 16, 51] respectively.

Age: An exploratory scatter plot of all trials of age versus odd ratios showed no trend and no sub-analysis was completed by age.

DISCUSSION

Cluster-randomised controlled trials with follow-up of a year or less demonstrated no overall significant effect, and the only individual curricula types within this group which showed positive results were the combined social competence/social influences curricula. The pooled results of the trials of all curricula at longest follow-up showed a positive effect in preventing starting smoking (OR 0.88, 95% CI 0.82 to 0.95). This represents an average reduction of 12% and suggests that the effect is more evident when assessed over a longer time period. There have been no studies to identify why curricula with longer periods of follow-up are more effective.

The only individual curricula types at longest follow-up that showed a statistically significant result were social competence and combined social competence/social influence curricula.

A significant finding of this review is that over 60% of trials use social influences curricula, but these were not effective. Social influences curricula are widely used worldwide. 43% of included trials in this review were based in the USA; here the DARE (Drug Abuse Resistance Education) program, which is a social influences curriculum, is used in 75% of school districts.[61] Few studies reported results by gender. For curricula presented by adults there were significant overall effects at longest follow-up and also for social competence and combined social competence/social influences curricula.

The focus of the curricula, tobacco prevention only or multifocal, did not appear to make

a difference. Pooled estimates at either one year or less or at longest follow-up showed estimates of a similar size. For curricula with booster sessions there was a significant effect only for combined social competence/social influences interventions with follow-up of one year or less and at longest follow-up.

Strengths

The strengths of the review are the comprehensive searches, use of baseline never-smoker intention-to-treat cohorts, and low heterogeneity between these trials. Comprehensive searches were conducted in multiple electronic databases, grey literature and reference lists with no limitations of date or language, and experts were consulted. It is unlikely that key trials were missed. We either derived cohorts of baseline never-smokers from trial articles or asked authors to provide such cohorts with new data runs. Using smoking outcomes from cohorts of baseline never-smokers provides the clearest indication of whether smoking prevention curricula are effective, and we were able to include 50 trials with 143,495 baseline never-smokers. Statistical heterogeneity between these trials was low and sensitivity analyses which assessed the effects of removing studies at unclear or higher risk of bias did not change the conclusions.

Limitations

The limitations of the review are that several trials did not provide data on baseline never-smokers, some trials which did not provide analysable data, and the complexity of some curricula which makes them difficult to classify. It is well documented that the reporting of interventions from RCTs is poor.[62] This leaves the possibility that the classification of these interventions might not be completely accurate. Nevertheless,

given that all information available was extracted from the published articles, we have confidence in our classification which reported good concordance with an independent evaluator.

We were not able to obtain baseline never-smoker data for 15 trials which reported data as changes in smoking behaviour over time, and 65 trials which provided only point prevalence of smoking data. The analyses for these trials are reported in the Cochrane review.[60] From the original 256 eligible trials we were unable to include 57 trials because authors did not provide analysable data on basic facts such as smoking outcomes or key elements of trial design (e.g., n's in intervention and control groups) either in the article or by e-mail correspondence. A further seven trials were excluded because the there was no comparison to a control group or there were concerns over the data that were not resolved by e-mail correspondence. Six trials used unique interventions that could neither be included in the pre-specified five basic curricula types, nor grouped together into a sixth group.

The pre-specified selection criteria were trials that compared a curriculum to a control group and we did not compare head-to-head the limited number of trials that compared curricula.

It is possible in some trials that "never smokers" could include some quitters, although most authors checked for inconsistencies in statements on baseline and follow-up questionnaires. Further bias could have been introduced by certain assumptions made by the review authors in data extraction, and subsequent statistical analysis. However, the consistency of results and low heterogeneity in the comparison suggest a consistent effect.

Results in the context of other reviews

This is the most systematic and comprehensive review of these curricula to date. Other reviews have considered large numbers of trials, but none have exclusively used randomised control trials or examined pure prevention cohorts of never-smokers. There are only three reviews published in the past five years which could be expected to be up-to-date with the most recent studies and potentially comparable. However, none of them focused on assessing the effectiveness of curricula in schools to prevent smoking. Ramo in 2012[63] assessed the co-use of tobacco and marijuana, Lisha in 2010[64] assessed athletic participation and tobacco and drug use and Griffin in 2010[65] described two frequently used school curricula (Life Skills Training and Project Toward No Drug Abuse) and reviewed family and community-based programmes. Griffin provided no outcome data but concluded: “The most effective programs are highly interactive in nature, skills-focused, and implemented over multiple years.” Earlier reviews are now out of date.[66-74]

A separate Cochrane review assessed interventions to help adolescent smokers quit.[75]

Summary

This review found that for baseline child and adolescent never-smokers there was no effect of school based smoking prevention curricula with a follow-up of one year or less, but a 12% reduction in the onset of smoking when assessed over a longer period of follow-up. When individual curricula are considered, only social competence and combined social competence/social influences studies are effective. One interpretation why social competence interventions are effective may be that students see these as helpful to their personal development and social skills as they provide general personal

and social competence, problem solving, decision-making, assertiveness and cognitive skills to resist interpersonal or media influences, coping strategies for stress, and how to increase self-control and self-esteem. There is no explanation why information-only, social influences (60% of all interventions used) and multi-modal curricula are not effective because no focus groups, surveys or design workshops have asked for student evaluations of their experiences with these curricula. It is possible that students perceive information curricula as lectures by adults about substance abuse.

Our review indicates that curricula delivered by adults are more effective. Adding boosters to trials with follow-up of one or less showed no significant effect, but did at longest follow-up. Trial designers and policymakers should consider tailoring future studies to explore the various aspects of the social competence curricula with adult presenters and no booster sessions.

This review has highlighted that there are still gaps in our knowledge with regard to smoking prevention curricula. Further research is required to test curricula that would be effective for both genders. We noted that over 50% of trials were from North America and that there were limited trials exploring curricula for different ethnic groups. This would suggest that our results may reflect and be more applicable to developed countries rather than developing countries. A limited number of trials used the internet to deliver curricula; future trials should incorporate the cultural world of adolescents (internet. media, music and teen idols). Future research needs to tailor study design to address these areas. Methodologically, the next steps in research are to standardise the trial design, definitions of smoking status and the content of interventions so that more studies examine pure baseline never-smokers. Standardisation of key study

design features could enable more reliable research into curricula intensity and duration (optimum number, length and frequency of sessions). Researchers should seek to utilise checklists that improve the quality of reporting[62] and increase the potential impact of study findings. There is minimal information on the costs of developing and implementing these programmes and this is important as many programmes have not proven to be effective. Policy makers need to implement only curricula with proven effectiveness, and fund research projects which meet the above standardisation criteria.

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The Lead and Corresponding Author affirms that the manuscript is an honest, accurate and transparent account of the review being reported.

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Data Sharing Statement

Data used to develop the tables and figures presented in this article are fully available in the original Cochrane review: Thomas RE, McLellan J, Perera R. School-based programmes for preventing smoking. Cochrane Database of Systematic Reviews 2013, Issue 4. Art. No.: CD001293. DOI: 10.1002/14651858.CD001293.pub3.

Figure 1: Flow diagram to show selection process

Figure 2: Forest plot showing results for all curricula versus control (one year or less follow-up)

Figure: Forest plot showing results for all curricula versus control (longest follow-up)

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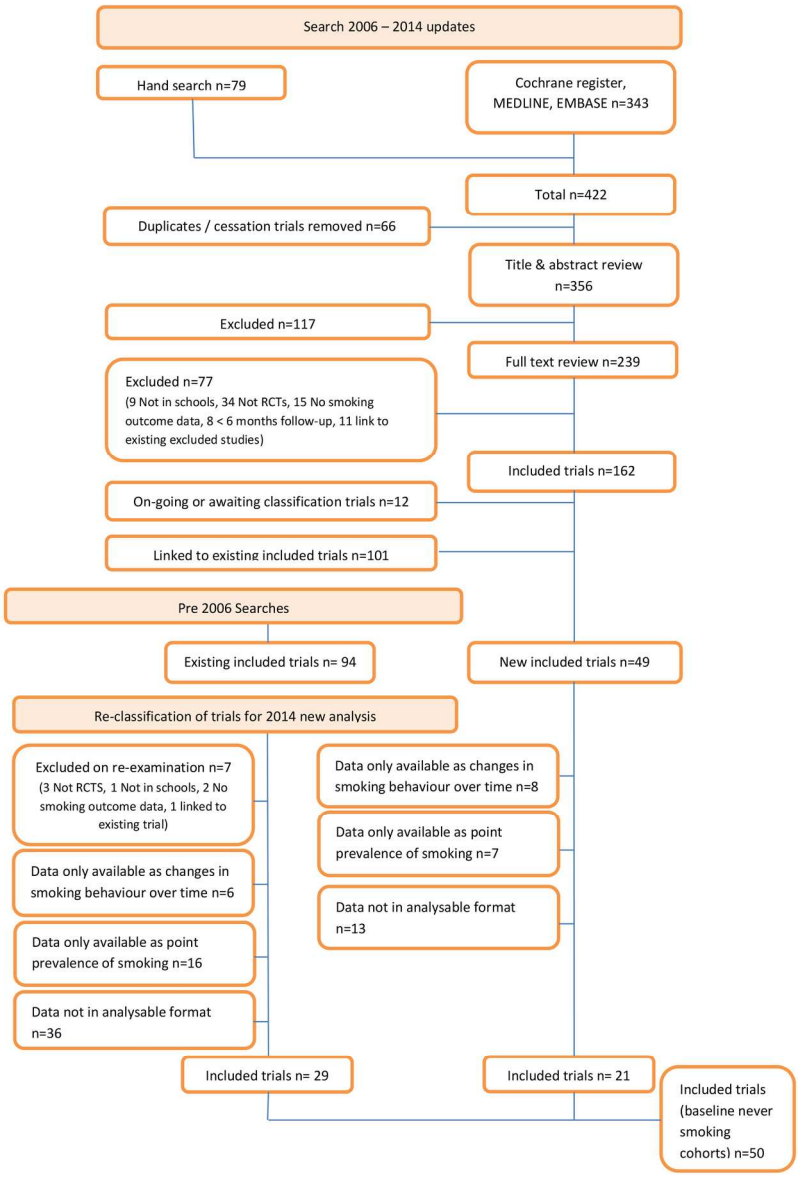

Flow diagram to show selection process
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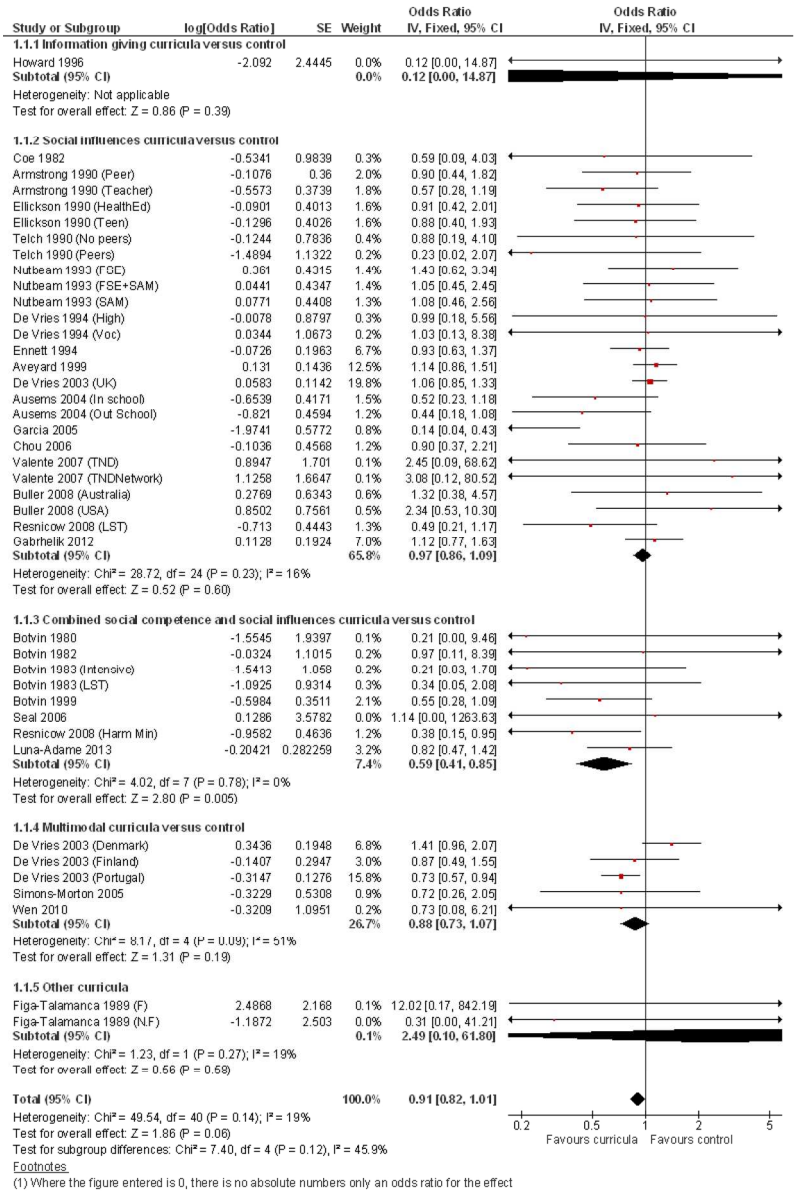
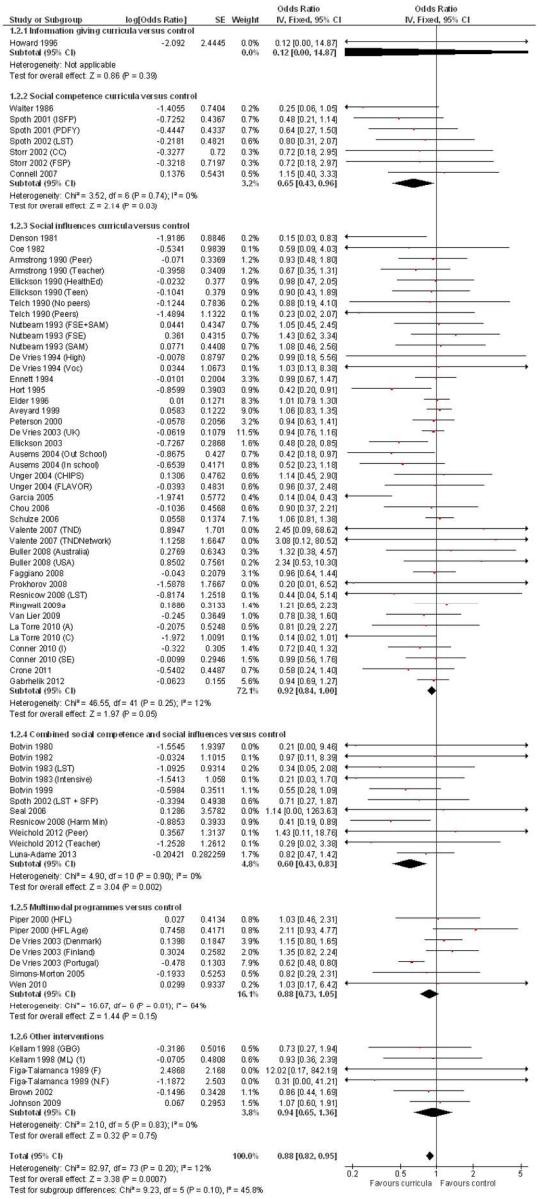


Forest plot showing results for all curricula versus control (one year or less follow-up)
153x233mm (300 x 300 DPI)



Forest plot showing results for all curricula versus control (longest follow-up)
104x233mm (300 x 300 DPI)

Online supplementary material A: Search strategy

MEDLINE

'SMOKING'/ all subheadings or 'SMOKING-CESSATION'/ all subheadings or SMOK* or TOBACCO or NICOTINE or SMOKING CESSATION
PREVENT* or STOP* or QUIT* or ABSTIN* or ABSTAIN* or REDUC* or TOBACCO USE DISORDER OR EX-SMOKER OR FREEDOM FROM SMOKING OR ANTI-SMOK*
#1 and #2
'HEALTH-PROMOTION'/ all subheadings
explode 'HEALTH-EDUCATION'/ all subheadings
'ADOLESCENT-BEHAVIOR'/ all subheadings
'PSYCHOTHERAPY,-GROUP'/ all subheadings
EDUCATION or PREVENT* or PROMOT* or TEACH* or (GROUP near THERAPY)
#4 or #5 or #6 or #7 or #8
#3 and #9
'CHILD-' or 'ADOLESCENCE'/ all subheadings or CHILD or ADOLESCEN* or STUDENT* or SCHOOL* or CLASS*
#10 and #11
(CLINICAL-TRIAL IN PT) OR (randomizED-CONTROLLED-TRIAL IN PT) OR (CONTROLLED-CLINICAL-TRIAL IN PT)
explode 'CLINICAL-TRIALS'/ all subheadings
'EVALUATION-STUDIES'
'PROGRAM-EVALUATION'/ all subheadings
'META-ANALYSIS'
SYSTEMATIC REVIEW
RANDOM*
#13 or #14 or #15 or #16 or #17 or #18
#12 and #20

CINAHL

#14 #9 and (trial* or meta-analysis or systematic review)
#13 review
#12 systematic
#11 meta-analysis
#10 trial*
#9 #2 or #4 or #6 or #8
#8 'Tobacco-Smokeless' /all topical subheadings / in-adolescence, in-infancy-and-childhood in DE
#7 'Tobacco-Smokeless' / all topical subheadings / in-adolescence, in-infancy-and-childhood
6 'Smoking-Cessation-Programs' / all topical subheadings / in-adolescence, in-infancy-and-childhood in DE
#5 'Smoking-Cessation-Programs' / all topical subheadings / in-adolescence, in-infancy-

and-childhood #4 'Smoking-Cessation' / all topical subheadings / in-adolescence, in-infancy-and-childhood in DE #3 'Smoking-Cessation' / all topical subheadings / in-adolescence, in-infancy-and-childhood #2 explode 'Smoking-' / prevention-and-control in-adolescence, in-infancy-and-childhood in DE #1 explode 'Smoking-' / prevention-and-control in-adolescence, in-infancy-and-childhood

Online supplementary material B: Data for included studies

Study name	Curriculum type	Smoking prevention group			Control group			OR	Follow-up (yrs)	ln(OR)	SE(lnOR)
		Number lost to baseline never-smokers	Number of never-smokers at baseline	Number of clusters (schools unless stated)	Number lost to baseline never-smokers	Number of never-smokers at baseline	Number of clusters (schools unless stated)				
Armstrong 1990 (Peer)[10]	SI	96	331	15	106	339	15		1	-0.107638	0.3600305
Armstrong 1990 (Peer)[10]	SI	132	331	15	70.5	169.5	7.5		1	-0.0709958	0.3369252
Armstrong 1990 (Teacher)[10]	SI	74	358	15	106	339	15		1	-0.5573098	0.3738808
Armstrong 1990 (Teacher)[10]	SI	116	358	15	70.5	169.5	7.5		1	-0.3958404	0.3408929
Ausems 2004 (In school)[11]	SI			9			9 baseline/7@1 yr	0.52 (adj)	1	-0.6539265	0.4171404
Ausems 2004 (Out School)[11]	SI			8 baseline/6@1 yr			9 baseline/8@1 yr	0.44 (adj)	1	-0.8209806	0.4594327
Ausems 2004 (Out school)[11]	SI			7 baseline/5@18 mths			8 baseline/7 @18 mths	0.42 (adj)	1.5	-0.8675006	0.4270348
Aveyard 1999[12]	SI			27			26	1.14 (unadj)	1	0.1310283	0.1436052
Aveyard 1999[12]	SI			27			26	1.06 (unadj)	2	0.0582689	0.1221937
Botvin 1980[13]	C	3	79	1	17	108	1		0.5	-1.5544749	1.9397012
Botvin 1982[14]	C	26	120	1	32	144	1		1	-0.0324353	1.1015238
Botvin 1983 (LST intensive)[15]	C	13	170	2	70	251	3		1	-1.5412947	1.0579649
Botvin 1983 (LST)[15]	C	31	270	2	70	251	3		1	-1.0924746	0.9313686
Botvin 1999[16]	C	144	1263	29 total	173	912	29 total		1	-0.5983711	0.3510914
Brown 2002[17]	Other	176	1313	15	183	1201	15		2	-0.1495555	0.3428201
Buller 2008 (Australia)[18]	SI	34	608	13	26	605	12		0.5	0.2769371	1.9529914

Buller 2008 (USA) [18]	SI	41	616	10	11	372	11		0.5	0.8501847	3.144401
Chou 2006[19]	SI	142	862	7	175	975	7		1	-0.1035984	0.4568406
Coe 1982[20]	SI	8	66	2	16	84	2		1	-0.5340825	0.9838762
Connell 2007[21]	SC	95	196	3	100	222	3			0.1376072	0.5431
Conner 2010 (I)[22]	SI	65	297	15	104	373	19			-0.3220296	0.3050
Conner 2010 (SE)[22]	SI	82	257	13	115	358	18			-0.0099374	0.2946
Crone 2011[23]	SI	25	1311	62	33	1022	59			-0.5402293	0.4487
De Vries 1994 (High)[24]	SI	26	317	5	19	230	3			-0.0078076	0.8797456
De Vries 1994 (Voc) [24]	SI	9	109	3	6	75	3			0.0344014	1.0672853
De Vries 2003 (Denmark)[25]	MM			30			30	1.41		0.3435897	0.1947775
De Vries 2003 (Denmark)[25]	MM			30			30	1.15 (adj)		0.1397619	0.1846732
De Vries 2003 (Finland) [25]	MM	185	756	13	248	913	14			-0.1406751	0.2947061
De Vries 2003 (Finland) [25]	MM	404	756	13	419	913	14		2.5	0.3024483	0.2582134
De Vries 2003 (Portugal) [25]	MM			14			11	0.73 (adj)	1	-0.3147107	0.1276131
De Vries 2003 (Portugal) [25]	MM			14			11	0.62 (adj)	2.5	-0.4780358	0.1303127
De Vries 2003 (UK) [25]	SI			22			21	1.06 (adj)	1	0.0582689	0.1142086
De Vries 2003 (UK) [25]	SI			22			21	0.94 (adj)	2.5	-0.0618754	0.1078716
Denson 1981[26]	SI	8	256	6	49	272	6		2	-1.9186357	0.8845767
Elder 1996[27]	SI			56			40	1.01 (adj)	3	0.0099503	0.1270629
Ellickson 1990 (HealthEd) [28]	SI	506	2099	10	561	2175	10		1	-0.0900877	0.4013297
Ellickson 1990 (HealthEd)[28]	SI	642	2099	10	338	1087.5	5		1.25	-0.0231861	0.3770386
Ellickson 1990 (Teen) [28]	SI	527	2253	10	561	2175	10		1	-0.1296114	0.4025698
Ellickson 1990 (Teen) [28]	SI	651	2253	10	338	1087.5	5		1.25	-0.1041381	0.3789543
Ellickson 2003[29]	SI	152	1765	34	191	1171	21		1.5	-0.7266914	0.2867711
Ennett 1994[30]	SI			18			18	0.93 (adj)	1	-0.0725707	0.1963062
Ennett 1994[30]	SI			18			18	0.99 (adj)	2	-0.0101	0.2004

Faggiano 2008[31]	SI	245	2939	78	242	2791	65		1.5	-0.0430055	0.2079089
Figa-Talamanca 1989 (F) [32]	Other	10	99	8	1	108	8		1	2.4867776	2.1680235
Figa-Talamanca 1989 (N.F)[32]	Other	0	88	8	1	108	8		1	-1.1871657	2.5029619
Gabrhelik 2012[33]	SI	160	917	40	125	787	34		1	0.1127624	0.1923887
Gabrhelik 2012[33]	SI	262	917	40	235	787	34		1	-0.0623282	0.1549634
Garcia 2005[34]	SI	7	147	6	18	68	4		1	-1.974081	0.5771636
Hort 1995[35]	SI	50	268	9	84	239	10		1	-0.8598637	0.3903232
Howard 1996[36]	I	0	51	3 classes	3	47	3 classes		1	-2.0920028	2.4444723
Johnson 2009[37]	Other	381	891	10	459	1116	10		1	0.0670225	0.2953
Kellam 1998 (GBG)[38]	Other	92	348	6	299	904	6		1	-0.318604	1.6092447
Kellam 1998 (ML)[38]	Other	111	352	7	299	904	6		1	-0.0704818	0.4808
La Torre 2010 (A)[39]	SI	22	135	8	23	119	7		1	-0.2074914	0.5248481
La Torre 2010 (C)[39]	SI	3	197	11	24	240	13		2	-1.9720213	1.0091488
Luna-Adame 2013[40]	SI & SC	124	367	14	174	452	14		1	-0.204214063	0.282259
Nutbeam 1993 (FSE) [41]	SI	362	848	10	325	951	10		1	0.3610075	0.4314552
Nutbeam 1993 (FSE+SAM)[41]	SI	325	924	10	325	951	10		1	0.0441355	0.4347184
Nutbeam 1993 (SAM) [41]	SI	263	732	9	325	951	10		1	0.0771232	0.4408302
Peterson 2000[42]	SI	1466	3684	20	1547	3756	20		12	-0.0578459	0.2056236
Piper 2000 (HFL Age) [43]	MM	385	614	7	159.5	359.5	4		4	0.7457948	0.4171
Piper 2000 (HFL) [43]	MM	254	564	7	159.5	359.5	4		4	0.0270354	0.4134
Prokhorov 2008[44]	SI	2	380	9	8	317	8		1.5	-1.5878473	1.7666892
Resnicow 2008 (Harm Min) [45]	C	126	1392	12	226	1097	12		1	-0.9582287	0.4636
Resnicow 2008 (Harm Min) [45]	C	206	1392	12	162.5	548.5	6		2	-0.885306	0.3933
Resnicow 2008 (LST) [45]	SI	182	1161	12	226	1097	12		1	-0.7130	0.4443
Resnicow 2008 (LST) [45]	SI	182	1161	12	162.5	548.5	6		2	-0.8173656	1.2518
Ringwalt 2009a[46]	SI	368	2335	17	332	2475	17		3	0.1886451	0.313302
Schulze 2006[47]	SI	838	1205	89	596	872	83		1.5	0.0558165	0.1373784

Seal 2006[48]	C	0	52	1	1	59	1		0.5	0.1286174	3.5782467
Simons-Morton 2005[49]	MM	333	1249	3	361	1080	4		1	-0.3228905	0.5308
Simons-Morton 2005[49]	MM	357	1249	3	353	1080	4		3	-0.1932719	0.5253
Spoth 2001 (ISFP)[50]	SC	46	141	11	71	142	11			-0.7252355	0.4366601
Spoth 2001 PDFY)[50]	SC	50	128	11	71	142	11			-0.4446858	0.4337062
Spoth 2002 (LST + SFP)[51]	C	48	385	12	34	204	6			-0.339444	0.4938
Spoth 2002 (LST)[51]	SC	64	462	12	68	408	12			-0.218131	0.4821
Storr 2002 (CC)[52]	SC	60	230	3	72	219	3			-0.3276874	0.7200
Storr 2002 (FSP)[52]	SC	60	229	3	72	219	3			-0.3217877	0.7197
Telch 1990 (No peers)[53]	SI	14	115	4	27	199	7			-0.1244056	0.7836
Telch 1990 (Peers)[53]	SI	4	117	4	27	199	7			-1.4894358	1.1322
Unger 2004 (CHIPS)[54]	SI	201	847	8	115.5	538.5	4			0.1306071	0.4762
Unger 2004 (FLAVOR)[54]	SI	194	933	8	115.5	538.5	4		1.5	-0.0393381	0.4831
Valente 2007 (TND)[55]	SI	3	106	22	1	85	28		1	0.8947001	1.7010
Valente 2007 (TNDNetwork)[55]	SI	4	113	25	1	85	28		1	1.1257633	1.66471
Van Lier 2009[56]	SI	52	349	16	51	279	15		4	-0.2449684	0.3649
Walter 1986[57]	SC	16	447	8	61	464	7		6	-1.4054567	0.7404415
Weichold 2011 (Peer)[58]	SI & SC	5	9	1	3.5	7.5	0.5		2	0.3566749	1.3137
Weichold 2012 (Teacher)[58]	SI & SC	9	45	3	3.5	7.5	0.5		2	-1.252763	1.2612
Wen 2010[59]	MM	92	1162	2	89	840	2		1	-0.3208561	1.0951
Wen 2010[59]	MM	77	571	2	59	449	2		2	0.0298792	0.9337

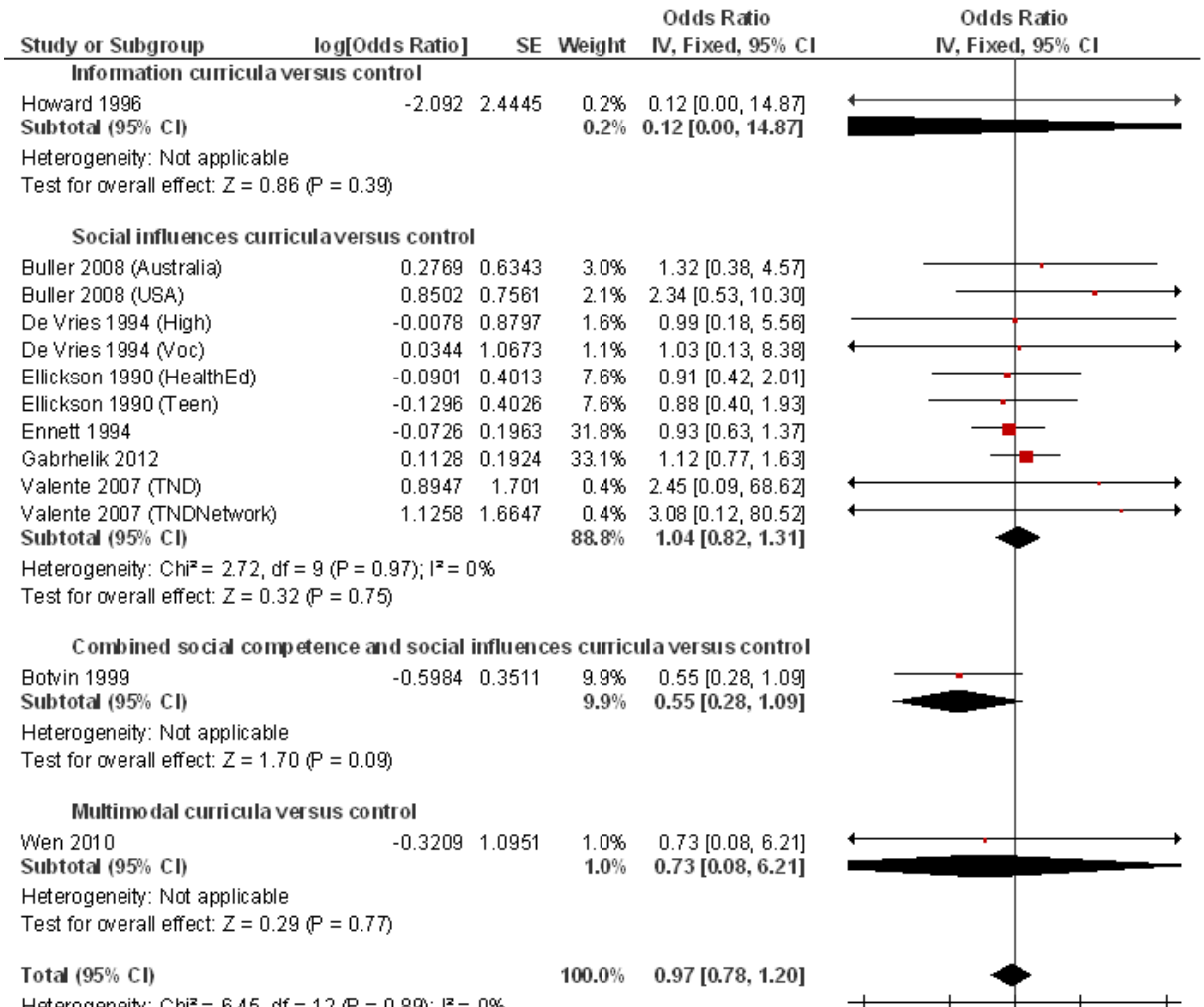
I Information; SI social influences; SC social competence; MM multi-modal; OR odds ratio; Ln(OR) natural log odds ratio; SE(lnOR) standard error of the natural log odds ratio; yrs years

Online supplementary material C: Table to show longest follow-up, with short term (one year or less) data removed

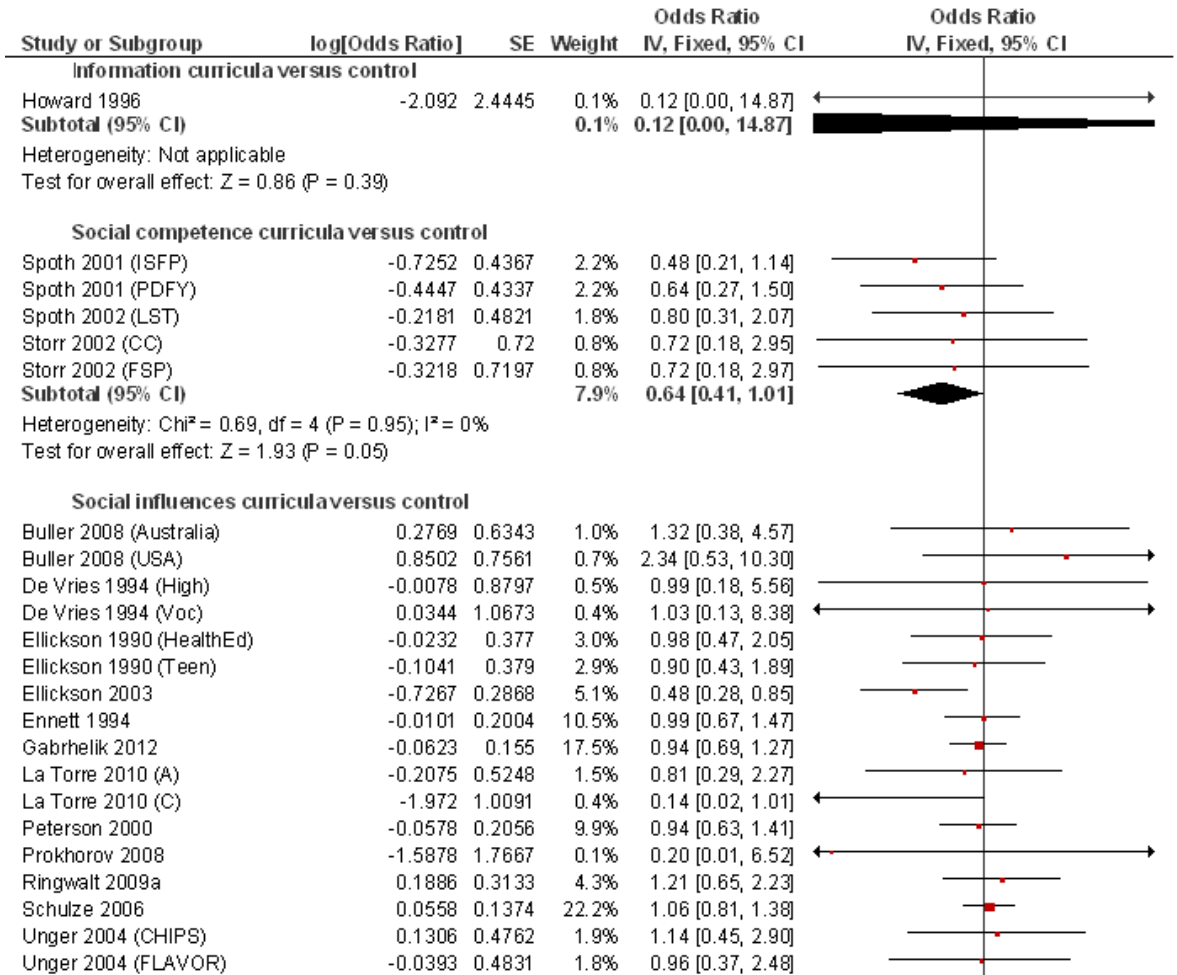
Theoretical orientation of curricula	Longest follow-up Odds ratios (95% CI)	Longest follow up with short term (1 year or less) data removed Odds ratios (95% CI)
Information only	0.12 (0.00, 14.87)	Not estimable
Social competence	0.65 (0.43, 0.96)	0.65 (0.43, 0.96)
Social influences	0.92 (0.84, 1.00)	0.93 (0.85, 1.01)
Combined Social competence and Social influences	0.60 (0.43, 0.83)	0.52 (0.29, 0.92)
Multi Modal	0.88 (0.73, 1.05)	0.88 (0.73, 1.05)
Overall	0.88 (0.82, 0.95)	0.90 (0.83, 0.97)

Online supplementary material D: Forest plots showing Sensitivity and Sub-group analyses

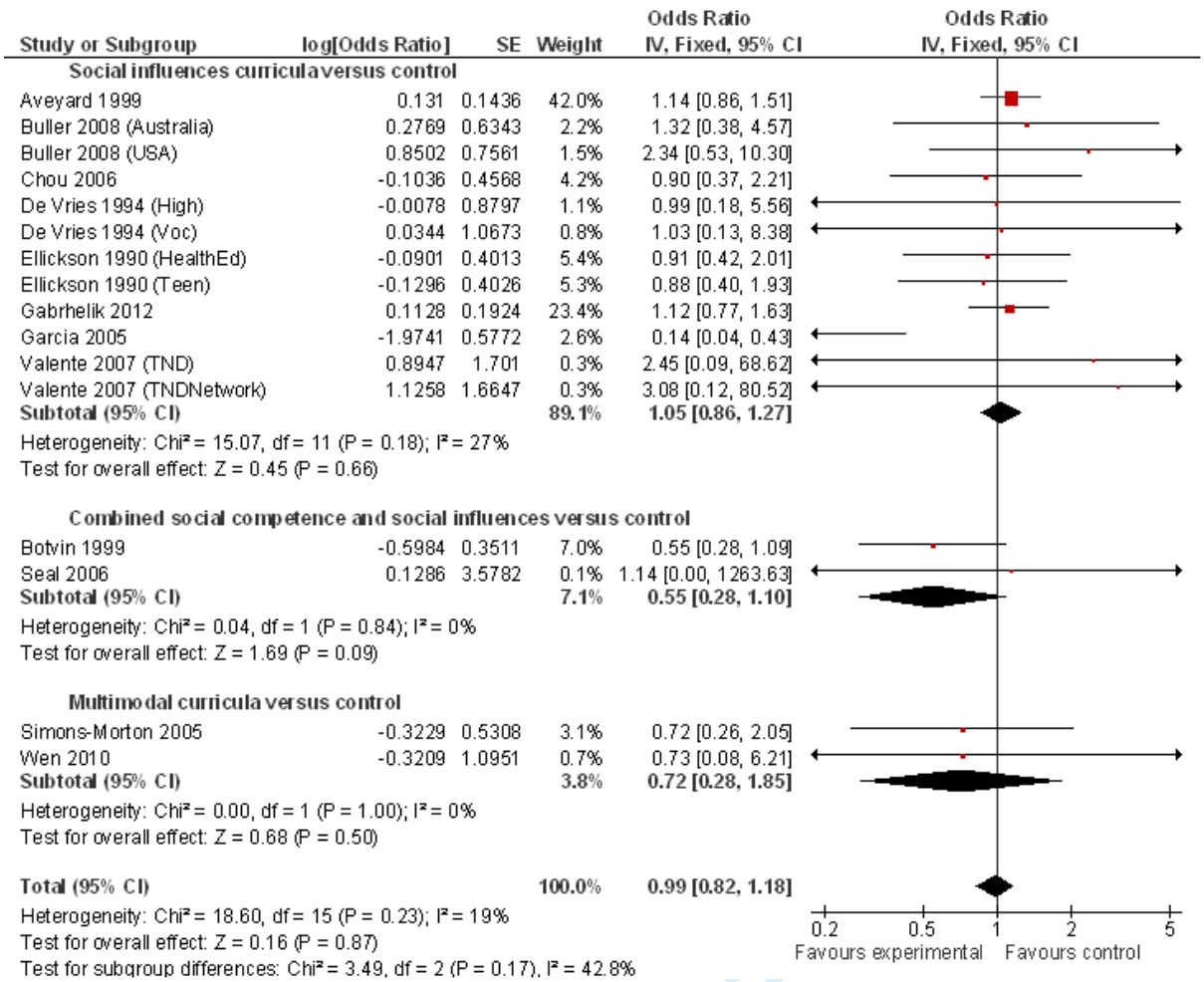
Forest plot showing results for curricula with low risk of attrition versus control (one year or less follow-up)



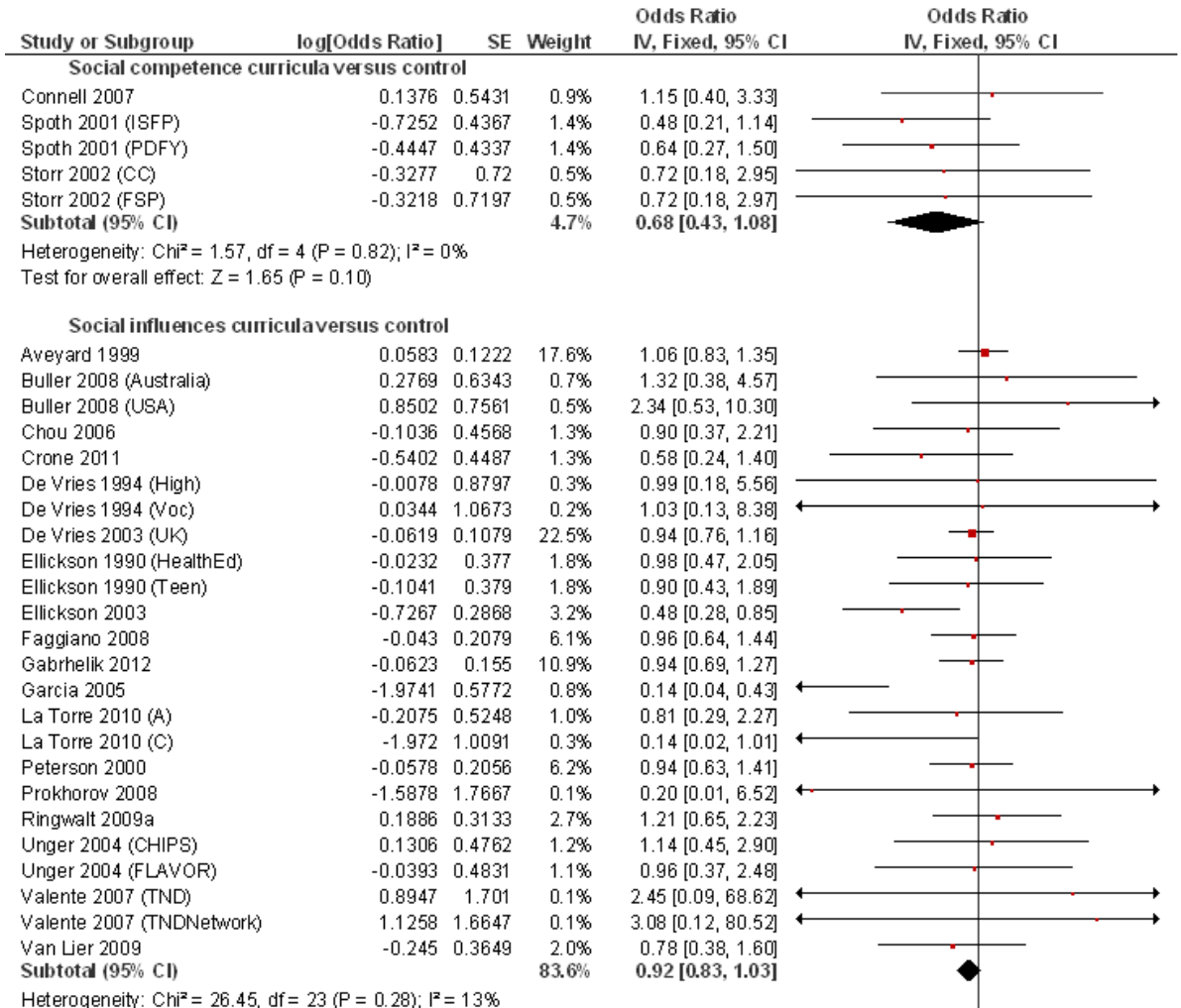
Forest plot showing results for curricula with low risk of attrition versus control (longest follow-up)



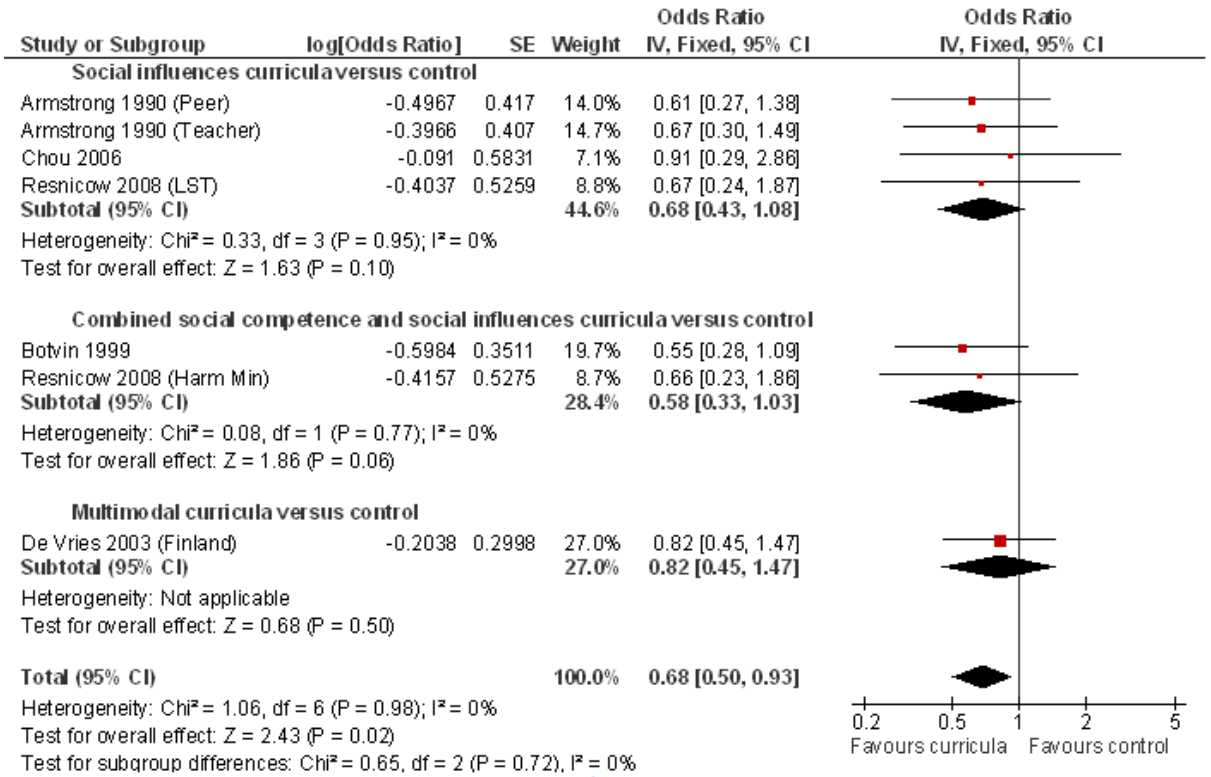
Forest plot showing results for curricula with low risk of selection bias versus control (one year or less follow-up)



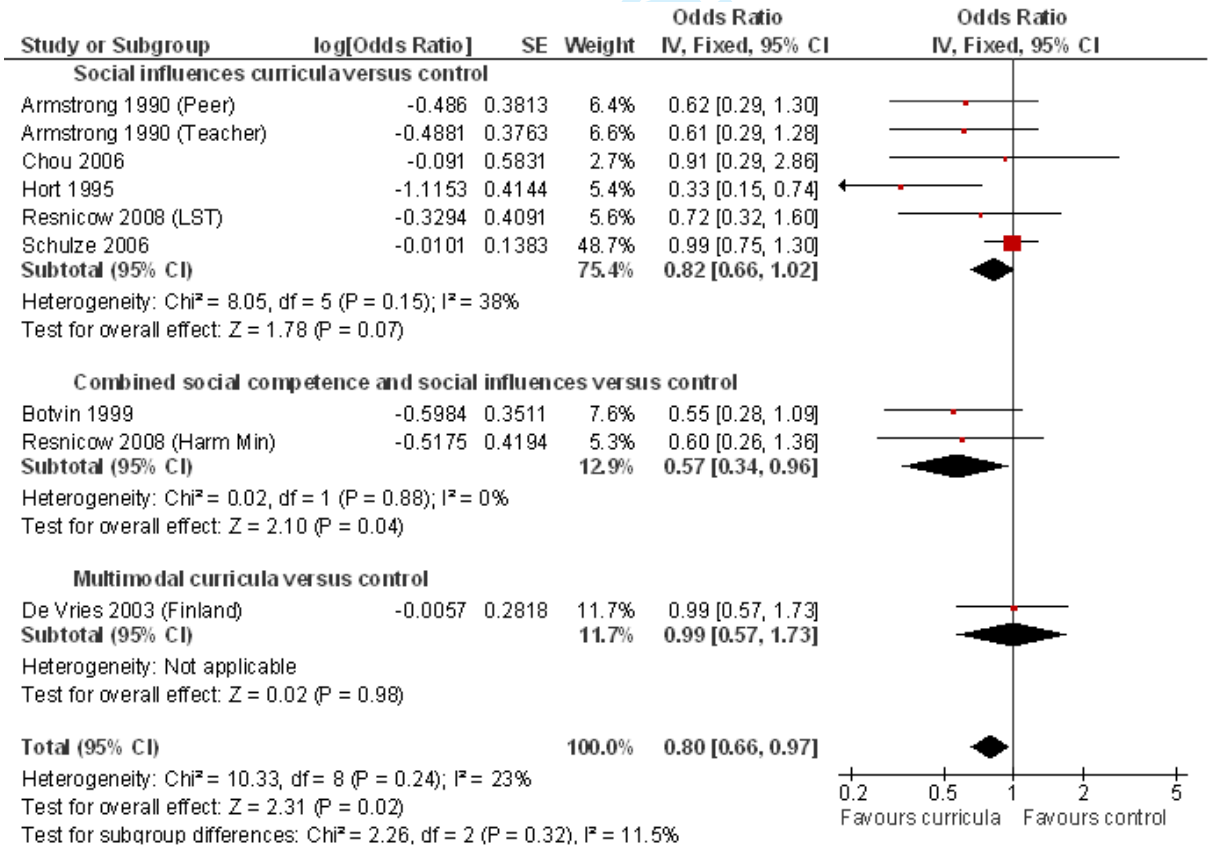
Forest plot showing results for curricula with low risk of selection bias versus control (longest follow-up)



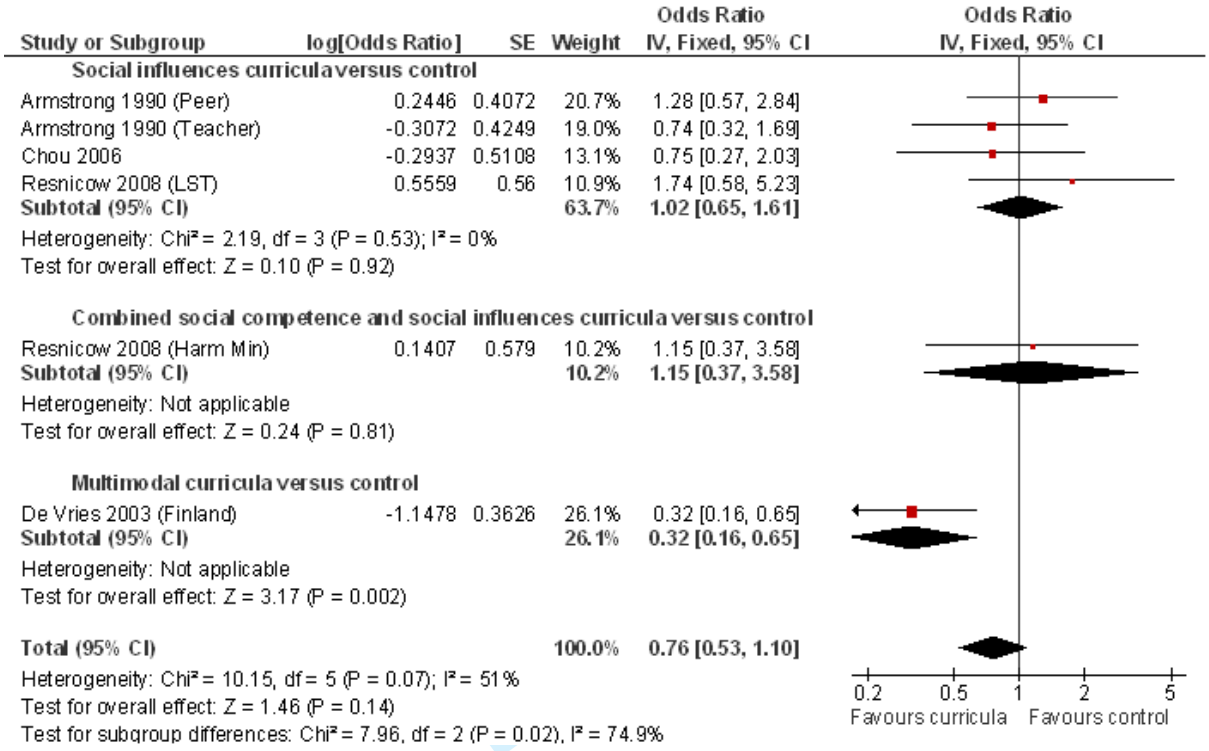
Forest plot showing results for curricula with female only data versus control (one year or less follow-up)



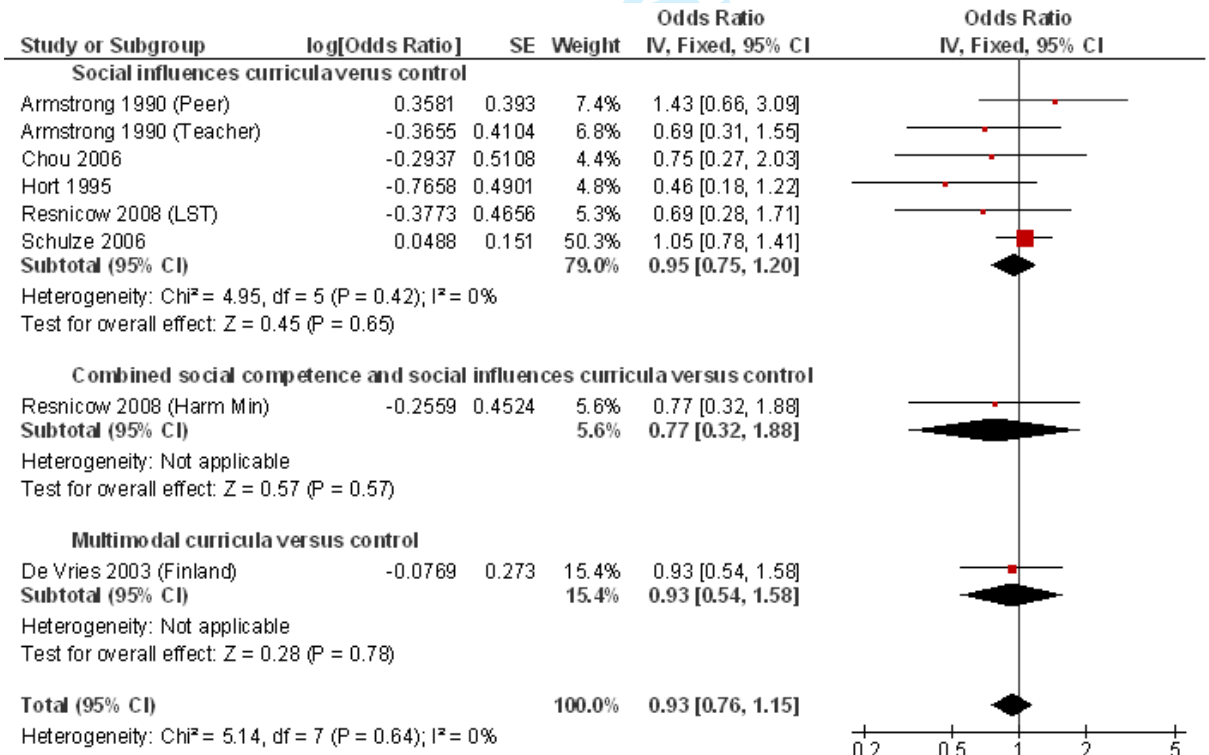
Forest plot showing results for curricula with female only data versus control (longest follow-up)



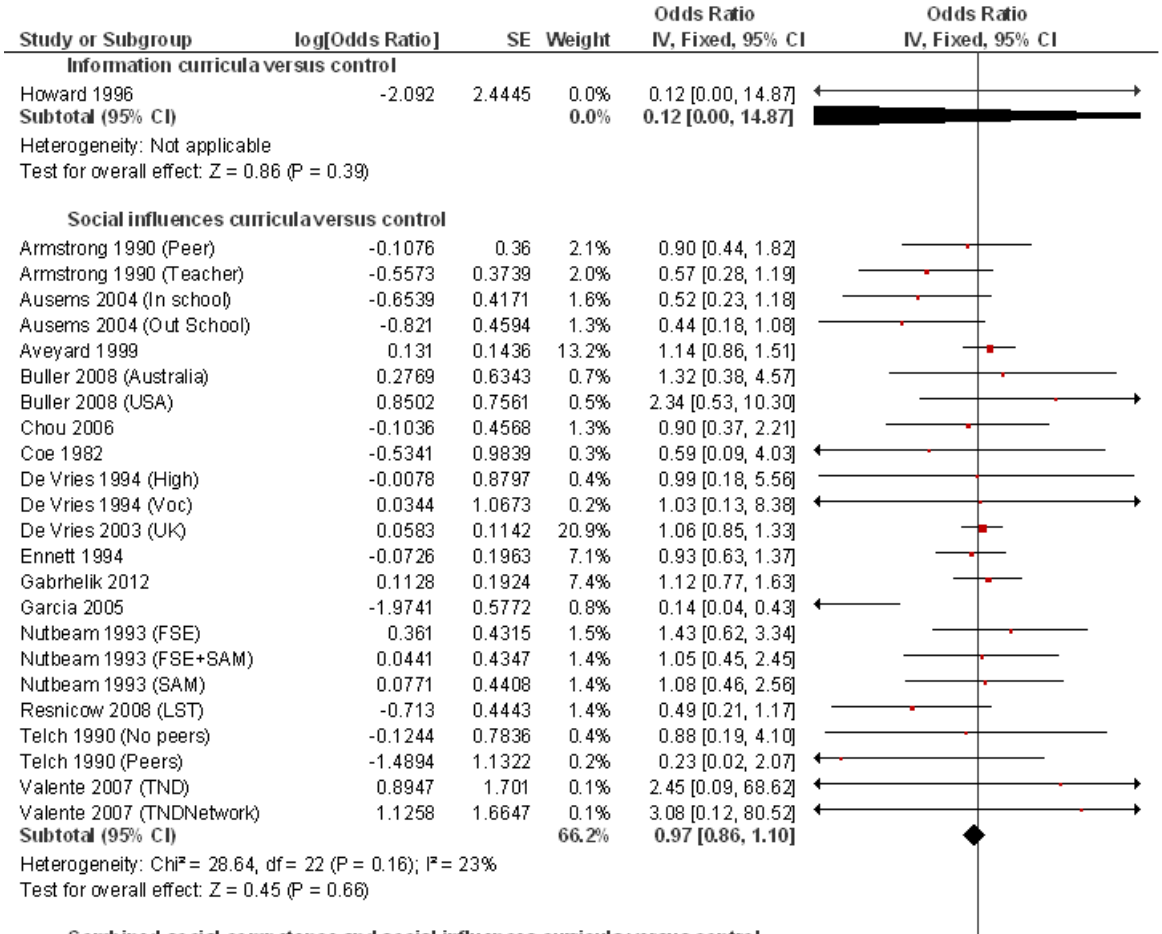
Forest plot showing results for curricula with male only data versus control (one year or less follow-up)



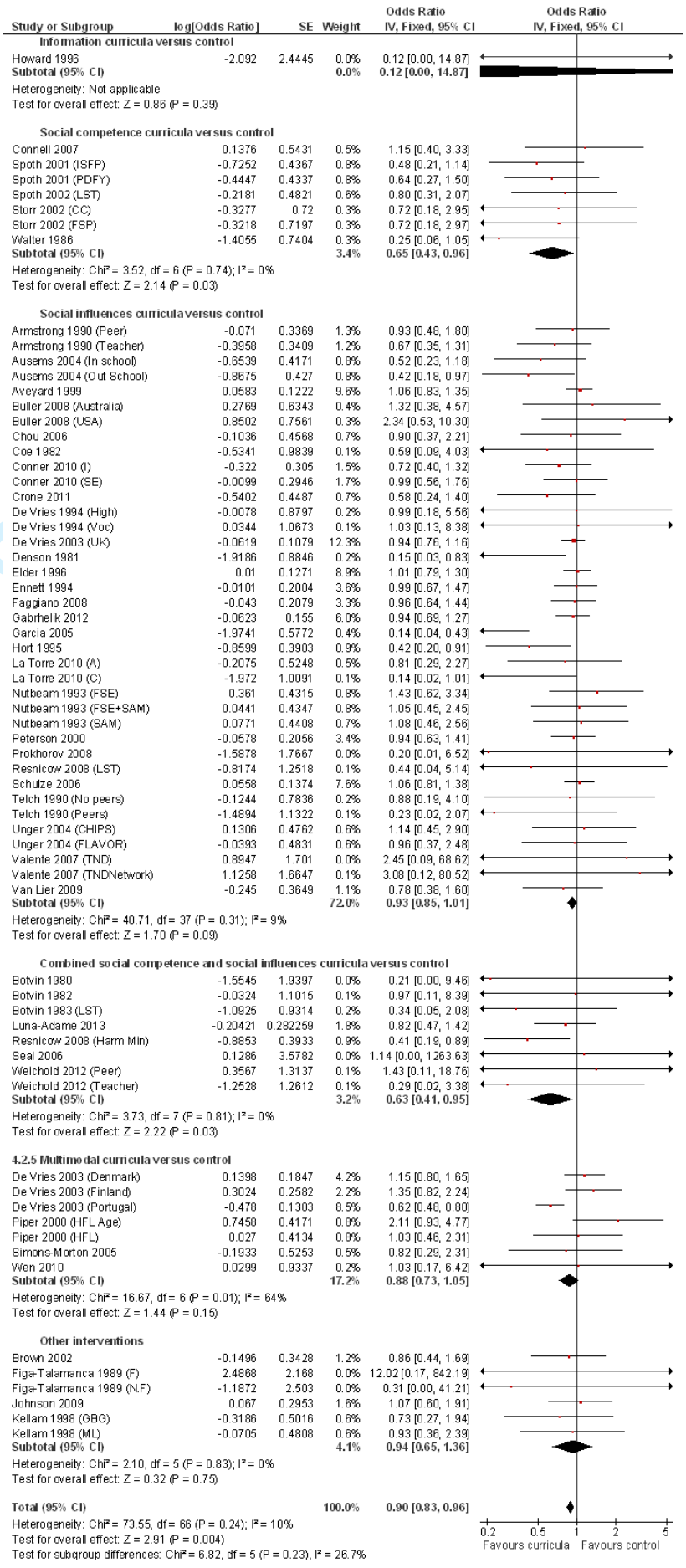
Forest plot showing results for curricula with male only data versus control (longest follow-up)



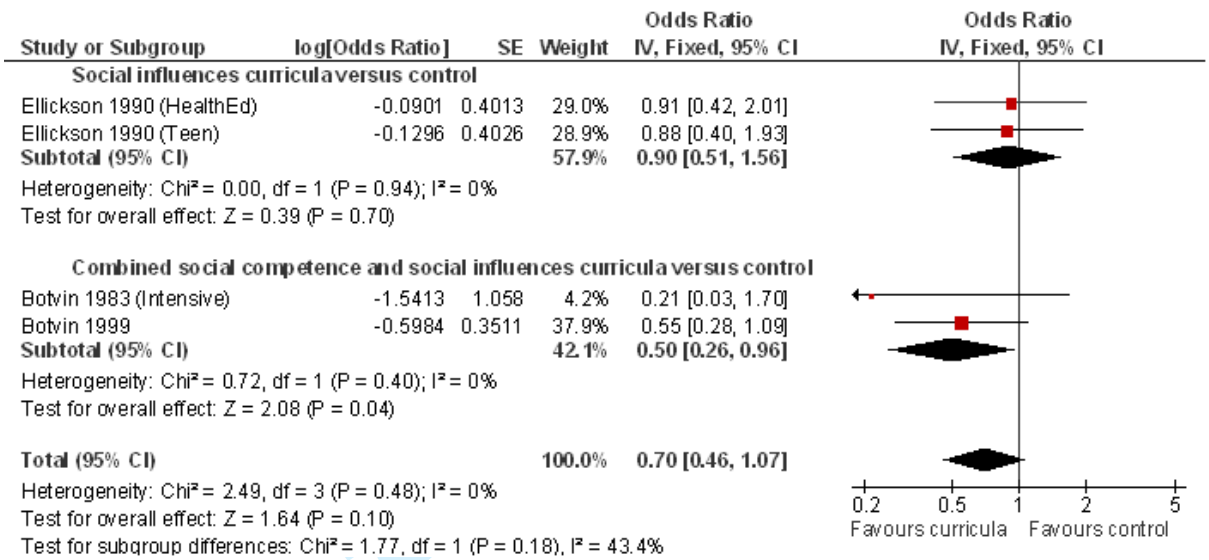
Forest plot showing results for curricula with no booster sessions versus control (one year or less follow-up)



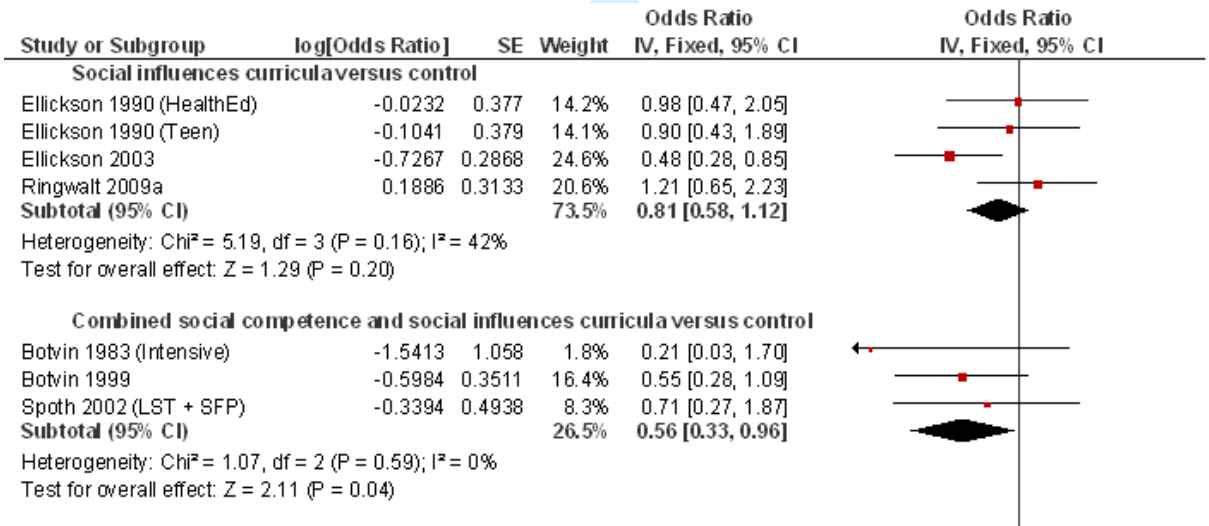
Forest plot showing results for curricula with no booster sessions versus control (longest follow-up)



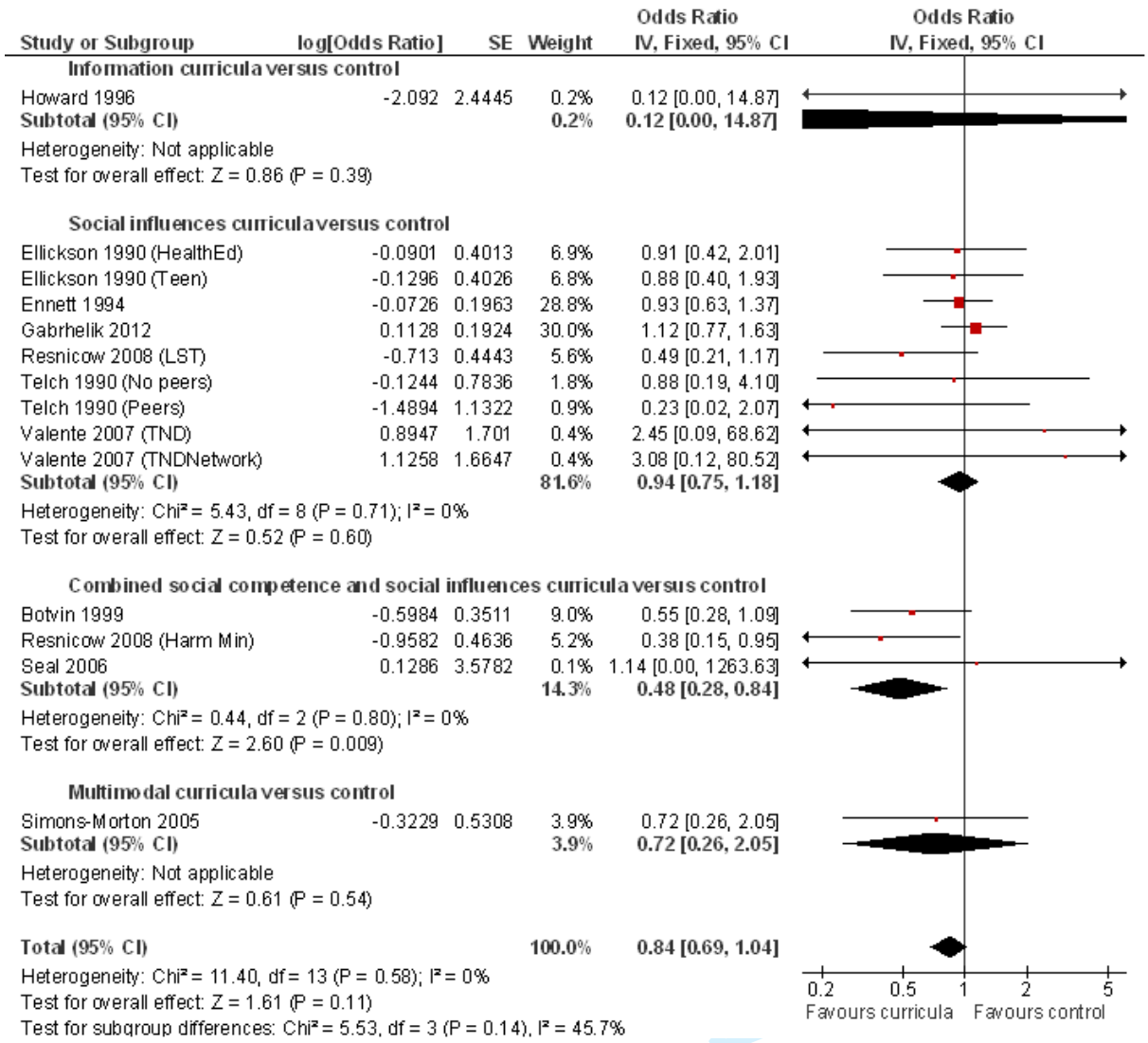
Forest plot showing results for curricula with booster sessions versus control (one year or less follow-up)



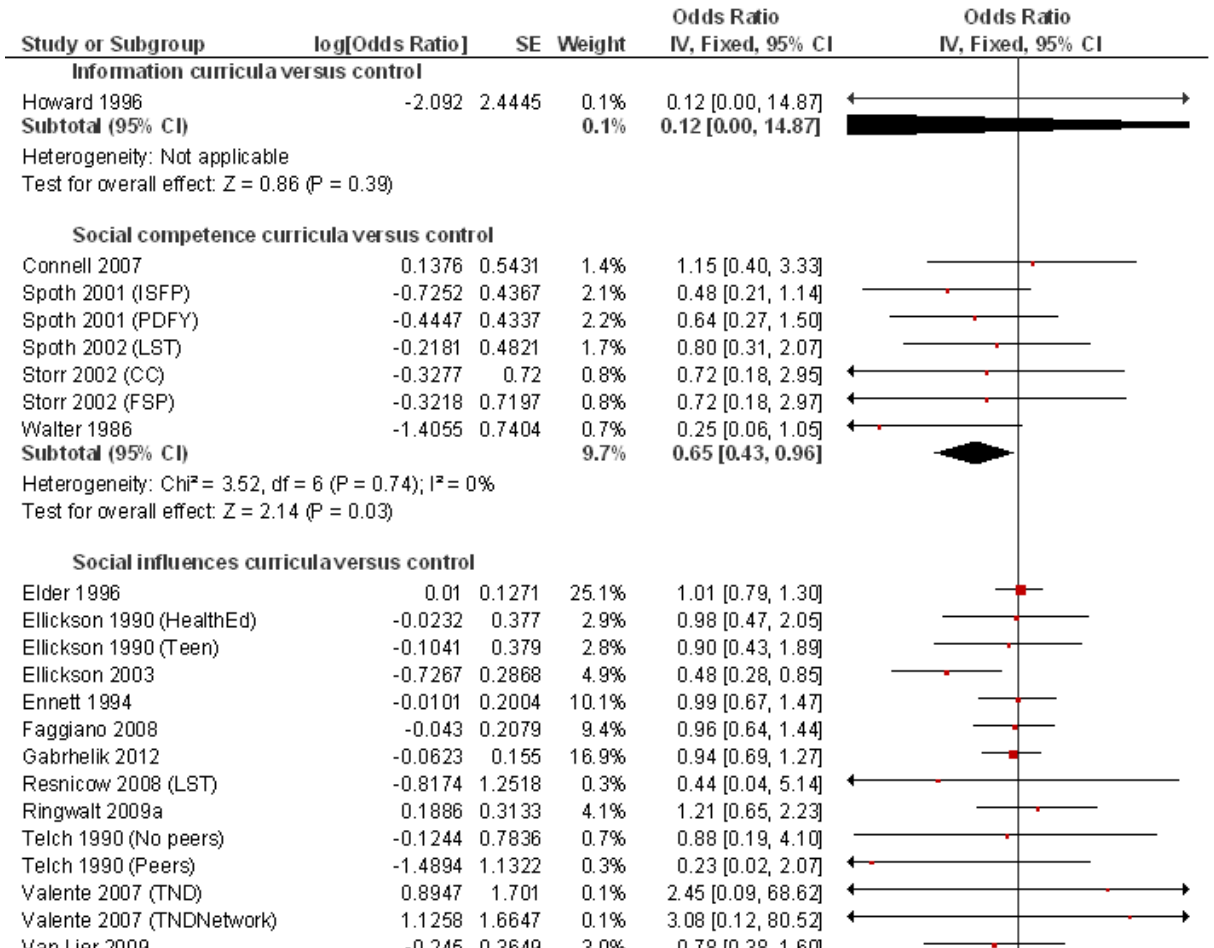
Forest plot showing results for curricula with booster sessions versus control (longest follow-up)



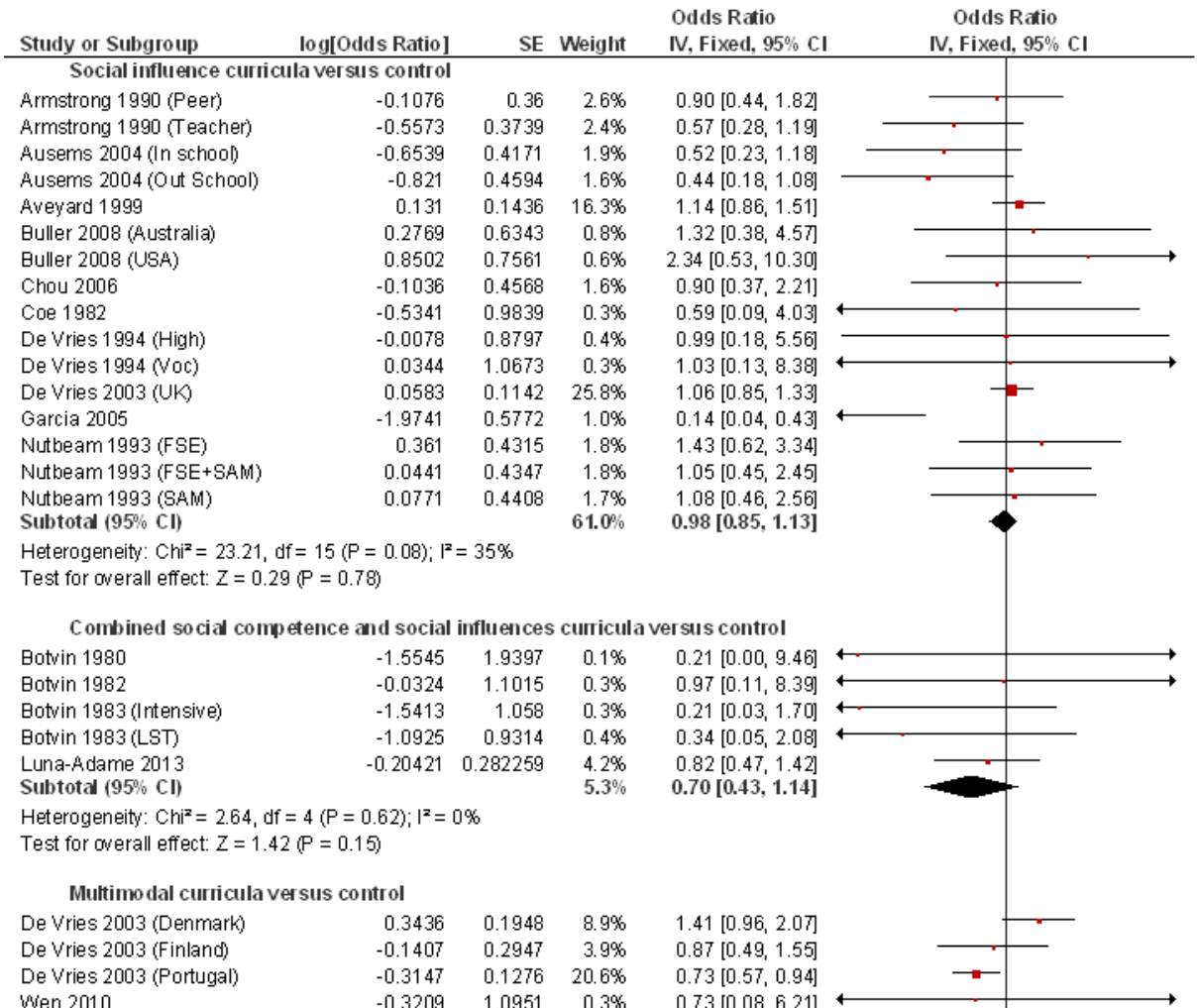
Forest plot showing results for multifocal curricula versus control (one year or less follow-up)

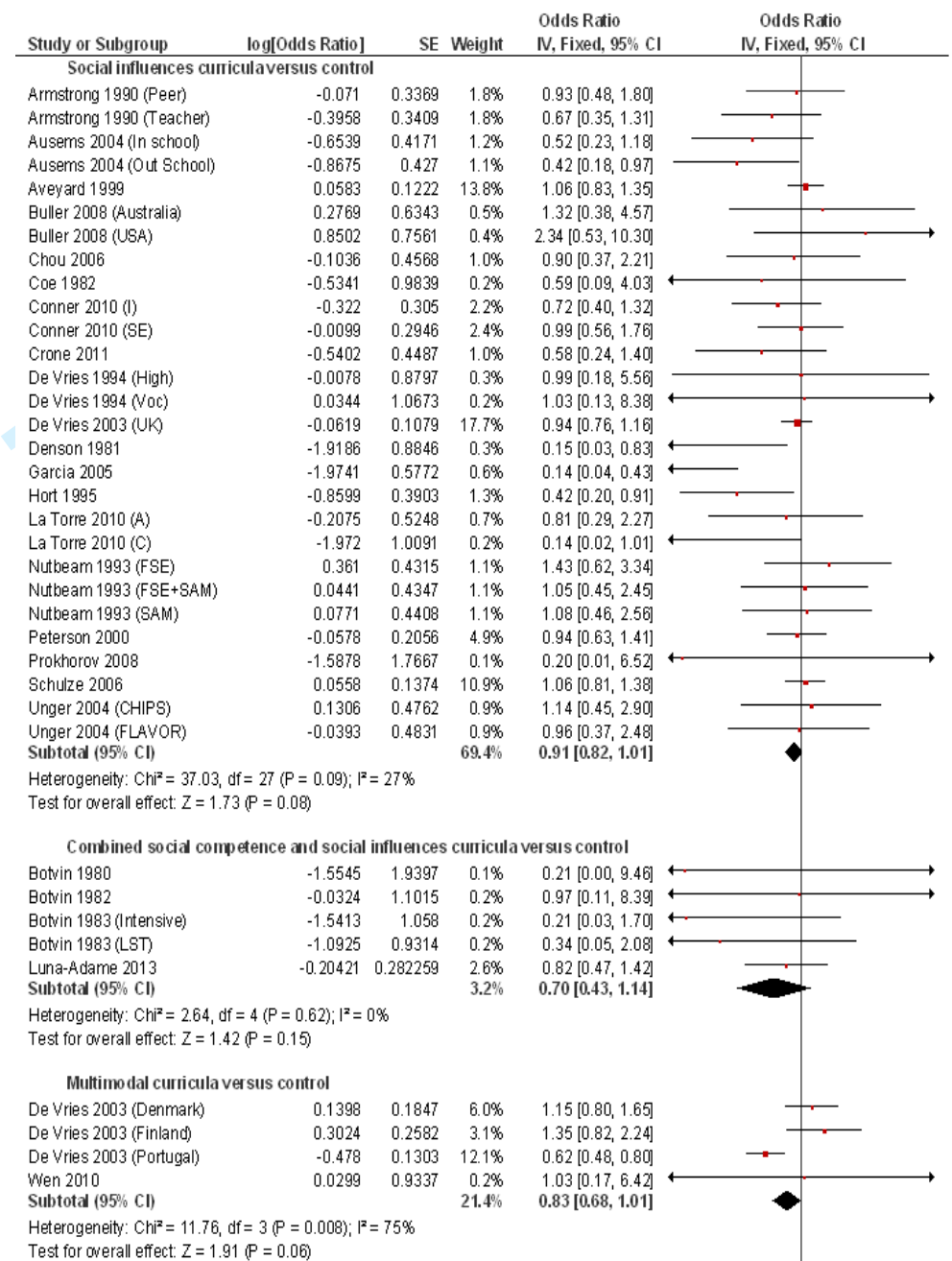


Forest plot showing results for multifocal curricula versus control (longest follow-up)



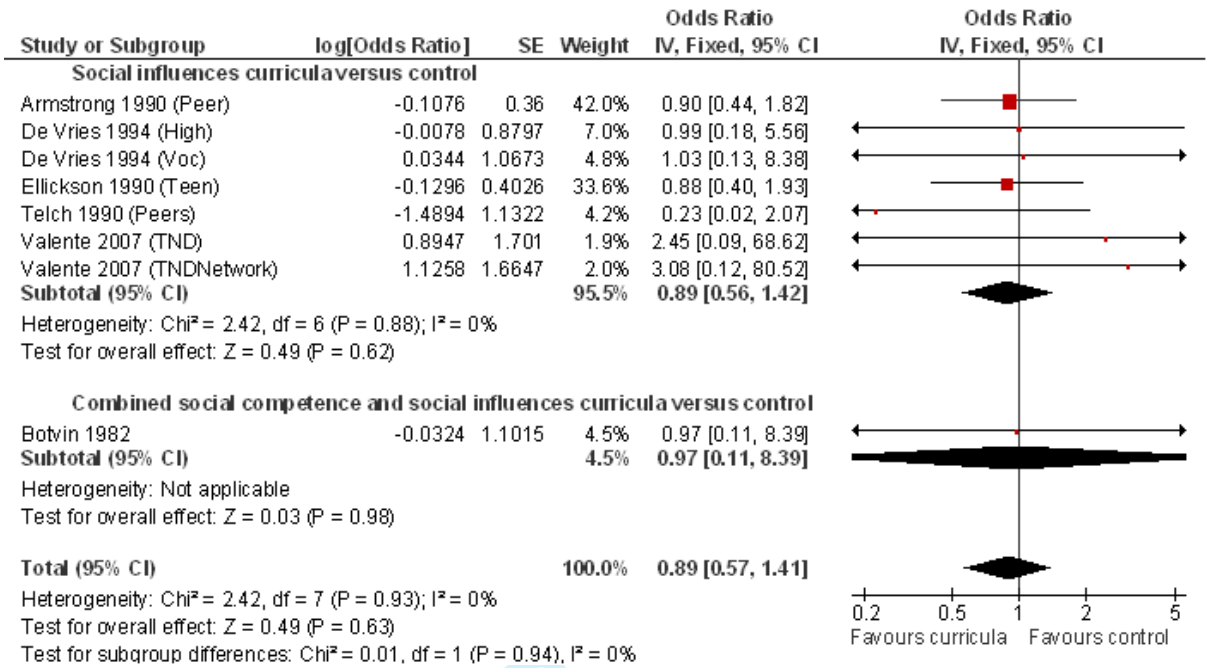
Forest plot showing results for tobacco-only curricula versus control (one year or less follow-up)



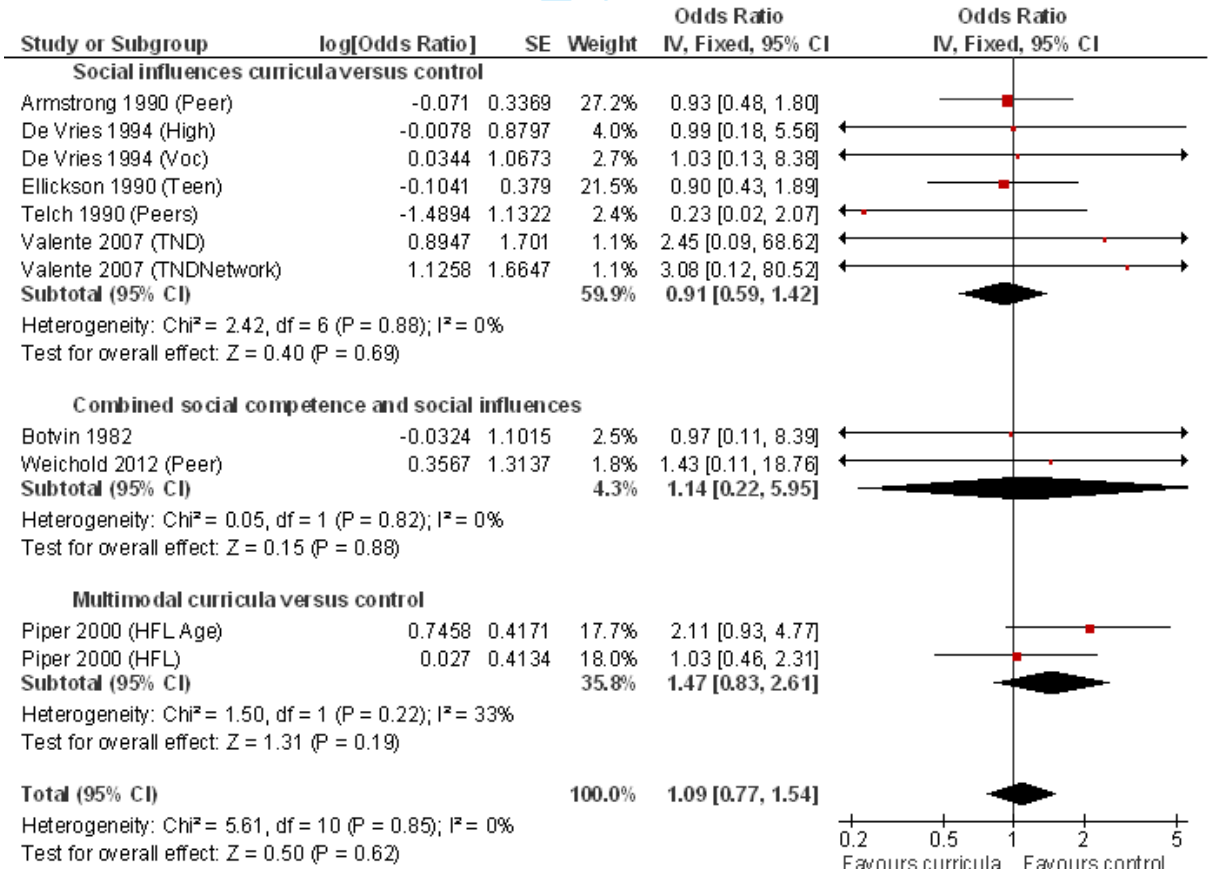


Forest plot showing results for tobacco-only curricula versus control (longest follow-up)

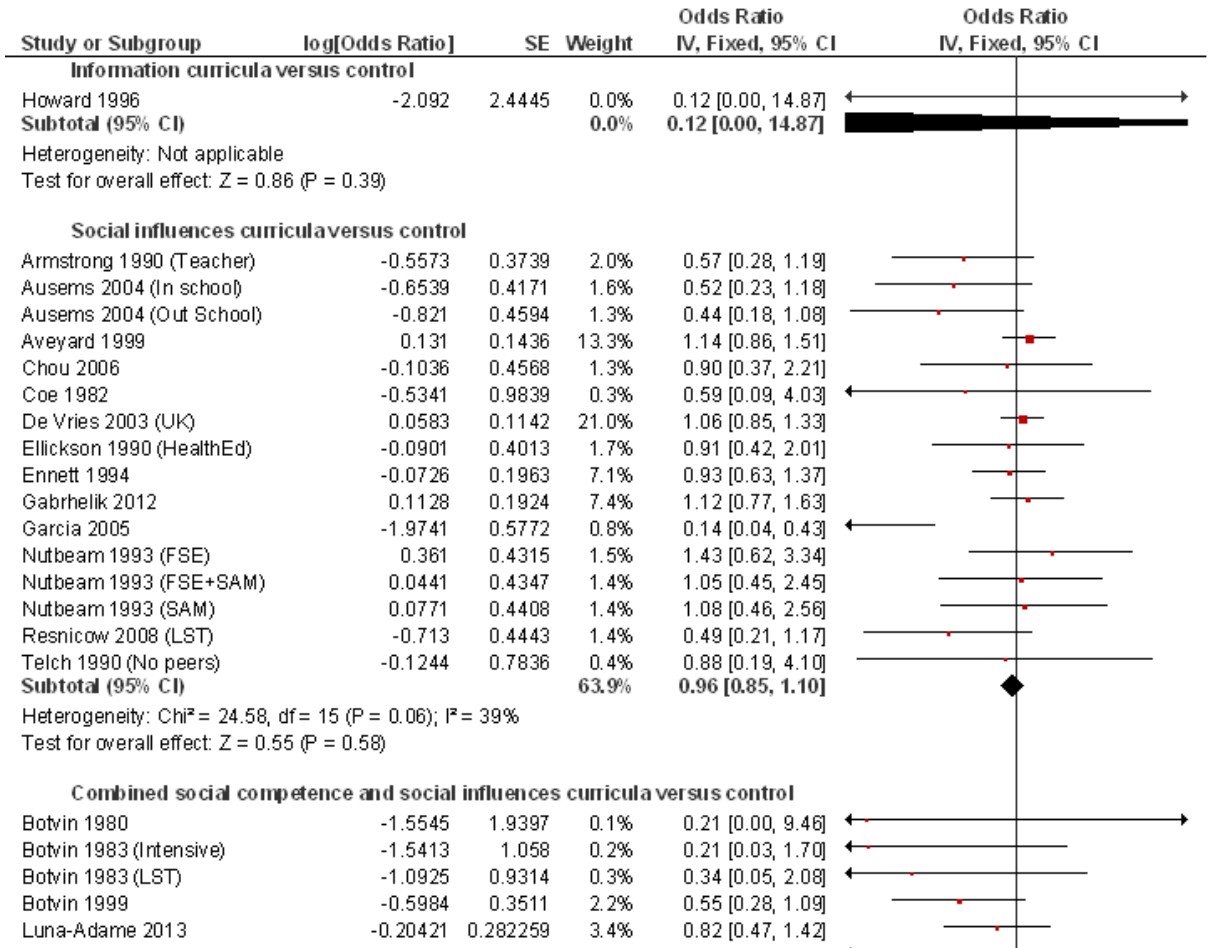
Forest plot showing results for curricula delivered by peers versus control (one year or less follow-up)



Forest plot showing results for curricula delivered by peers versus control (longest follow-up)



Forest plot showing results for curricula delivered by adults versus control (one year or less follow-up)



Forest plot showing results for curricula delivered by adults versus control (longest follow-up)