



What public health strategies work to reduce the tobacco demand among young people? An umbrella review of systematic reviews and meta-analyses

Alice Mannocci^a, Insa Backhaus^{a,*}, Valeria D'Egidio^a, Antonio Federici^b, Paolo Villari^a, Giuseppe La Torre^a

^a Department of Public Health and Infectious Diseases, Sapienza University of Rome, Italy

^b Ministry of Health, Italy

ARTICLE INFO

Article history:

Received 27 February 2018

Received in revised form 11 February 2019

Accepted 19 February 2019

Keywords:

Systematic review

Tobacco policies

Smoking cessation

Framework convention on tobacco control

Adolescents

Preventive interventions

ABSTRACT

Objective: To perform an umbrella review of systematic reviews and meta-analyses of health policy and health promotion strategies to reduce the tobacco demand in adolescents, youth and young adults.

Methods: Reviewers independently performed an electronic database search, reviewed titles and abstracts, assessed articles' eligibility for inclusion and quality, and extracted relevant data. Only systematic reviews and meta-analyses reporting data on tobacco policies and interventions focusing on individuals aged <25 years were included. The Framework Convention on Tobacco Control was used to guide data synthesis.

Results: 13 articles were included. Studies were of mixed quality with five studies ranked as critically low and seven as high quality. Overall, mixed results were found on the effectiveness for tobacco policies and interventions. Strategies such as increasing taxes on tobacco products were most promising.

Conclusion: Though data on a variety of measures to reduce smoking is available, conclusions concerning the effectiveness are inconclusive. Tobacco policies and interventions have the potential to reduce smoking, but conclusions are hampered due to both lack of high-quality trials and numerous biases in primary studies. Further high-quality research is required to examine the effectiveness of interventions and policies to reduce the tobacco demand in adolescents, youth and young adults.

© 2019 Elsevier B.V. All rights reserved.

1. Introduction

With nearly six million deaths annually worldwide, tobacco consumption remains one of the biggest threats to public health. This trend is predicted to become more serious by 2030, causing eight million deaths per year. Many countries are at different stages of the tobacco epidemic; while some countries were able to reduce smoking prevalence rates, others are still experiencing increases in smoking prevalence [1].

With the introduction of the WHO Framework Convention on Tobacco Control (FCTC) on 27 February 2005, tobacco control policies and interventions are being implemented worldwide. The FCTC is a framework that was developed in response to the globalization of the tobacco epidemic and supports several control

strategies such as pricing and taxation measures, smoke-free policies, tobacco product legislation, appropriate labelling of products (including health warnings), tobacco-related education, control of illicit tobacco product trade and control of tobacco sale to/by minors [2]. Subsequently, governments across the world have become increasingly engaged with the tobacco problem. In 2013, the Italian government, for instance, introduced a law prohibiting smoking on school premises; and in 2014 the EU issued a law requiring EU countries to implement health warnings that must occupy at least 65 percent of both the front and back of cigarette packets [3].

However, despite this large number of interventions, campaigns and policies, thousands of young people start to smoke cigarettes every year. Of course, this topic has also raised considerable interest among researchers, which has led to the production of many primary studies [4–6] as well as systematic reviews and meta-analyses regarding the efficacy and effectiveness of tobacco control approaches. Still, complete overviews focusing particularly on adolescents and young adults are rare. Lemmens and colleagues performed a systematic review of reviews on the effectiveness of

* Corresponding author at: Department of Public Health and Infectious Diseases, Sapienza University of Rome, Piazzale Aldo Moro 5, 00185 Rome, Italy.
E-mail address: insa.backhaus@uniroma1.it (I. Backhaus).

smoking cessation interventions, but their work focused on adults only and was completed almost 10 years ago [7]. Since then, many other tobacco control strategies have been implemented. To our knowledge, no systematic overview of the effectiveness of tobacco control interventions for adolescents and young adults has been performed. Thus, the present systematic review aimed to:

- A.) provide a complete overview of systematic reviews and meta-analyses focusing on adolescents and young adults published since 2010;
- B.) identify the most effective health policy and health promotion strategies for reducing the tobacco demand and increasing smoking cessation in accordance to the FCTC focusing on adolescents, youth and young adults.

2. Materials and methods

The Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) Statement [8] and the guidelines developed by Aromataris et al. [9] were followed to perform this umbrella review of systematic reviews and meta-analyses. The study was based on a previously established protocol reviewed by a research team with expertise in knowledge synthesis and overview reviews. The study was not registered with PROSPERO or similar registers.

2.1. Identification of relevant studies

Relevant systematic reviews and meta-analyses that examined the impact of tobacco control policies, interventions and strategies in adolescents, youth and young adults were identified through systematic searches of three electronic databases: PUBMED, Scopus and the Cochrane Library. Articles published between January 2010 and September 2017 were included. This time window for research was chosen as PRISMA was developed after 2009, meaning that high-quality reviews were expected to be found. Reviews that did not follow a systematic methodology and other overviews of systematic reviews were not included. Nevertheless, they were examined (e.g. check of reference list) to ensure that no relevant review has been missed. All studies - regardless of the language of publication were considered for inclusion. Systematic reviews and meta-analyses of randomized-controlled trials (RCT), controlled trials (CT), non-randomized controlled trials (n-RCT) and observational studies were included in the overview. While results of RCTs are considered more robust and gold standard, well-conducted quasi-experimental studies may also provide strong evidence. Eligible studies were selected through a multi-step approach (title reading, abstract and full-text assessment) by three independent researchers. In addition, the researchers searched the reference list of included articles and grey literature to ensure that no relevant article had been missed. The following search algorithms were used:

2.1.1. PUBMED

(Smoke[Title] OR tobacco[Title] OR cigarette[Title]) AND ((poli*{Title/Abstract} OR health policy{Title/Abstract} OR health promotion{Title/Abstract} OR health impact{Title/Abstract}) AND ((Review[ptyp] OR systematic[sb] OR Meta-Analysis[ptyp]) AND (2010/01/01[PDAT] : 2017/09/01[PDAT]) AND English[lang]).

2.1.2. Scopus

(TITLE(Smoke) OR TITLE(Tobacco) OR TITLE (cigarette) AND TITLE-ABS-KEY (policyOR health policyOR health promotionOR health impact)) AND DOCTYPE(re) AND PUBYEAR > 2010 AND LANGUAGE(English)

2.1.3. Cochrane

Smokein Title, Abstract, Keywords or tobaccoin Title, Abstract, Keywords or cigarettein Title, Abstract, Keywords and reviewand policyOnline Publication Date from Jan 2010 to September 2017, in Cochrane Reviews (Reviews only) (Word variations have been searched).

2.2. Study selection and eligibility criteria

The first selection was performed by filtering duplicated articles using a bibliographic software. Three researchers independently performed title and abstract screening. Each investigator independently evaluated full-texts according to the inclusion criteria. Disagreements between the reviewers were resolved during a consensus session with a fourth reviewer. Regarding Cochrane Reviews, only the most recent reviews were included. Furthermore, this umbrella review was restricted to population-based interventions, and therefore, pharmaco-intervention were excluded. Apart from that medications such as nicotine replacement and bupropion among adolescents were linked to adverse events [10]. Table 1 shows the inclusion and exclusion criteria.

2.2.1. Indicators of effectiveness

The effectiveness of an intervention or policy was based on several outcome measures. The primary outcome of interest was a change in smoking behavior, e.g. being a smoker at baseline and becoming an ex-smoker at posttest, a decrease in smoking prevalence, a decrease in smoking initiation, and other tobacco-related outcomes.

2.3. Data extraction and quality assessment

Data were independently extracted by three reviewers, who then independently rated the quality of each article using the updated AMSTAR 2 version for systematic reviews and meta-analyses [11]. Any disagreement was resolved through a consensus session with a fourth researcher. The following study characteristics were extracted:

- author name;
- publication year;
- study design of included studies in the article;
- primary and secondary outcome;
- population (<25 years old);
- countries of the primary studies included the reviews;
- comparator group;
- risk of bias;
- results of the tobacco control measure.

In addition, since flaws in the design, conduct, analysis, and reporting of studies can cause the effect of an intervention to be under or overestimated, reviewers extracted data on the quality of evidence as well as on the risk of bias of primary studies, including selection bias (e.g. sequence generation) and detection bias (e.g. blinding of outcome assessment). Where possible, the authors referred to results of the GRADE assessment and/or the Cochrane Risk of bias tool.

2.4. Data synthesis

To organize the amount of information, the FCTC was used as a framework for data synthesis. Summaries were performed by sub-categories corresponding to the articles of the FCTC. In particular, reference was made to articles 6-14. These articles contain the core demand reduction provisions and are subdivided into three main articles: price and tax measures to reduce the demand for tobacco

Table 1
Inclusion and exclusion criteria.

	Include	Exclude
Population	Pre-natal, children, adolescents, college students, young ≤ 25 . Healthy individuals.	Adults, young >25 . Patients
Interventions	Interventions and policies to reduce smoking, smoking cessation intervention policies	Pharmaco-intervention and interventions and policies against alcohol or other drugs
Comparators	No intervention, any comparators	Pharmaco-interventions
Outcomes	Initiating tobacco use, cessation, consumption, decrease smoking, smoking initiation prevalence, smoking prevalence and other tobacco related outcomes	Not listed as an included outcome
Context/setting	All settings, geographic location and culture	
Timing	Any duration	None
Study types and designs	Systematic review and meta-analysis of RCT, CT, n-RCT and observational studies	Non-systematic reviews, overview, primary studies, systematic review including theoretical studies or published opinion

(Art. 6), non-price measures to reduce the demand for tobacco (Art. 7) and demand reduction measures concerning tobacco dependence and cessation (Art. 14). Article 7 is divided into further seven articles (Art. 8–13), namely:

- Protection from exposure to tobacco smoke (Art. 8);
- Regulation of the contents of tobacco products (Art. 9);
- Regulation of tobacco product disclosures (Art. 10);
- Packaging and labelling of tobacco products (Art. 11);
- Education, communication, training and public awareness (Art. 12);
- Tobacco advertising, promotion, and sponsorship (Art. 13).

3. Results

The electronic search initially resulted in 1304 citations of which 1058 remained after deduplication. Another 835 studies were excluded after screening the titles and abstracts. About 220 full-text articles were selected and read. Only systematic reviews and meta-analyses focusing on adolescents or young adults were included in the analysis. A total of 13 studies were included in this umbrella review, of which six were systematic reviews [12–17] and 7 were meta-analyses [18–24]. Most systematic reviews and meta-analyses included primary studies from a range of countries (e.g. Australia, Germany, USA, etc.). One review included primary studies specific to India [17], and another study reviewed studies that examined the impact of tobacco prices or taxes in countries of Latin America and the Caribbean [25]. Fig. 1 shows the PRISMA flowchart and the study selection process. A list of excluded studies can be found in the supplemental material. Study outcomes are described narratively because considerable variation in measures across studies precluded meta-analysis.

3.1. Characteristics of studies

Characteristics of included systematic reviews and meta-analyses are shown in Table 2. Most articles ($n=6$) referred to FCTC Article 12 (Education, communication, training and public awareness), followed by FCTC Article 8 ($n=5$, Protection from exposure to tobacco smoke). No systematic reviews or meta-analyses were found relating to FCTC Article 9 (Regulation of the contents of tobacco products) and Article 10 (regulation of tobacco product disclosures).

3.2. Quality of included reviews

Findings of the quality assessment are presented in Table 3. Seven systematic reviews were judged to be of high quality [14,15,18,20–22,24], one of low quality [16] and five studies of critically low quality [12,13,23,27,28]. Apart from the study conducted by Thomas et al. [23], all studies judged as critically low failed to sat-

isfy AMSTAR item 9 (a satisfactory technique for assessing the risk of bias in individual studies included in the review). The systematic review conducted by Allen et al. failed to meet nearly all items, besides Item 10 (sources of funding of included studies), this, however, was only partially met [12]. Most of the systematic reviews and/or meta-analyses judged their studies to be at high or unclear risk of bias. Table 4 indicates the quality of evidence of included primary studies in systematic reviews and meta-analyses.

3.3. Summary of findings

Table 5 represents a summary of the strength of evidence to reduce and prevent smoking. The column evidence of effectiveness is based on the overall conclusion of the systematic reviews/meta-analyses, the column quality of review/meta-analysis is based on the AMSTAR assessment, and the column quality of primary studies is based on the quality and risk of bias assessment by the authors of the systematic reviews and meta-analyses.

3.4. Price and tax measures to reduce the demand for tobacco (Article 6 FCTC)

The one identified systematic review in this category found out that raising cigarette prices through increased taxes is an effective tobacco control policy measure for reducing smoking participation and consumption among youth and young adults. Bader et al. who focused on youth (<19 years) and young adults, (18–24 years) [13], showed that people aged below the age of 19 were generally two to three times more price-responsive than the general population. Nonetheless, the impact of increased price on youth (<19 years) smoking initiation, is debatable. Whereas some studies included in the review found that increasing prices prevents smoking onset among youth, other studies found no significant effect [13]. Positive results were also found among young adults. Increased prices resulted in reductions in smoking in people aged between 18 and 24 years. In addition, the authors found out that price is inversely related to both smoking participation and consumption. Price has also been found to have an impact on encouraging cessation, but as with youth, the impact of price on smoking initiation is somewhat unclear. According to the AMSTAR 2 assessment, this review was of critically low quality.

3.5. Non-price measures to reduce the demand for tobacco (Article 7 FCTC)

3.5.1. Article 8: Protection from exposure to tobacco smoke

Four reviews present research evidence on the effectiveness of policies and interventions concerning the protection from exposure to tobacco smoke (Table 2). All of these studies were of mixed quality varying from high quality to critically low quality [15–17,28].

Table 2
Characteristic of meta-analys.

FCTArticle	First author, year	Review type	Study design of included studies in the review	Tobacco control measure	Studies included in the systematic review	Primary outcome	Secondary outcome	Participants	Follow-up	Effectiveness
8	Lupton, 2015	Meta-analysis	RCT, cross-sectional	Smoke-free policies	19	Percentage of students of smoke-free policy		College students	Not stated	Support smoke-free policies: students OR = 58.94 (95%CI: 52.35 - 65.53) and faculty OR = 68.39 (95%CI: 65.12 - 71.67)
12	Taylor, 2017	Meta-analysis	RCT, quasi-randomized CT	Internet-based interventions	67	Smoking cessation at least 6 months after the start of the intervention and longer	Not specified	Adolescents and young adults	> 4 weeks	Smoking cessation at 6 months + follow-up (young adults) RR = 1.95 (95%CI: 1.42 - 2.69), internet versus active control: young adults: RR = 1.42 (95%CI: 0.74 - 2.71), adolescents: RR = 0.44 (95%CI: 0.14 - 1.36)
12	Thomas, 2016	Meta-analysis	RCT	Family-based interventions alone and combined with school-based interventions	27	Initiating tobacco use		5-18 years	> 6 months to 29 years	Family intervention versus nonintervention control group: high intensity RR = 0.71 (95%CI: 0.61 - 0.82), medium RR = 0.84 (95%CI: 0.67 - 1.03), low RR = 0.61 (95%CI: 0.61 - 0.85). Total RR = 0.76 (95%CI: 0.68 - 0.84). Evidence of a benefit for combining family and school intervention versus school intervention alone (RR = 0.85 (95%CI: 0.75 - 0.96). Lower odds of weekly or monthly smoking: peer-led intervention smoking: OR = 0.78 (95%CI: 0.62 - 0.99)
14	Macarthur, 2016	Meta-analysis	RCT	Peer-led interventions	17	Tobacco use (including smokeless tobacco)		11-21 years	> 3 months to 7 years	Trans theoretical model of change: RR = 1.56 (95%CI: 1.21 - 2.01); Interventions including motivational enhancement compared to brief interventions: RR = 1.6 (95%CI: 1.28 - 2.01); Anti-tobacco program "NoT" smoking cessation in young people: RR = 1.31 (95%CI: 1.01 - 1.71)
14	Stanton, 2013	Meta-analysis	RCT, c-RCT, CT	Pharmacotherapy, psychosocial interventions and complex programs targeting families, schools or communities	28	Smoking status	Adverse events	< 20 years	> 6 months	No statistically significant effect: RR = 1.00 (95%CI: 0.84 - 1.19); non-r-CT: RR = 0.82 (95%CI: 0.63 - 1.08)
14	Hefler, 2017	Meta-analysis	RCT, CT, n-RCT	Incentives (contests, competitions, incentive schemes, lotteries, raffles, and contingent payments to reward not starting to smoke, thereby remaining a non-smoker)	8	Initiating tobacco use	Dose-response of the amount of incentive	5-18 years	6 months to 24 months	

Table 2 (Continued)

FCTArticle	First author, year	Review type	Study design of included studies in the review	Tobacco control measure	Studies included in the systematic review	Primary outcome	Secondary outcome	Participants	Follow-up	Effectiveness
12	Thomas, 2013	Meta-analysis	RCT, c-RCT	School smoking interventions	34	Smoking initiation prevalence	Frequency of smoking, number of cigarettes smoked, smoking indices	5 - 12 and 13- 18	> 6 months	Pure prevention cohorts detected a significant effect at longest follow-up, with an average 12% reduction in starting smoking compared to the control groups, but no overall effect was at one-year follow-up (OR = 0.94, 95%CI: 0.85 - 1.05). Change in smoking behavior studies showed a small but statistically significant effect favoring controls at one year or less.
6	Bader, 2011	Systematic Review	Not specified	Tobacco taxation and pricing	67	Reducing smoking	initiation, cessation, consumption (quantity smoked by smokers)	<19 years and 19 - 24 years		Strong evidence that raising cigarette prices through increased taxes is effective for reducing smoking behavior among youth and young adults.
8	Galanti, 2014	Systematic Review	Any study design	anti-tobacco policies (exposure) such as sanctions or punishment	31	smoking initiation prevalence	smoking prevalence	10-21 years	Not specified	The evidence of effectiveness of school tobacco policies is weak and inconclusive.
8	Coppo, 2014	Systematic Review	cRCT, CT, interrupted time series, observational	School tobacco policies	1	Smoking prevalence	Actual tobacco use by teachers and school staff, Tobacco use of teachers, school staff, and students as perceived by other students, Compliance with the policy by students, teachers and school staff, Exposure to environmental tobacco smoke	Students (primary & secondary schools) (10 to 18 years old)	1 year	No significant evidence.
6, 8, 11, 12	McKay, 2015	Systematic Review	Cross-sectional	All	80	Knowledge about tobacco use, advocacy skills	tobacco consumption	young people	Not specified	Tobacco-use outcomes could be improved by school/community-based and adult education interventions, and cessation assistance.
12	Allen, 2015	Systematic Review	Quantitative studies	Mass media campaigns	34	Cognitions and behaviour	effectiveness of campaign characteristics among youth	<19 years	None	
12	Carson-Chahhoud, 2017	Systematic Review	cRCT, CT, interrupted time series	Media interventions (e.g. television, radio, newspapers, billboards, posters, leaflets or booklets)	8	Smoking rates /tobacco use	Smoking attitudes, Intentions to smoke, smoking knowledge, self-esteem/self-efficacy, smoking perception, process perception, process measures, cost-effectiveness	< 25 years	18 months to 6 years	No certainty about the effects of mass media campaigns on smoking behaviour.

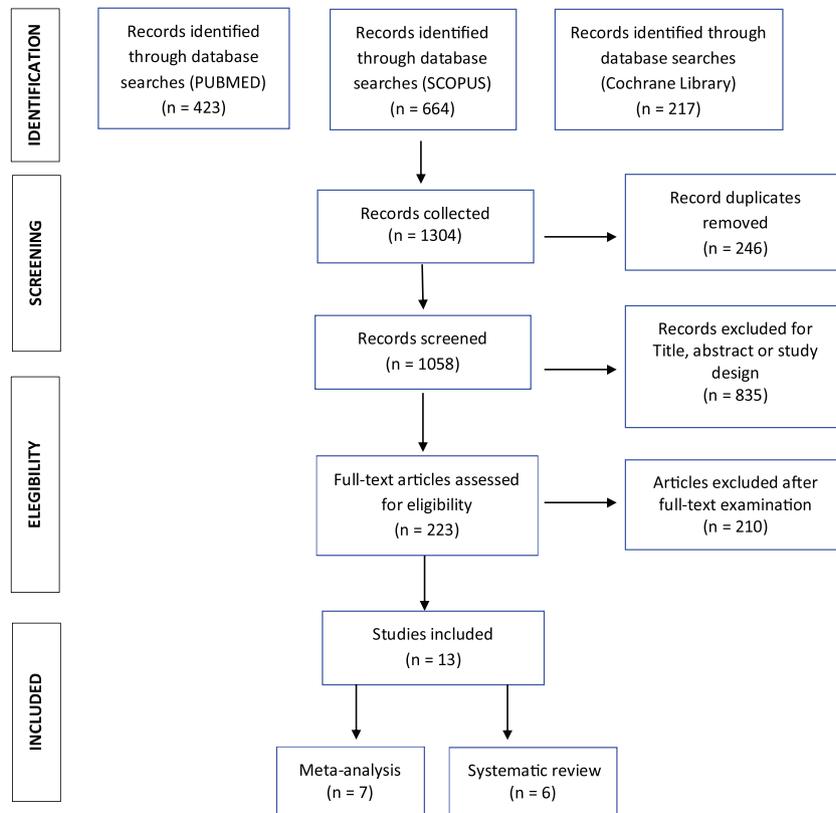


Fig. 1. Flow diagram of the literature search results conducted.

Table 3
Quality assessment of included systematic reviews and meta-analyses according to Amstar2.^a

Author, year	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Final rating
Allen, 2015	0	0	0	0	0	0	0	0	0	2	NA	NA	0	0	0	0	Critically low
Bader, 2011	1	0	0	1	1	0	0	2	0	0	NA	NA	0	0	NA	1	Critically low
Carson-Chahhoud, 2017	1	1	0	2	1	1	1	1	1	0	NA	NA	1	0	NA	1	High
Coppo, 2016	1	1	1	1	1	1	1	1	1	0	NA	NA	1	1	1	1	High
Hefler, 2017	1	1	1	2	1	1	1	1	1	0	1	1	1	1	1	1	High
MacArthur, 2017	1	1	0	2	1	1	2	1	1	0	1	1	1	1	1	1	High
Lupton, 2015	0	0	0	2	0	0	2	2	0	0	1	0	0	0	1	1	Critically low
Galanti, 2014	1	0	1	2	1	1	0	1	0	0	NA	NA	1	1	NA	1	Critically low
McKay, 2015	1	0	0	1	1	1	1	1	1	1	1	0	1	0	0	1	Low
Stanton, 2013	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	High
Taylor, 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	High
Thomas, 2015	1	1	1	2	1	1	0	0	1	1	0	0	0	0	1	1	Critically low
Thomas, 2013	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	High

^a AMSTAR 2 Item 2, 4, 7, 9, 11, 13, 15 are considered critical domains that are believed to critically affect the validity of a review and its conclusion. Studies were judged critically low if the review had more than one critical flaw with or without non-critical weaknesses. 0=no, 1=yes, 2=partial yes, NA=not applicable.

3.5.1.1. *Smoke-free legislation/policy at universities.* Lupton and Townsend [28] included 19 studies in their systematic review and meta-analysis and focused on the effectiveness of smoke-free policies at the university campus. The authors discussed several studies (cross-sectional and longitudinal) from the US. One study compared two US universities and their campus-wide smoke-free policy. While one university implemented a full smoke-free policy, the other one implemented an outdoor ban only (within a certain distance of doorways). They found a post-ban reduction from 16.5% to 12.8% after one year ($p < 0.001$) and 9.5% to 7.0% ($p < 0.036$) after three years at the university with the full smoke-free campus, whereas the control university's undergraduate smoking prevalence increased non-significantly from 9.5% to

10.1% [29]. Nevertheless, the quality of this review was rated as critically low quality. In particular, because Lupton and Townsend did not use a satisfactory technique for assessing the risk of bias (RoB) nor did they account for RoB in individual studies when interpreting and discussing the results.

3.5.1.2. *Smoke-free legislation/policies at school.* Three studies assessed the effectiveness of smoke-free policies at school [15–17]. The authors of a Cochrane Review found no reliable evidence to support the effectiveness of school tobacco policies aiming to prevent smoking initiation among students [15]. The review authors considered one c-RCT eligible for inclusion in the review. No significant differences were found concerning the smoking prevalence between intervention and control schools. Besides, the study was

Table 4
Quality of evidence of primary studies.

Author, Year	Quality assessment	Risk of bias	Reason/Explanation for risk of bias and/or quality rating
Allen, 2015	Not assessed	Not assessed	Not further explained
Bader, 2011	Quality ratings for all studies were strong or moderate ¹	Not assessed	Not further explained
Carson-Chahhoud, 2017	Very Low ⁶	Risks of bias were high across all included studies ³	Sequence generation was unclear in three studies, and at high risk in the remaining five, Allocation concealment was unclear in two studies and at high risk in the remaining six. All studies were at high risk for blinding of participants due to the nature of the intervention. No authors mentioned an attempt to conceal allocation from outcome assessors. Incomplete outcome reporting of data could not be excluded in any of the seven controlled trials and we rated all of them at high risk of bias due to a lack of information from individual study authors. Selective reporting was unclear in five studies, due to a lack of information reported in the publications, and at high risk in the remaining three studies. Three studies failed to address an imbalance in outcome measures at baseline, three studies were unclear, leaving two studies that adequately addressed this outcome.
Coppo, 2016	Very Low ⁶	The one study included was judged to be at high risk of bias ³	The only study included (Chen 2014), had a small sample size of only 4 schools, a high risk of intraclass correlation, a likely absence of blinding, and lack of information to assess the presence of selective reporting; we judged the risk of bias of this study to be very high.
Hefler, 2017	Low for RCTs and Very Low for non-RCTs ⁶	RCTs unclear risk of bias, non-RCTs high risk of bias ³	Using GRADE, the authors rated the overall quality of the evidence for our primary outcome as 'low' (for RCTs) and 'very low' (for non-RCTs), because of imprecision (all studies had wide confidence intervals), and for the risks of bias identified.
McArthur, 2017	Quality of evidence for each outcome was considered to be low ^{3,6}	Unclear risk of selection bias, high risk of performance bias. For many studies, due to insufficient information and/or poor reporting, difficult to judge risk of bias ³	Insufficient information was provided around the methods of random sequence generation and/or allocation concealment
Lupton, 2015	Not further specified	All 12 studies resulted in a significant negative publication bias. No other risk of bias is not investigated	The risks of bias connected with improper control for confounding when the exposure is measured at the group level have been highlighted
Galanti, 2014	Low or very low ⁶	High risk of bias	The risks of bias connected with improper control for confounding when the exposure is measured at the group level have been highlighted
McKay, 2015	Well reported for each article Low ⁶	Well reported for each article The majority of studies were judged to be at high or unclear risk of bias in at least one domain ³	Not further explained
Stanton, 2013			Seven studies were judged as high risk of selection bias either because groups or institutions were not randomly allocated or because of the way in which students within clusters were recruited. Four of the individual studies were rated at high risk of selection bias because of the method of allocation or concealment.
Taylor, 2017	Moderate ⁶	Some of the included studies were at high risk of bias ³	Most studies at low risk of bias in most or all domains, we judged a number of studies to be at high or unclear risk of bias. Over a quarter were at high or unclear risk of attrition bias, characterized by overall attrition rates greater than 50%, or more than 20% difference in attrition rates between trial arms. Several studies were at unclear risk, as there was insufficient detail to assess risks of bias for random sequence generation or allocation concealment or both.
Thomas, 2015	Moderate ⁶	Most studies have low or unclear risk of bias	Absence of specific statements by authors.
Thomas, 2013	Not further specified	Low risk of bias	Not further explained

1: Effective Public Health Practice Project Quality Assessment Tool, 2: EPOC quality criteria, 3: Cochrane Risk of bias assessment tool, 4: QATSDD scores, 5: Newcastle-Ottawa Quality Assessment Scale, 6: GRADE Working Group grades of evidence.

judged to be at high risk of bias. In addition, when authors considered another 24 observational studies for hypothesis generation, no differences in smoking prevalence between intervention and control groups were detected [15]. Likewise, Galanti et al. [16] examined 31 cross-sectional studies focusing on a student population aged between 10 to 21 years. The authors state that due to the heterogeneity of the study, methodological limitations, the very low quality and a high risk of bias, evidence concerning the effectiveness of school policies cannot be made. The authors stress that the evidence is weak and conclusions about the effectiveness of an anti-tobacco policy could not be drawn. The included studies examined were classified as very low quality with a high risk of bias. McKay and colleagues [17] studied which tobacco control approaches have been successful in India. The authors reviewed five cross-sectional studies and conclude that secondhand smoke

(SHS) exposure declined among young people between 2003 and 2006 from 36.4% to 26.6% at home and from 48.7% to 40.3% in public places, after the introduction of a smoking ban on the college campus.

3.5.2. Article 12: Education, communication, training and public awareness

Six reviews focused on education, communication, training, and public awareness (Table 1), of which two were of critically low quality [12,23], one of low quality [17] and three of high quality [14,22,24]. Of those reviews, all but one found that education or media campaigns are effective to either reduce tobacco use. The reviews also indicate that knowledge about the harmful effects of tobacco use significantly increased.

Table 5
Summary of strength of evidence on strategies to reduce and prevent smoking.

Intervention	Evidence of effectiveness	Quality of review/meta-analysis	Quality of primary studies	Quantity of primary studies	Overall conclusion
Price and tax measures to reduce the demand for tobacco	Mixed results for young people (<19 years). Effective For young adults (>19 years)	Critically low	Moderate to strong	86	Price and tax measures might be an effective policy tool for reducing smoking participation and consumption among, young adults.
Smoke-free legislation and or policy at universities	Mixed results	Critically low	Not assessed	19	There is only weak evidence about the effectiveness of smoke-free university campuses, therefore no appropriate conclusions about the effectiveness can be drawn.
Smoke-free legislation and or policy at school	Not effective	Critically low to high	Low	12	No conclusion about the effectiveness of School tobacco policies can be drawn.
School education	Mixed results	High	Moderate	54	School-based education can be effective. Particularly, programs that use a social competence approach and those that combine a social competence with a social influence approach.
Mass-Media Campaigns	Mixed results	Critically low to high	Very low	42	Appropriate conclusion cannot be drawn.
Internet-based interventions	Not effective	High	Moderate to low	4	Appropriate conclusion cannot be drawn.
Family-based interventions	Effective	High	Moderate	27	There is moderate quality evidence that family-based interventions can prevent children and adolescents from starting to smoke.
Peer-led interventions	Mixed results	High	Low	45	Appropriate conclusion cannot be drawn.
Incentives	Not effective	High	Very low to low	8	Not effective.

3.5.2.1. School education. Thomas et al. [24] aimed to determine whether school smoking interventions prevent youth from starting smoking. Based on the type of outcome, the authors placed studies into three groups: 1. Pure Prevention cohorts (Group 1), 2. Change in Smoking Behavior over time (Group 2) and 3. Point Prevalence of Smoking (Group 3). Group 1 included studies in which never-smokers were followed. Group 2 included studies in which an individual's smoking behavior was measured as change over time, and group 3 included studies that reported smoking prevalence at baseline and follow-ups. Thomas et al. found no overall effect for pure prevention cohorts at one year or less (OR=0.94; 95% CI: 0.85–1.05), but a significant effect at longest follow-up, with an average 12% reduction in starting smoking compared to the control groups. The subgroup analysis demonstrated a statistically significant effect preventing the onset of smoking (OR=0.49; 95%CI: 0.28–0.87) for interventions combining social competence and social influences. Programs involving information only (OR=0.12; 95%CI: 0.00–14.87, one study), social influences only (OR=1.00; 95%CI: 0.88–1.13), or multimodal interventions (OR=0.89; 95%CI: 0.73–1.08) were ineffective. Group 2 included studies in which the smoking behavior was measured as change over time. Studies reporting change in smoking behavior over time did not show an overall effect. In fact, pooling data found a small but statistically significant effect favoring controls ((standardized mean difference (SMD) 0.04, 95% CI 0.02–0.06)) at one year or less. For follow-up longer than one year a statistically nonsignificant effect was found (SMD 0.02, 95% CI –0.00–0.02).

McKay et al. [17] reviewed the extent of tobacco control measures and the outcomes of associated trialed interventions in India. The author argued that school-based education and cessation assistance interventions demonstrated a positive impact on knowledge, advocacy skills as well as on tobacco use.

3.5.2.2. Mass-media campaigns. Two studies examined the effectiveness of mass-media campaigns [12,14]. Of the identified

studies, one study [12] detected that mass-media campaigns are effective in reducing tobacco-use across young people, while the other study expressed uncertainty towards their effectiveness [14]. The quality of these reviews varied from critically low [12] to high [14]. Allen et al. [12], in particular, stress the positive effects of mass-media campaigns to reduce tobacco across young people and racial and ethnic populations. The researchers further highlight that the magnitude of the campaign effect can differ by race and ethnicity. Young people were particularly sensitive to advertising that included personal testimonials, intense images, and a surprising narrative and as well as sound and editing. On the contrary, Carson-Chahhoud [14] conclude that a reliable conclusion could not be drawn due to inconsistency between study design and results, as well as methodological issues and hence the high risk of bias of included studies.

3.5.2.3. Internet-based interventions. One meta-analysis focused on determining the effectiveness of internet-based interventions [22]. The meta-analysis was judged as high quality. The authors included 67 RCTs in their review of which only four RCTs emphasized adolescents and young adults and were subsequently included for a meta-analysis. In all four trials, web-based interventions are compared to control groups receiving another kind of intervention: internet intervention, a non-internet intervention or no intervention. For example, in one included RCT university students were randomized to one of two intervention groups. One intervention group “websmoke” was a tailored and interactive internet intervention, in which students were asked to create a video message about smoking to be included on the website. Participants also had access to the website that included interactive components such as a smoking cost calculator and quizzes. In the other intervention arm, participants had access to a similar webpage, but interactive features were not available. Although the analysis found a favoring effect for the intervention group, the results were not significant (RR = 1.42; 95%CI: 0.74–2.71) [31]. Another research team

compared the effect of home-based internet-delivered treatment with in-person (individual) counselling sessions, among university students. Again, the confidence interval crossed the null and no significant differences between internet versus in-person counselling were found (RR = 0.44; 95%CI: 0.14–1.36) [30]. Overall, the authors conclude that the effectiveness of internet interventions in adolescents or young adults is unknown.

3.5.2.4. Family-based interventions. One research team investigated whether family interventions can influence children and adolescents' smoking behavior. Thomas et al. [23] suggest that family-based interventions can have a positive effect on preventing children and adolescents from initiating smoking compared to no-intervention controls or as an add-on to a school intervention. Family-based intervention were interventions including components to change parenting behavior, parental or sibling smoking behavior, or family communication and interaction. Meta-analyzed data detected a significant reduction in smoking behavior in the intervention arms with a RR of 0.76, (95%CI: 0.68 - 0.84). There is also evidence that combining family-based intervention and school interventions may be effective (RR = 0.85; 95%CI: 0.75 - 0.96) [23]. The study was judged as high quality.

3.6. Demand reduction measures concerning tobacco dependence and cessation (Article 14 FCTC)

Three articles related to demand reduction measures using peer-led interventions or incentives. All articles were rated as high quality [18,20,21].

3.6.1. Peer-led interventions

Two high-quality meta-analyses summarized data on the effectiveness of peer-led interventions. MacArthur et al. [20] meta-analyzed 10 studies and found overall positive results. Young people who received peer-led interventions had lower odds of smoking compared with those who did not (OR = 0.78; 95%CI: 0.62 to 0.99).

Stanton and Grimshaw [21] included 28 trials and around 6000 young people. Their analysis found out that complex approaches (interventions including more than one approach, e.g. quit kit and tailored telephone counselling), showed the most promising results, specifically those incorporating elements sensitive to stage of change and using motivational enhancement and CBT. Interventions using the trans-theoretical model (TTM) achieved moderate long-term success at 1 year (RR = 1.56; 95%CI: 1.21–2.01) and intervention incorporating motivational enhancement gave an estimated RR of 1.60 (95%CI: 1.28–2.01). However, the authors emphasize that the majority of studies included in their analysis were rated at high or unclear risk of bias.

3.6.2. Incentives

Hefler et al. [18] aimed to assess the effect of incentives on preventing children and adolescents (aged 5 to 18 years) from up-taking smoking, taking data from eight trials (three eligible RCTs and five CTs). Incentives were defined as “any tangible benefit externally provided with the explicit intention of preventing smoking”. These included contests, competitions, incentive schemes, lotteries, raffles, and contingent payments to reward not starting to smoke, thereby remaining a non-smoker as well as rewards to third parties (e.g. to schools, healthcare providers or family members), as well as interventions that directly rewarded children and adolescents. The authors did not find statistically significant results for the use of incentives to prevent smoking. However, the review authors stress that only relatively few published studies are currently avail-

able, and these are of variable quality. As a result, conclusions regarding effectiveness cannot be drawn.

4. Discussion

The purpose of this paper was to summarize and comprehensively review systematic reviews and meta-analyses on the effectiveness and efficacy of tobacco control policies and interventions in adolescents, youth and young adults. This review found unclear evidence on the effectiveness and impact of single policies, interventions, and other tobacco reductions programs, but highlights several promising strategies. It is important to note that a rigorous evaluation of policies and complex population-based interventions was methodologically challenging, because of the difficulty of controlling for all possible biases in a real-world setting. The fact that many primary studies are deemed ‘low quality’ or ‘at high risk of bias’ reflects these methodological challenges.

Despite these difficulties some strategies have been proven more effective than others. Among those an increase in cigarette prices has been proven effective in reducing smoking participation and consumption, especially among young adults [13,34]. The effects of price on smoking behavior, however may depend on age, gender, income, peer and family influences as well as the broader context (e.g., school-status). Previous authors have argued that young people generally are more sensitive to changes in cigarette prices than adults. This may be due to numerous reasons. First, researchers, propose that given the addictive nature of cigarette smoking, younger persons, who had been smoking for a rather short time, are more likely to adjust faster to changes in price compared to adult smokers, who had been smoking for a longer time and therefore are likely to be more addicted [35,36]. Second, a young person's disposable income, for example, is much smaller than that of an adult [37]. In fact, adolescents' personal income has been positively related to smoking behavior independent of family socioeconomic status. One explanation is that adolescents with a higher income have more means to purchase cigarettes. Adolescents with lower personal income, on the other hand, have little or no money at all, which can be a powerful barrier against smoking [37]. Third, young people are more likely to feel influenced by their peers. Researchers found out that an increase in cigarette price directly reduces a given youth's smoking by indirectly reducing peer smoking. Peer smoking has a much greater impact on teenage smoking than it does on adult smoking [34,38].

Apart from price increases, somewhat positive results were found for warning young people about the dangers of tobacco through mass-media campaigns. But again, it was very difficult to disentangle their true effect due to inconsistency between studies in both design and results, and due to methodological flaws amongst primary studies included [14]. However, previous research has shown that well-planned mass-media campaigns can strengthen health literacy, raise awareness and consciousness about the consequences of smoking among adults [39,40]. In addition, mass-media campaigns may have a particular ability to change attitudes and perceived social environments of young people and might be especially appropriate for those young people that are at an increased risk of becoming smokers, particularly because these are also often the heaviest media users [41,42]. Other promising strategies included education, communication, training, and public awareness such as complex family-based interventions, and complex school educational programs combining social competence and social influence approaches. Although reviews indicated that education, communication, training, and public awareness significantly increased knowledge it is important to note that knowledge and attitude change does not necessarily translate into behavior

change, and that the effects of interventions aimed at changing knowledge and behavior tend to recede quickly.

Evidence-based judgement varied regarding the effectiveness of smoke-free policies in the school setting. While Lupton and Townsend [28] argued that smoke-free campuses are able to reduce the smoking behavior, change students' attitudes and second-hand smoke exposure; other review authors concluded that the evidence concerning the effectiveness that school policy alone in preventing youth tobacco use is weak and inconclusive [15,16]. This was due to great heterogeneity in the definitions of exposure to school anti-tobacco policy and of tobacco use, adjustment for potential confounders and bias, but also a general lack of primary evidence [15,16]. In fact, Coppo and colleagues were able to include only one study in their analysis.

In addition, no appropriate conclusions regarding the effectiveness of incentives could be drawn. This was due to the 'absence of evidence' (e.g. there are no/few high-quality primary studies). After all, if the quality of the primary studies is low and risk of bias high, then how can one be sure than non-significant results are correct. It is possible that there is a true effect that was not detectable due to bias.

The effectiveness of internet-based interventions in younger people is unclear. Reviews highlighted the fact that only little primary evidence was available making it difficult to determine their effectiveness [22]. Nevertheless, we believe, that in general, internet-based interventions can be a more effective means of reaching young people than the more traditional approaches. This is especially important because internet use by adolescents, youth and young adults has grown exponentially over the years and it can be accessed in young people's homes, on their smartphones, in public spaces and is usually available all day every day [22]. Besides, internet-based intervention hold promise since they are able to target a great span of adolescents, youth and young adults of any kind of background and socio-economic status and at any time of the day, and since they do not rely on school classroom time or resources [32,33].

We could not find evidence concerning the effectiveness of regulating the contents of tobacco products. However, research indicated that menthol cigarettes can lead to increased smoking initiation among youth and young adults, greater addiction and decreased success in quitting smoking. According to a systematic review conducted by Huang et al. [27] banning non-menthol flavors from tobacco products could help to protect the health of young people. The review demonstrated that non-menthols flavors play a key role in the initiation, progress, and continuation of smoking among young individuals [27]. The European Union and the U.S. Food and Drug Administration, for instance, have already implemented laws banning cigarettes containing characterizing flavors such as vanilla or candy [3,43]. A recent study from 2017 that used data from middle and high schoolers supports this and demonstrated that such a ban indeed had positive effects on tobacco use among adolescents [44].

Furthermore, despite our best efforts, we could not find systematic reviews and/or meta-analyses on age restrictions on tobacco sales. However, this has been a key policy strategy for preventing smoking uptake in adolescents. Several primary studies have been published on this topic suggesting a favorable impact of tobacco access laws on adolescent smoking [45–47]. Di Franza and colleagues, for instance, found that state compliance with tobacco sales laws was associated with a decreased risk of current daily smoking among adolescents. Similar results were found by Schneider et al. who compared youth smoking trends in a US City that had raised the minimum purchase age with those of surrounding communities. The authors detected a significant decrease in 30-day smoking in the city with higher purchase age compared to the communities with lower purchase age.

No systematic reviews or meta-analyses on the effectiveness of point-of-sale (POS) marketing restrictions were found. However, previous studies have found consistent evidence of a positive association between exposure to POS tobacco promotion and increased smoking and smoking susceptibility among young people [26,48]. Robertson et al. summarized in their meta-analysis (n = 13 studies included) that children and adolescents who are frequently exposed to POS tobacco promotion are about 60% more likely to have tried smoking (OR = 1.61; 95%CI: 1.33–1.96) and are around 30% more vulnerable to future smoking (OR = 1.32; 95%CI: 1.09–1.61) compared with those less frequently exposed. Therefore, policies banning tobacco POS promotion may effectively reduce smoking among children and adolescents.

Although we are unable to explicitly declare which intervention is most effective, studies included in this review indicate tobacco control measures such as a cigarette price increase and measures combining several tobacco control approaches may be effective in preventing and reducing tobacco consumption among adolescents, youth and young adults. More favorable long-term results, for instance, may be attained when school interventions are combined with other channels of influence such as the media and smoke-free policies [49,50].

In summary, many of the individual tobacco control interventions and policies assessed may help to reduce tobacco smoking uptake and support cessation, but their effectiveness is unclear due to a lack of reliable evidence from primary research studies. Yet, when making conclusions about the effectiveness of tobacco control measures, it is important to consider the context of each intervention. Clearer evidence was found to support increasing the price of tobacco products than to support other more visible interventions such as health warnings and school interventions. However, we believe various measures are likely to have synergistic effects and a comprehensive approach, including more than just one measure, is likely to be most effective. This is particularly relevant because adolescents, young people, and smokers are often exposed to a plethora of policies and interventions. Therefore, it can be difficult to detangle the effectiveness of a single measure. Each intervention and policy may be complemented by another [51].

5. Strengths and limitations

This overview has several strengths and limitations that should be acknowledged. This overview of systematic reviews and meta-analyses used rigorous and transparent methods throughout the entire process. It was guided by a protocol reviewed by a research team with expertise in knowledge synthesis and overview reviews. Therefore, the main strength of this review includes the use of a comprehensive and rigorous methodology including a broad search strategy, extraction of data and risk of bias and quality by three independent reviewers. Another strength is that many of the reviews (n = 7) included in our study were Cochrane Reviews, which are considered to be methodologically rigorous and of high quality [52]. Furthermore, prioritizing systematic reviews allowed a large amount of research evidence to be synthesized covering a wide variety of strategies, while at the same time narrowing it down to a particular focus group. Nevertheless, this umbrella review has some limitations. First, searches were restricted to the three databases and some (unpublished) systematic reviews and meta-analyses may have been missed. Second, the validity of our results depends on the quality of primary studies included in the systematic review. There are undoubtedly limitations in the evidence base of primary studies, and most review authors report on the low quality and high risk of bias in primary studies. If the raw material is flawed, then the conclusions of a systematic review cannot be fully trusted [53]. Many systematic reviews and meta-analyses relied

on RCTs and non-RCTs, which were often judged to be at unclear or even high risk of bias. Some authors, for instance, highlighted that studies were at risk of multiple biases such as attrition bias or selection bias [18,22]. Therefore, the results should be interpreted with caution since less rigorous studies might be biased towards overestimating or underestimating true intervention effects [54]. Third, an inherent limitation of the 'review of reviews' approach is that the most recent primary studies are not included. Fourth, an overall challenge in dealing with a diverse public health evidence base is the need to incorporate considerable heterogeneity in intervention, study design, and appropriateness of that design, study quality and study outcomes [55]. Fifth, there was only insufficient data to compare the impact of interventions in different risk groups (e.g. certain ethnicities). However, it is possible that the effectiveness of policies and interventions differs among particular risk groups. Therefore, further research evaluating the effectiveness of tobacco control interventions and policies among varying populations from different socioeconomic and ethnic backgrounds is required.

6. Conclusions

This overview of systematic reviews and meta-analyses provides a summary of current research evidence on the effectiveness of tobacco control measures in adolescents and young people. The quality of systematic reviews and meta-analyses varied from critically low to high, which makes the judgement about the effectiveness of health promotion strategies and policies difficult. Promising strategies to prevent or reduce the tobacco demand include price increases, complex family-based interventions, and complex school educational programs combining social competence and social influence approaches. However, further and methodologically rigorous studies investigating the effect of smoking policies, strategies and interventions are needed in order to resolve remaining uncertainties. A combination of more than just one approach might be most effective. Finally, it is a key responsibility of all stakeholders to work together, to protect young individuals from tobacco smoke and tobacco consumption and to protect them against threats to their fundamental right – the right to the highest attainable standard of health.

Funding

This research was carried out within the Joint Action “Cancer Control”, Co-funded by the Health Programme of the European Union.

Declaration of interest

None.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.healthpol.2019.02.009>.

References

- [1] Wilson LM, Avila Tang E, Chander G, Hutton HE, Odelola OA, Elf JL, et al. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review. *International Journal of Environmental Research and Public Health* 2012;2012:961724, <http://dx.doi.org/10.1155/2012/961724>.
- [2] World Health Organization. *WHO framework convention on tobacco control*; 2003.
- [3] Council Directive 2014/40/EU. *Directive 2014/40/EU of the European parliament and of the council*; 2014.
- [4] Mannocci A, Antici D, Boccia A, La Torre G. Impact of cigarette packages warning labels in relation to tobacco-smoking dependence and motivation to quit. *Epidemiology and Preventive* 2012;36:100–7.
- [5] Sherman EJ, Primack BA. What works to prevent adolescent smoking? A systematic review of the national cancer institute's research-tested intervention programs. *Journal of School Health* 2009;79:391–9, <http://dx.doi.org/10.1111/j.1746-1561.2009.00426.x>.
- [6] Harvey J, Chadi N. Canadian paediatric society, adolescent health committee. *preventing smoking in children and adolescents: recommendations for practice and policy*. *Paediatrics & Child Health* 2016;21:209–21.
- [7] Lemmens V, Oenema A, Knut IK, Brug J. Effectiveness of smoking cessation interventions among adults: a systematic review of reviews. *European Journal of Cancer Prevention* 2008;17:535–44, <http://dx.doi.org/10.1097/CEJ.0b013e3282f75e48>.
- [8] Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Journal of Clinical Epidemiology* 2009;62:e1–34, <http://dx.doi.org/10.1016/j.jclinepi.2009.06.006>.
- [9] Aromataris E, Fernandez R, Godfrey CM, Holly C, Khalil H, Tungpunkom P. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. *The International Journal of Evidence-Based Healthcare* 2015;13:132–40, <http://dx.doi.org/10.1097/XEB.0000000000000055>.
- [10] Fanshawe TR, Halliwell W, Lindson N, Aveyard P, Livingstone-Banks J, Hartmann-Boyce J. Tobacco cessation interventions for young people. *The Cochrane Database of Systematic Reviews* 2017, <http://dx.doi.org/10.1002/14651858.CD003289.pub6>.
- [11] Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ* 2017;358:j4008.
- [12] Allen JA, Duke JC, Davis KC, Kim AE, Nonnemaker JM, Farrelly MC. Using mass media campaigns to reduce youth tobacco use: a review. *The American Journal of Health Promotion* 2015;30:e71–82, <http://dx.doi.org/10.4278/ajhp.130510-LIT-237>.
- [13] Bader P, Boisclair D, Ferrence R. Effects of tobacco taxation and pricing on smoking behavior in high risk populations: a knowledge synthesis. *International Journal of Environmental Research and Public Health* 2011;8:4118–39, <http://dx.doi.org/10.3390/ijerph8114118>.
- [14] Carson-Chahhoud Kristin V, Ameer F, Sayehmiri K, Hnin K, van Agteren Joseph EM, Sayehmiri F, et al. *Mass media interventions for preventing smoking in young people*. John Wiley & Sons, Ltd; 2017.
- [15] Coppo A, Galanti MR, Giordano L, Buscemi D, Bremberg S, Faggiano F. School policies for preventing smoking among young people. *The Cochrane Database of Systematic Reviews* 2014:CD009990, <http://dx.doi.org/10.1002/14651858.CD009990.pub2>.
- [16] Galanti MR, Coppo A, Jonsson E, Bremberg S, Faggiano F. Anti-tobacco policy in schools: upcoming preventive strategy or prevention myth? A review of 31 studies. *Tobacco Control* 2014;23:295–301, <http://dx.doi.org/10.1136/tobaccocontrol-2012-050846>.
- [17] McKay AJ, Patel RKK, Majeed A. Strategies for tobacco control in India: a systematic review. *PLoS One* 2015;10, <http://dx.doi.org/10.1371/journal.pone.0122610>.
- [18] Hefler M, Liberato Selma C, Thomas David P. *Incentives for preventing smoking in children and adolescents*. John Wiley & Sons, Ltd; 2017.
- [19] Lupton D. *Health risk behavior*. Blackwell Encycl. Sociol. John Wiley & Sons, Ltd; 2007, <http://dx.doi.org/10.1002/9781405165518.wbeosh016>.
- [20] Macarthur GJ, Sean H, Deborah MC, Matthew H, Rona C. Peer-led interventions to prevent tobacco, alcohol and/or drug use among young people aged 11–21 years: a systematic review and meta-analysis. *Addiction* 2016;111:391–407, <http://dx.doi.org/10.1111/add.13224>.
- [21] Stanton A, Grimshaw G. Tobacco cessation interventions for young people. *The Cochrane Database of Systematic Reviews* 2013:CD003289, <http://dx.doi.org/10.1002/14651858.CD003289.pub5>.
- [22] Taylor GMJ, Dalili MN, Semwal M, Civljak M, Sheikh A, Car J. Internet-based interventions for smoking cessation. *The Cochrane Database of Systematic Reviews* 2017;9:CD007078, <http://dx.doi.org/10.1002/14651858.CD007078.pub5>.
- [23] Thomas RE, Baker PRA, Thomas BC, Lorenzetti DL. Family-based programmes for preventing smoking by children and adolescents. *The Cochrane Database of Systematic Reviews* 2015:CD004493, <http://dx.doi.org/10.1002/14651858.CD004493.pub3>.
- [24] Thomas RE, McLellan J, Perera R. School-based programmes for preventing smoking. *The Cochrane Database of Systematic Reviews* 2013:CD001293, <http://dx.doi.org/10.1002/14651858.CD001293.pub3>.
- [25] Guindon GE, Paraje GR, Chaloupka FJ. The impact of prices and taxes on the use of tobacco products in latin america and the caribbean. *American Journal of Public Health* 2015;105:e9–19, <http://dx.doi.org/10.2105/AJPH.2014.302396>.
- [26] Robertson L, Cameron C, McGee R, Marsh L, Hoek J. Point-of-sale tobacco promotion and youth smoking: a meta-analysis. *Tobacco Control* 2016;25:e83–9, <http://dx.doi.org/10.1136/tobaccocontrol-2015-052586>.
- [27] Huang L-L, Baker HM, Meernik C, Ranney LM, Richardson A, Goldstein AO. Impact of non-menthol flavours in tobacco products on perceptions and use among youth, young adults and adults: a systematic review. *Tobacco Control* 2016, <http://dx.doi.org/10.1136/tobaccocontrol-2016-053196>.

- [28] Lupton JR, Townsend JL. A systematic review and meta-analysis of the acceptability and effectiveness of university smoke-free policies. *Journal of American College Health* 2015;63:238–47, <http://dx.doi.org/10.1080/07448481.2015.1015029>.
- [29] Seo D-C, Macy JT, Torabi MR, Middlestadt SE. The effect of a smoke-free campus policy on college students' smoking behaviors and attitudes. *Preventive Medicine* 2011;53:347–52, <http://dx.doi.org/10.1016/j.ypmed.2011.07.015>.
- [30] Patten CA, Croghan IT, Meis TM, Decker PA, Pingree S, Colligan RC, et al. Randomized clinical trial of an Internet-based versus brief office intervention for adolescent smoking cessation. *Patient Education and Counseling* 2006;64:249–58, <http://dx.doi.org/10.1016/j.pec.2006.03.001>.
- [31] Simmons VN, Heckman BW, Fink AC, Small BJ, Brandon TH. Efficacy of an experiential, dissonance-based smoking intervention for college students delivered via the internet. *Journal of Consulting and Clinical Psychology* 2013;81:810–20, <http://dx.doi.org/10.1037/a0032952>.
- [32] Woodruff SI, Conway TL, Edwards CC, Elliott SP, Crittenden J. Evaluation of an Internet virtual world chat room for adolescent smoking cessation. *Addictive Behaviors* 2007;32:1769–86, <http://dx.doi.org/10.1016/j.addbeh.2006.12.008>.
- [33] An LC, Klatt C, Perry CL, Lein EB, Hennrikus DJ, Pallonen UE, et al. The RealU online cessation intervention for college smokers: a randomized controlled trial. *Preventive Medicine* 2008;47:194–9, <http://dx.doi.org/10.1016/j.ypmed.2008.04.011>.
- [34] Grossman M, Chaloupka FJ. Cigarette taxes. *The straw to break the camel's back*. *Public Health Reports* 1997;112:290–7.
- [35] Ding A. Youth are more sensitive to price changes in cigarettes than adults. *Yale Journal of Biology and Medicine* 2003;76:115–24.
- [36] Lantz PM, Jacobson PD, Warner KE, Wasserman J, Pollack HA, Berson J, et al. Investing in youth tobacco control: a review of smoking prevention and control strategies. *Tobacco Control* 2000;9:47–63, <http://dx.doi.org/10.1136/tc.9.1.47>.
- [37] Perelman J, Alves J, Pfoertner T-K, Moor I, Federico B, Kuipers MAG, et al. The association between personal income and smoking among adolescents: a study in six European cities. *Addiction (Abingdon, England)* 2017;112:2248–56, <http://dx.doi.org/10.1111/add.13930>.
- [38] Chaloupka FJ, Hu T, Warner KE, Jacobs R, Yurekli A. The taxation of tobacco products. In: Jha P, Chaloupka F, editors. *Tob. Control Dev. Ctries*. University Press; 2000. p. 237–72.
- [39] Bala MM, Strzeszynski L, Topor-Madry R. Mass media interventions for smoking cessation in adults. *The Cochrane Database of Systematic Reviews* 2017;11:CD004704, <http://dx.doi.org/10.1002/14651858.CD004704.pub4>.
- [40] Sugden C, Phongsavan P, Gloede S, Filiaj S, Tongamana VO. Developing antitobacco mass media campaign messages in a low-resource setting: experience from the Kingdom of Tonga. *Tobacco Control* 2017;26:344–8, <http://dx.doi.org/10.1136/tobaccocontrol-2015-052755>.
- [41] Worden JK, Flynn BS. Using mass media to prevent cigarette smoking. *Public Health Commun. Evid. Behav. Change*. Lawrence Erlbaum Associates, Inc.; 2002.
- [42] Gutschoven K, Van den Bulck J. Television viewing and smoking volume in adolescent smokers: a cross-sectional study. *Preventive Medicine* 2004;39:1093–8, <http://dx.doi.org/10.1016/j.ypmed.2004.04.019>.
- [43] European Commission - PRESS RELEASES - Press release - 10 key changes for tobacco products sold in the EU; 2019, n.d. http://europa.eu/rapid/press-release_IP-16-1762_en.htm [Accessed 7 February 2018].
- [44] Courtemanche CJ, Palmer MK, Pesko MF. Influence of the flavored cigarette ban on adolescent tobacco use. *American Journal of Preventive Medicine* 2017;52:e139–46, <http://dx.doi.org/10.1016/j.amepre.2016.11.019>.
- [45] Pokorny SB, Jason LA, Schoeny ME. The relation of retail tobacco availability to initiation and continued smoking. *Journal of Clinical Child & Adolescent Psychology* 2003;32:193–204, http://dx.doi.org/10.1207/S15374424JCCP3202_4.
- [46] Kessel Schneider S, Buka SL, Dash K, Winickoff JP, O'Donnell L. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tobacco Control* 2016;25:355–9, <http://dx.doi.org/10.1136/tobaccocontrol-2014-052207>.
- [47] DiFranza JR, Savageau JA, Fletcher KE. Enforcement of underage sales laws as a predictor of daily smoking among adolescents: a national study. *BMC Public Health* 2009;9(107), <http://dx.doi.org/10.1186/1471-2458-9-107>.
- [48] Shang C, Huang J, Cheng K-W, Li Q, Chaloupka FJ. Global evidence on the association between POS advertising bans and youth smoking participation. *International Journal of Environmental Research and Public Health* 2016;13, <http://dx.doi.org/10.3390/ijerph13030306>.
- [49] Perry CL, Kelder SH, Murray DM, Klepp KI. Communitywide smoking prevention: long-term outcomes of the Minnesota Heart Health Program and the Class of 1989 Study. *American Journal of Public Health* 1992;82:1210–6.
- [50] Backinger CL, Fagan P, Matthews E, Grana R. Adolescent and young adult tobacco prevention and cessation: current status and future directions. *Tobacco Control* 2003;12(Suppl. 4):IV46–53.
- [51] Chapman S. Unravelling gossamer with boxing gloves: problems in explaining the decline in smoking. *BMJ* 1993;307:429–32.
- [52] Jadad AR, Cook DJ, Jones A, Klassen TP, Tugwell P, Moher M, et al. Methodology and reports of systematic reviews and meta-analyses: a comparison of Cochrane reviews with articles published in paper-based journals. *JAMA* 1998;280:278–80.
- [53] Jüni P, Altman DG, Egger M. Assessing the quality of controlled clinical trials. *BMJ* 2001;323:42–6.
- [54] Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011;343:d5928.
- [55] Thomas S, Fayter D, Misso K, Ogilvie D, Petticrew M, Sowden A, et al. Population tobacco control interventions and their effects on social inequalities in smoking: systematic review. *Tobacco Control* 2008;17:230–7, <http://dx.doi.org/10.1136/tc.2007.023911>.